HEALTH SCIENCE 300



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1: BASIC PRINCIPLES OF HEALTH EDUCATION

Basic Principles of Health Education

In this module, you will learn about the definition of health, health education, and health promotion. This will help you to understand then important components of health.

- **Physical**
- **Psychological**
- **Social**

Personal Views on Health

Think about your responses to the following questions:

- What does health mean to you?
- How important is health to you?
- What do you do (if anything) to stay healthy?

Definition and Concepts of Health

In the *Oxford English Dictionary* health is defined as: “the state of being free from sickness, injury, disease, bodily conditions; something indicating good bodily condition.”

Now stop for a minute and think about someone you think is healthy and someone else who you would consider not to be healthy.

- Look at the definition of health again.
- Is it similar to the what you thought about for a healthy or an unhealthy person?

This definition of health is a widely publicized one. But you may have thought of someone who has a disability or wondered about someone who looks OK but who you know does not exercise. Clearly health is not quite as simple as the definition implies.
The concept of health is wide, and the way we define health also depends on individual perception, religious beliefs, cultural values, norms, and social class. Generally, there are two different perspectives concerning people’s own definitions of health: a narrow perspective and a broader perspective.

1. Narrow Perspectives of Health

People with a narrow perspective consider health as the absence of disease, disability, or biological dysfunction. According to this view, to call someone unhealthy or sick means there should be evidence of a particular illness. Social, emotional, and psychological factors are not believed to cause unhealthy conditions. This view is narrow and limits the definition of health to the physical and physiological capabilities that are necessary to perform routine tasks.

According to this definition, the individual is healthy if all the body parts, cells, tissues, and organ systems are functioning well, and there is no apparent dysfunction of the body. Using this view, people view the human body in the same say as a computer or mechanical device. When something is wrong, the object is taken to experts who will maintain it. Hence, physicians often focus on treatment and clinical interventions with medication rather than health education to bring about behavior change.

Serena’s Story

- About two months ago Serena lost her six month old twins. She is grief stricken. She has always been slender, but now she looks very thin. She cannot sleep; she cannot eat, and she doesn’t want to talk to anyone.
- Do you think the view of health you have just read about applies to Serena?

This view of health ignores many of the social and psychological causes of ill health. Serena’s grief is not an illness, but it is certainly affecting her health.

2. Broader Perspectives of Health

In the previous section you read about a narrow definition of health. Now this section will help you understand the concept of health in a broader and more holistic way.

The most widely used broader definition of health is that within the constitution of the World Health Organization (1948), which defines health as: “Health is not only the absence of infirmity and disease but also a state of physical mental and social well-being.” This classic definition is important, as it identifies the vital components of health. To more fully understand the meaning of health, it is important to understand each of its individual components.

- Think back to Serena.
- Describe her state of health.
- Serena is mentally distressed. She does not by any means have mental and social well-being.

Physical Health

Physical health, which is one of the components of the definition of health, could be defined as the absence of diseases or disability of the body parts. Physical health could be defined as the ability to perform routine tasks without any physical restriction

To understand physical health, one needs to know what is considered to be physically unhealthy.

The following examples can help to understand someone who is physically unhealthy:

- A person who has been harmed due to a car accident
- A farmer infected by malaria and unable to do their farming duties
- A person infected by tuberculosis and unable to perform his or her tasks.

According to the WHO definition, do you see any of the above unhealthy examples as healthy? Also think about someone in your community who you would consider to be physically disabled.

While both of these people may be restricted in their movement and ability to do routine tasks, they may still be in a state of physical and mental well-being.

Psychological Health

Health is not limited to the biological integrity and the physiological functioning of the human body. Psychological health is also an important aspect of a health definition.

- Think about people in the community who are showing behavior that may indicate they are going through a period of mental distress in their lives.
- Or think about Serena again.
- Do you think that everyone in distress shows the same sorts of symptoms?

Sometimes it can be really difficult to tell if people are struggling with mental health issues, but at other times they may show symptoms that suggest a lack of self-awareness or personal identity, or an inability of rational and logical decision-making. At other times it might be apparent that they are not looking after themselves and are without a proper purpose in their lives. They may be drinking alcohol and have a non-logical response to any request. It may also be noticed that they have an inability to maintain their personal autonomy and are unable to maintain good relationships with people around them.

Social Health

The social component of health is considered to be the ability to make and maintain “acceptable” and “proper” interactions and to communicate with other people within the social environment. This component also includes being able to maintain satisfying interpersonal relationships and being able to fulfill a social role. Having a social role is the ability that people have to maintain their own identity while sharing, cooperating, communicating, and enjoying the company of others. This is really important when participating in friendships and taking a full part in family and community life.

Which of the following examples could be considered to contribute to social health? Explain and discuss your answers.

1. Mourning when a close family member dies
2. Going to a football game or involvement in a community meeting
3. Celebrating traditional cultural events within a community

4. Shopping in the market
5. Creating and maintaining friendships

In reality, all these events could have a social component and help towards building people's social view of health. They all involve interacting with others and gaining support, friendship, and in many instances joy from being with other people.

The World Health Organization said that health promotion is defined as the process of enabling people to increase control over, and to improve, their health. The aim of health promotion is to reduce the underlying causes of ill-health so that there is a long-term reduction in many diseases.

Summary

When broadly defined, health is a state of complete physical, mental, and social well being not merely the absence of disease or infirmity. It contains several different aspects which can include physical and mental health issues often interrelated. According to this definition, physical, social, and psychological factors all contribute to health. Wellness is then expressed through the integration of the physical, intellectual, emotional, spiritual, social, and environmental components called the Six Dimensions of Health.

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1.1: PROMOTING GOOD HEALTH

Learning Outcomes

By the end of this chapter you will be able to:

- Describe the Nine Dimensions of Wellness
- Identify positive actions you could take to increase your wellness in each of the dimensions.
- Employ the skills of Health Literacy
- Explain the leading causes of death along with the risk factors
- Utilize SMART goal setting and action planning for behavior change

Are you healthy?

What does being healthy mean to you?

Have you tried setting healthy New Years goals? Did it work?

Welcome to Health! I hope you enjoy learning this information. Please read the required chapters for each module, then use information from your reading in your discussion and reflection posts.

As you read this book, you will be taken on a learning journey that will continually ask you to reflect on your own life, your health, your wellness, your choices, and your behaviors. Health is a topic that impacts all of us, thus this learning journey is personal to you and your life experiences.

1.1.1: What does Health and Wellness mean?

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- 10.2: Reading- Flatworms by Michael J. Gregory, Ph.D is licensed CC BY-NC-SA 4.0.

1.1.1: What does Health and Wellness mean?

How have you used the word Health or Wellness in your communication with others? The terms Health and Wellness are often used interchangeably. What do they mean to you?

Activity: Healthy versus Unhealthy

What do you mean by healthy and unhealthy?

- Take a piece of paper and fold it in half.
- On one side of the paper write “healthy” and the other side write “unhealthy”
- Either make a list or draw pictures of what you consider healthy and unhealthy.

As you review the following information about the wellness, see if you have an opportunity to expand your list or drawings for aspects of health that may be missing from your list.

The World Health Organization (WHO) defines health as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (illness)” and defines wellness as “the optimal state of health of individuals and groups,[1]” which may be expressed as “a positive approach to living.” The National Wellness Institute[2], explains wellness as “an active process through which people become aware of, and make choices toward, a more successful existence.”

The National Wellness Institute states that there is general agreement that:

1. Wellness is considered a conscious, self-directed and evolving process of achieving full potential.
2. Wellness is multidimensional and holistic, encompassing lifestyle, mental and spiritual well-being, and the environment.
3. Wellness is positive and affirming.

The primary difference between health and wellness is that health is your state of being, or a goal to achieve, and wellness is the active process of achieving it through growth and change. Through wellness we hope to reach our fullest potential of health and well-being.

The Nine Dimensions of Wellness

Both health and wellness are very broad terms. To help identify ways we can grow and change to reach our optimal health, it is helpful to view wellness in terms of the Nine Dimensions of Wellness. The Nine Dimensions of Wellness can help to identify ways you can make wellness a part of your everyday life.

The Nine Dimensions of Wellness include: Physical, Emotional, Social, Environmental, Financial, Intellectual, Occupational, Spiritual, and Cultural. These dimensions of wellness are not isolated, but rather are interconnected. Problems or challenges in one dimension can impact the other, while the opposite can also be true, that by improving your health and wellness in one area can help to improve other dimensions. For example, your emotional wellness can be positively impacted through exercise (physical wellness) but negatively impacted by financial struggles that often lead to high stress.

Reflection Opportunity: My Wellness Ratings and Actions

As you read through the following Nine Dimensions of Wellness, give yourself a score from 1 (low) to 10 (high) for your level of wellness in each dimension. Along with your score, also record a list of possible behaviors you could change or actions you could take that would increase your wellness score for each dimension.

> For example:
>
> "For Physical Wellness I would give myself a score of [insert your score 1 being low] out of 10. I could increase this score by either changing or implementing the following two behaviors: [insert a behavior you could change or an action you could take] and [insert a behavior you could change or an action you could take]"

Physical Wellness

People who are focused on improving their physical health recognize the need for regular physical activity, they choose healthy foods, go to the doctor, and get adequate sleep. People who are physically well actively make healthy decisions on a daily basis. This may include making a habit of exercising three to five times per week or recording their dietary intake to ensure they are receiving proper nutrition for optional health.

How would you rate your physical wellness and what behaviors could you change, or actions could you take, to positively improve your physical wellness?

Emotional Wellness

Coping effectively with life and expressing emotions in an appropriate manner are keys to emotional wellness. An emotionally well person successfully expresses and manages an entire range of feelings, including anger, doubt, hope, joy, desire, fear, and many others. People who are emotionally well maintain a high level of self-esteem. They have a positive body-image and the ability to regulate their feelings. They know where to seek support and help regarding their mental health, including but not limited to, seeking professional counseling services.

How would you rate your emotional wellness and what behaviors could you change, or actions could you take, to positively improve your emotional wellness?

Social Wellness

People who are focused on their social wellness are striving for positive relationships, developing a sense of connection, belonging, and sustained support system. A socially well person builds healthy relationships based on interdependence, trust, and respect. Those who are socially well have a keen awareness of the feelings of others. They develop a network of friends and co-workers who share a common purpose, and who provide support and validation.

How would you rate your social wellness and what behaviors could you change, or actions could you take, to positively improve your social wellness?

Environmental Wellness

Environmental wellness includes a desire to positively impact our planet Earth and also our local community by striving to occupy pleasant, healthy, and safe environments that support well-being and positively impact the quality of our surroundings (including protecting and preserving nature). An environmentally well person appreciates the external cues and stimuli that an environment can provide . People who have achieved environmental wellness recognize the limits to controlling an environment and seek to understand the role an individual plays in the environment.

How would you rate your environmental wellness and what behaviors could you change, or actions could you take, to positively improve your environmental wellness?

Financial Wellness

Financial wellness refers to achieving satisfaction with current and future financial situations by handling finances wisely. Those who are financially well are fully aware of their current financial state. They set long- and short-term goals regarding finances that will allow them to reach their personal financial goals.

How would you rate your financial wellness and what behaviors could you change, or actions could you take, to positively improve

your financial wellness?

Intellectual Wellness

Intellectual wellness includes being open-minded, recognizing creative abilities, and/or finding ways to expand knowledge and skills. Those who enjoy intellectual wellness engage in lifelong learning. They seek knowledge and activities that further develop their critical thinking and heighten global awareness. They engage in activities associated with the arts, philosophy, and reasoning.

How would you rate your intellectual wellness and what behaviors could you change, or actions could you take, to positively improve your intellectual wellness?

Occupational Wellness

Occupational wellness refers to personal fulfillment and enrichment from one's work and/or responsibilities. An occupationally well person enjoys the pursuit of a career which is fulfilling on a variety of levels. This person finds satisfaction and enrichment in work, while always in pursuit of opportunities to reach the next level of professional success.

How would you rate your occupational wellness and what behaviors could you change, or actions could you take, to positively improve your occupational wellness?

Spiritual Wellness

Spiritual wellness refers to having a sense of purpose and meaning in life, this may come from establishing peace, harmony, and balance in our lives. People who can be described as spiritually well have identified a core set of beliefs that guide their decision making, and other faith- based endeavors. While firm in their spiritual beliefs, they understand others may have a distinctly different set of guiding principles. They recognize the relationship between spirituality and identity in all individuals.

How would you rate your spiritual wellness and what behaviors could you change, or actions could you take, to positively improve your spiritual wellness?

Cultural Wellness

Cultural wellness refers to the way you interact with others who are different from you. This includes understanding and celebrating our differences. Culturally well people are aware of their own cultural background, as well as the diversity and richness present in other cultural backgrounds. Cultural wellness implies understanding, awareness and intrinsic respect for aspects of diversity. A culturally well person acknowledges and accepts the impact of these aspects of diversity on sexual orientation, religion, gender, racial and ethnic backgrounds, age groups, and disabilities

How would you rate your cultural wellness and what behaviors could you change, or actions could you take, to positively improve your cultural wellness?

Check your Learning: The 9 Dimensions of Wellness

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1.2: Well-Being Concepts

Well-being Concepts

Well-being is a positive outcome that is meaningful for people and for many sectors of society because it shows that people perceive that their lives are going well. Good living conditions (e.g., housing, employment) are fundamental to well-being. Tracking these conditions is important. However, many indicators that measure living conditions fail to measure what people think and feel about their lives such as the quality of their relationships, their positive emotions and resilience, the realization of their potential, or their overall satisfaction with life—i.e., their "well-being." Well-being generally includes global judgments of life satisfaction and feelings ranging from depression to joy.

Why is well-being useful?

- Well-being integrates mental health (mind) and physical health (body) resulting in more holistic approaches to disease prevention and health promotion.
- Well-being is a valid population outcome measure beyond morbidity, mortality, and economic status that tells how people perceive their lives are going from their own perspective.
- Well-being is an outcome that is meaningful to the public.
- Results from cross-sectional, longitudinal, and experimental studies find that well-being is associated with:
    - Self-perceived health
    - Longevity
    - Healthy behaviors
    - Mental and physical illness
    - Social connectedness
    - Productivity
    - Factors in the physical and social environment

Measuring, tracking, and promoting well-being can be useful in disease prevention and health promotion. Well-being is associated with numerous health-, job-,family-,and economically-related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities.

How does well-being relate to health promotion?

Health is more than the absence of disease; it is a resource that allows people to realize their aspirations, satisfy their needs, and to cope with the environment in order to live a long, productive, and fruitful life. In this sense, health enables social, economic, and personal development fundamental to well-being. Health promotion is the process of enabling people to increase control over, and to improve their health. Environmental and social resources for health can include: peace, economic security, a stable ecosystem, and safe housing. Individual resources for health can include: physical activity, healthful diet, social ties, resiliency, positive emotions, and autonomy. Health promotion activities aimed at strengthening such individual, environmental, and social resources may ultimately improve well-being.

How is well-being defined?

There is no consensus around a single definition of well-being, but there is general agreement that at minimum, well-being includes the presence of positive emotions and moods (e.g., contentment, happiness), the absence of negative emotions (e.g., depression, anxiety), satisfaction with life, fulfillment and positive functioning, (e.g., feeling very healthy and full of energy). In simple terms, well-being can be described as judging life positively and feeling good. The following areas have been examined by different disciplines and include six of the dimensional wellness categories:

- Physical well-being
- Economic well-being
- Social well-being

- Development and activity
- Emotional well-being
- Psychological well-being
- Life satisfaction
- Domain specific satisfaction
- Engaging activities and work

What are some determinants of individual-level well-being?

There is no sole determinant of individual well-being, but in general, well-being is dependent upon good health, positive social relationships, and availability and access to basic resources (e.g., shelter, income). Life satisfaction is dependent more closely on the availability of basic needs being met (food, shelter, income) as well as access to modern conveniences (e.g., electricity). Pleasant emotions are more closely associated with having supportive relationships. Having supportive relationships is one of the strongest predictors of well-being, having a notably positive effect.

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1.3: Health Literacy

What is Health Literacy?

In the report, *Healthy People*, the U.S. Department of Health and Human Services included improved consumer health literacy and identified health literacy as an important component of health communication, medical product safety, and oral health. Health literacy is defined in *Healthy People* as: "The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions."

Health literacy includes the ability to understand instructions on prescription drug bottles, appointment slips, medical education brochures, doctor's directions and consent forms, and the ability to negotiate complex health care systems. Health literacy is not simply the ability to read. It requires a complex group of reading, listening, analytical, and decision-making skills, and the ability to apply these skills to health situations.

Health literacy varies by context and setting and is not necessarily related to years of education or general reading ability. A person who functions adequately at home or work may have marginal or inadequate literacy in a health care environment. With the move towards a more "consumer-centric" health care system as part of an overall effort to improve the quality of health care and to reduce health care costs, individuals need to take an even more active role in health care related decisions. To accomplish this people need strong health information skills.

Why Does Health Literacy Matter?

Every day, people confront situations that involve life-changing decisions about their health. These decisions are made in places such as grocery and drug stores, workplaces, playgrounds, doctors' offices, clinics and hospitals, and around the kitchen table. Obtaining, communicating, processing, and understanding health information and services are essential steps in making appropriate health decisions; however, research indicates that today's health information is presented in ways that are not usable by most adults. "Limited health literacy" occurs when people can't find and use the health information and services they need.

- Nearly 9 out of 10 adults have difficulty using the everyday health information that is routinely available in our healthcare facilities, retail outlets, media, and communities.
- Without clear information and an understanding of the information's importance, people are more likely to skip necessary medical tests, end up in the emergency room more often, and have a harder time managing chronic diseases like diabetes or high blood pressure.

Whom Does Health Literacy Affect?

People of all ages, races, incomes, and educational levels can find it difficult to obtain, communicate, process, and understand health information and services. Literacy skills are only a part of health literacy. Even people with strong reading and writing skills can face health literacy challenges when they are not familiar with medical terms or how their bodies work. They have to interpret or calculate numbers or risks that could have immediate effects on their health and safety. They are diagnosed with a serious illness and are scared or confused. They have health conditions that require complicated self-care. Every organization involved in health information and services needs its own health literacy plan to improve its organizational practices to help everyone of all ages.

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1.4: HEALTH WELLNESS

1.4: HEALTH WELLNESS

How have you used the word Health or Wellness in your communication with others? The terms Health and Wellness are often used interchangeably. What do they mean to you?

Activity: Healthy versus Unhealthy

What do you mean by healthy and unhealthy?

- Take a piece of paper and fold it in half.
- On one side of the paper write “healthy” and the other side write “unhealthy”
- Either make a list or draw pictures of what you consider healthy and unhealthy.

As you review the following information about the wellness, see if you have an opportunity to expand your list or drawings for aspects of health that may be missing from your list.

The World Health Organization (WHO) defines health as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (illness)” and defines wellness as “the optimal state of health of individuals and groups,[1]” which may be expressed as “a positive approach to living.” The National Wellness Institute[2], explains wellness as “an active process through which people become aware of, and make choices toward, a more successful existence.”

The National Wellness Institute states that there is general agreement that:

1. Wellness is considered a conscious, self-directed and evolving process of achieving full potential.
2. Wellness is multidimensional and holistic, encompassing lifestyle, mental and spiritual well-being, and the environment.
3. Wellness is positive and affirming.

The primary difference between health and wellness is that health is your state of being, or a goal to achieve, and wellness is the active process of achieving it through growth and change. Through wellness we hope to reach our fullest potential of health and well-being.

The Nine Dimensions of Wellness

Both health and wellness are very broad terms. To help identify ways we can grow and change to reach our optimal health, it is helpful to view wellness in terms of the Nine Dimensions of Wellness. The Nine Dimensions of Wellness can help to identify ways you can make wellness a part of your everyday life.

The Nine Dimensions of Wellness include: Physical, Emotional, Social, Environmental, Financial, Intellectual, Occupational, Spiritual, and Cultural. These dimensions of wellness are not isolated, but rather are interconnected. Problems or challenges in one dimension can impact the other, while the opposite can also be true, that by improving your health and wellness in one area can help to improve other dimensions. For example, your emotional wellness can be positively impacted through exercise (physical wellness) but negatively impacted by financial struggles that often lead to high stress.

Reflection Opportunity: My Wellness Ratings and Actions

As you read through the following Nine Dimensions of Wellness, give yourself a score from 1 (low) to 10 (high) for your level of wellness in each dimension. Along with your score, also record a list of possible behaviors you could change or actions you could take that would increase your wellness score for each dimension.

For example:

"For Physical Wellness I would give myself a score of [insert your score 1 being low] out of 10. I could increase this score by either changing or implementing the following two behaviors: [insert a behavior you could change or an action you could take] and [insert a behavior you could change or an action you could take]"

Physical Wellness

People who are focused on improving their physical health recognize the need for regular physical activity, they choose healthy foods, go to the doctor, and get adequate sleep. People who are physically well actively make healthy decisions on a daily basis. This may include making a habit of exercising three to five times per week or recording their dietary intake to ensure they are receiving proper nutrition for optional health.

How would you rate your physical wellness and what behaviors could you change, or actions could you take, to positively improve your physical wellness?

Emotional Wellness

Coping effectively with life and expressing emotions in an appropriate manner are keys to emotional wellness. An emotionally well person successfully expresses and manages an entire range of feelings, including anger, doubt, hope, joy, desire, fear, and many others. People who are emotionally well maintain a high level of self-esteem. They have a positive body-image and the ability to regulate their feelings. They know where to seek support and help regarding their mental health, including but not limited to, seeking professional counseling services.

How would you rate your emotional wellness and what behaviors could you change, or actions could you take, to positively improve your emotional wellness?

Social Wellness

People who are focused on their social wellness are striving for positive relationships, developing a sense of connection, belonging, and sustained support system. A socially well person builds healthy relationships based on interdependence, trust, and respect. Those who are socially well have a keen awareness of the feelings of others. They develop a network of friends and co-workers who share a common purpose, and who provide support and validation.

How would you rate your social wellness and what behaviors could you change, or actions could you take, to positively improve your social wellness?

Environmental Wellness

Environmental wellness includes a desire to positively impact our planet Earth and also our local community by striving to occupy pleasant, healthy, and safe environments that support well-being and positively impact the quality of our surroundings (including protecting and preserving nature). An environmentally well person appreciates the external cues and stimuli that an environment can provide . People who have achieved environmental wellness recognize the limits to controlling an environment and seek to understand the role an individual plays in the environment.

How would you rate your environmental wellness and what behaviors could you change, or actions could you take, to positively improve your environmental wellness?

Financial Wellness

Financial wellness refers to achieving satisfaction with current and future financial situations by handling finances wisely. Those who are financially well are fully aware of their current financial state. They set long- and short-term goals regarding finances that will allow them to reach their personal financial goals.

How would you rate your financial wellness and what behaviors could you change, or actions could you take, to positively improve your financial wellness?

Intellectual Wellness

Intellectual wellness includes being open-minded, recognizing creative abilities, and/or finding ways to expand knowledge and skills. Those who enjoy intellectual wellness engage in lifelong learning. They seek knowledge and activities that further develop their critical thinking and heighten global awareness. They engage in activities associated with the arts, philosophy, and reasoning.

How would you rate your intellectual wellness and what behaviors could you change, or actions could you take, to positively improve your intellectual wellness?

Occupational Wellness

Occupational wellness refers to personal fulfillment and enrichment from one's work and/or responsibilities. An occupationally well person enjoys the pursuit of a career which is fulfilling on a variety of levels. This person finds satisfaction and enrichment in work, while always in pursuit of opportunities to reach the next level of professional success.

How would you rate your occupational wellness and what behaviors could you change, or actions could you take, to positively improve your occupational wellness?

Spiritual Wellness

Spiritual wellness refers to having a sense of purpose and meaning in life, this may come from establishing peace, harmony, and balance in our lives. People who can be described as spiritually well have identified a core set of beliefs that guide their decision making, and other faith- based endeavors. While firm in their spiritual beliefs, they understand others may have a distinctly different set of guiding principles. They recognize the relationship between spirituality and identity in all individuals.

How would you rate your spiritual wellness and what behaviors could you change, or actions could you take, to positively improve your spiritual wellness?

Cultural Wellness

Cultural wellness refers to the way you interact with others who are different from you. This includes understanding and celebrating our differences. Culturally well people are aware of their own cultural background, as well as the diversity and richness present in other cultural backgrounds. Cultural wellness implies understanding, awareness and intrinsic respect for aspects of diversity. A culturally well person acknowledges and accepts the impact of these aspects of diversity on sexual orientation, religion, gender, racial and ethnic backgrounds, age groups, and disabilities

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1.4.1: INTRODUCTION TO HEALTH

In this section, readers will learn about the nature of health, health education, health promotion and related concepts. This will help to understand the social, psychological and physical components of health.

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Thuimbnail: Health is a critical aspect of human life. (CC BY-SA 2.0 Generic;Tulane Public Relations).

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1.4.1.1: Levels of Disease Prevention

Prevention includes a wide range of activities — known as “interventions” — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviors that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- Legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)
- Education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- Immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent re-injury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems.

Examples include:

- Regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- Daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- Suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- Cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- Support groups that allow members to share strategies for living well
- Vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

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1.4.1.2: Behavior Change and Goal Setting

Transtheoretical Model (Stages of Change)

The transtheoretical model of behavior change, developed by Prochaska and DiClemente, assesses an individual's readiness to implement a healthier behavior and provides insight into the decision making process that leads to action. For many people, changing or modifying a behavior that is unhealthy or potentially harmful can be quite challenging. Here are the stages that lead to behavior change:

- Precontemplation (Not Ready) – You are not intending to take action in the foreseeable future, and can be unaware that your behavior is problematic
- Contemplation (Getting Ready) – You are beginning to recognize that your behavior is problematic, and start to look at the pros and cons of your continued actions
- Preparation (Ready) – You are intending to take action in the immediate future, and may begin taking small steps toward behavior change
- Action – You are making actual changes to your problem behavior by incorporating healthy choices/behaviors into your life
- Maintenance – You have been able to sustain action for at least six months and are working to prevent relapse into previous unhealthy behaviors

Stage 1: Precontemplation (not ready)

People at this stage do not intend to start the healthy behavior in the near future (within 6 months), and may be unaware of the need to change. People here learn more about healthy behavior: they are encouraged to think about the pros of changing their behavior and to feel emotions about the effects of their negative behavior on others.

Precontemplators typically underestimate the pros of changing, overestimate the cons, and often are not aware of making such mistakes.

One of the most effective steps that others can help with at this stage is to encourage them to become more mindful of their decision-making and more conscious of the multiple benefits of changing an unhealthy behavior.

Stage 2: Contemplation (getting ready)

At this stage, participants are intending to start the healthy behavior within the next 6 months. While they are usually now more aware of the pros of changing, their cons are about equal to their Pros. This ambivalence about changing can cause them to keep putting off taking action. People here learn about the kind of person they could be if they changed their behavior and learn more from people who behave in healthy ways.

Others can influence and help effectively at this stage by encouraging them to work at reducing the cons of changing their behavior.

Stage 3: Preparation (ready)

People at this stage are ready to start taking action within the next 30 days. They take small steps that they believe can help them make the healthy behavior a part of their lives. For example, they tell their friends and family that they want to change their behavior.

People in this stage should be encouraged to seek support from friends they trust, tell people about their plan to change the way they act, and think about how they would feel if they behaved in a healthier way. Their number one concern is: when they act, will they fail? They learn that the better prepared they are, the more likely they are to keep progressing.

Stage 4: Action (current action)

People at this stage have changed their behavior within the last 6 months and need to work hard to keep moving ahead. These participants need to learn how to strengthen their commitments to change and to fight urges to slip back. People in this stage progress by being taught techniques for keeping up their commitments such as substituting activities related to the unhealthy behavior with positive ones, rewarding themselves for taking steps toward changing, and avoiding people and situations that

tempt them to behave in unhealthy ways.

Stage 5: Maintenance (monitoring)

People at this stage changed their behavior more than 6 months ago. It is important for people in this stage to be aware of situations that may tempt them to slip back into doing the unhealthy behavior—particularly stressful situations. It is recommended that people in this stage seek support from and talk with people whom they trust, spend time with people who behave in healthy ways, and remember to engage in healthy activities to cope with stress instead of relying on unhealthy behavior.

Relapse (recycling):

Relapse in the TTM specifically applies to individuals who successfully quit smoking or using drugs or alcohol, only to resume these unhealthy behaviors. Individuals who attempt to quit highly addictive behaviors such as drug, alcohol, and tobacco use are at particularly high risk of a relapse. Achieving a long-term behavior change often requires ongoing support from family members, a health coach, a physician, or another motivational source. Supportive literature and other resources can also be helpful to avoid a relapse from happening.

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1.4.1.3: SMART Goal Setting



Figure 1.4.1.3.1 SMART Acronym

Have you ever said to yourself that you need to "eat healthier" or "exercise more" to improve your overall health? How well did that work for you? In most cases, probably not very well. That's because these statements are too vague and do not give us any direction for what truly needs to be done to achieve such goals. To have a better chance at being successful, try using the SMART acronym for setting your goals (S= Specific, M= Measurable, A=Attainable, R= Realistic, T= Time-oriented):

Specific – Create a goal that has a focused and clear path for what you actually need to do.

Examples:

- I will drink 8 ounces of water 3 times per day
- I will walk briskly for 30 minutes, 5 times per week
- I will reduce my soda intake to no more than 2 cans of soda per week

Do you see how that is more helpful than just saying you will eat healthier or exercise more? It gives you direction.

Measurable – This enables you to track your progress, and ties in with the "specific" component. The above examples all have actual numbers associated with the behavior change that let you know whether or not it has been met.

Attainable – Make sure that your goal is within your capabilities and not too far out of reach. For example, if you have not been physically active for a number of years, it would be highly unlikely that you would be able to achieve a goal of running a marathon within the next month.

Realistic – Try to ensure that your goal is something you will be able to continue doing and incorporate as part of your regular routine/lifestyle. For example, if you made a goal to kayak 2 times each week, but don't have the financial resources to purchase or rent the equipment, no way to transport it, or are not close enough to a body of water in which to partake in kayaking, then this is not going to be feasible.

Time-oriented – Give yourself a target date or deadline in which the goal needs to be met. This will keep you on track and motivated to reach the goal, while also evaluating your progress.

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1.4.1.4: Definition and Concepts of Health

In the Oxford English Dictionary health is defined as: "the state of being free from sickness, injury, disease, bodily conditions; something indicating good bodily condition." Clearly, health is not quite as simple as the definition implies. The concept of health is wide and the way we define health also depends on individual perception, religious beliefs, cultural values, norms, and social class. Generally, there are two different perspectives concerning people's own definitions of health: a narrow perspective and a broader perspective.

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1.4.1.5: Narrow Perspectives of Health

People with a narrow perspective consider health as the absence of disease or disability or biological dysfunction. According to this view (or model), to call someone unhealthy or sick means there should be evidence of a particular illness. Social, emotional and psychological factors are not believed to cause unhealthy conditions. This model is narrow and limits the definition of health to the physical and physiological capabilities that are necessary to perform routine tasks.

According to this definition, the individual is healthy if all the body parts, cells, tissues and organ systems are functioning well and there is no apparent dysfunction of the body. Using this model people view the human body in the same terms as a computer, or mechanical device, when something is wrong you take it to experts who maintain it. Physicians, unlike behavioral experts, often focus on treatment and clinical interventions with medication rather than educational interventions to bring about behavior change.

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1.4.1.6: Broader Perspectives of Health

The most widely used of the broader definitions of health is that within the constitution of the World Health Organization (WHO), which defines health as: A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. This classic definition is important, as it identifies the vital components of health.

Well-being includes the presence of positive emotions and moods (e.g., contentment, happiness), the absence of negative emotions (e.g., depression, anxiety), satisfaction with life, fulfillment and positive functioning. In simple terms, well-being can be described as judging life positively and feeling good. Well-being is associated with numerous health-, job-, family-, and economically related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities.

Many practitioners have expanded their focus to include wellness at the positive end of the health continuum. Wellness is being in good physical and mental health. Because mental health and physical health are linked, problems in one area can impact the other. At the same time, improving your physical health can also benefit your mental health, and vice versa. It is important to make healthy choices for both your physical and mental well-being. Remember that wellness is not just the absence of illness or stress. One can still strive for wellness even if he/she is experiencing these challenges in life.

To more fully understand the meaning of health, it is important to understand each of its individual components.

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1.4.1.7: The Six Dimensions of Health

1. **Physical**

Body size and functioning; recognizing the need for physical activity, healthy foods, and adequate sleep; avoiding unhealthy habits

2. **Social**

Developing a sense of connection, belonging, and sustained support system; having positive relationships

3. **Intellectual**

Recognizing creative abilities and finding ways to expand knowledge and skills; being open-minded

4. **Emotional**

Coping effectively with life and expressing emotions in an appropriate manner

5. **Spiritual**

Having a sense of purpose and meaning in life; establishing peace, harmony, and balance in our lives

6. **Environmental**

Occupying pleasant, healthy, and safe environments that support wellbeing; positively impacting the quality of our surroundings (including protecting and preserving nature)

Learning about the Six Dimensions of Health can help a person choose how to make wellness a part of everyday life. Wellness strategies are practical ways to start developing healthy habits that can have a positive impact on physical and mental health.

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1.4.1.8: Life Expectancy at Birth

Life expectancy is a measure often used to gauge the overall health of a population. Life expectancy at birth represents the average number of years that a group of infants would live if the group were to experience the age-specific death rates present in the year of birth. Differences in life expectancy among various demographic subpopulations, including racial and ethnic groups, may reflect differences in a range of factors such as socioeconomic status, access to medical care, and the prevalence of specific risk factors in a particular subpopulation.

During 1975–2015, life expectancy at birth in the United States increased from 68.8 to 76.3 years for males and from 76.6 to 81.2 years for females. During this period, life expectancy at birth for males and females was longer for white persons than for black persons. Racial disparities in life expectancy at birth persisted for both males and females in 2015, but continued to narrow.

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1.4.1.9: Leading Causes of Death

In 1975, the five leading causes of death were heart disease, cancer, stroke, unintentional injuries, and influenza and pneumonia. In 2015, the five leading causes of death were heart disease, cancer, chronic lower respiratory diseases, unintentional injuries, and stroke. Throughout 1975–2015, heart disease and cancer remained the top two leading causes of death.

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1.4.1.10: About Determinants of Health

The range of personal, social, economic, and environmental factors that influence health status are known as determinants of health.

What makes some people healthy and others unhealthy?

How can we create a society in which everyone has a chance to live a long, healthy life?

Determinants of health are factors that contribute to a person's current state of health. These factors may be biological, socioeconomic, psychosocial, behavioral, or social in nature. Scientists generally recognize five determinants of health of a population:

Healthy People 2020 is exploring these questions by:

- Developing objectives that address the relationship between health status and biology, individual behavior, health services, social factors, and policies.
- Emphasizing an ecological approach to disease prevention and health promotion. An ecological approach focuses on both individual-level and population-level determinants of health and interventions.
- Genes and biology: for example, sex and age
- Health behaviors: for example, alcohol use, injection drug use (needles), unprotected sex, and smoking
- Social environment or social characteristics: for example, discrimination, income, and gender
- Physical environment or total ecology: for example, where a person lives and crowding conditions
- Health services or medical care: for example, access to quality health care and having or not having insurance
- Other factors that could be included are culture, social status, and healthy child development.

Determinants of health fall under several broad categories:

Policymaking

Policies at the local, state, and federal level affect individual and population health. Increasing taxes on tobacco sales, for example, can improve population health by reducing the number of people using tobacco products. Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. For example, the 1966 Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the Federal Government to set and regulate standards for motor vehicles and highways. This led to an increase in safety standards for cars, including seat belts, which in turn reduced rates of injuries and deaths from motor vehicle accidents.

Social Factors:

Social determinants of health reflect the social factors and physical conditions of the environment in which people are born, live, learn, play, work, and age. Also known as social and physical determinants of health, they impact a wide range of health, functioning, and quality-of-life outcomes. Examples of social determinants include:

- Availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods
- Social norms and attitudes, such as discrimination
- Exposure to crime, violence, and social disorder, such as the presence of trash
- Social support and social interactions
- Exposure to mass media and emerging technologies, such as the Internet or cell phones
- Socioeconomic conditions, such as concentrated poverty
- Quality schools
- Transportation options
- Public safety
- Residential segregation

Examples of physical determinants include:

- Natural environment, such as plants, weather, or climate change

- Built environment, such as buildings or transportation
- Worksites, schools, and recreational settings
- Housing, homes, and neighborhoods
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities
- Aesthetic elements, such as good lighting, trees, or benches

Poor health outcomes are often made worse by the interaction between individuals and their social and physical environment. For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with state and national averages. Poor air quality can worsen asthma symptoms, especially in children.

Both access to health services and the quality of health services can impact health. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas.

Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment.

Barriers to accessing health services include:

- Lack of availability
- High cost
- Lack of insurance coverage
- Limited language access

These barriers to accessing health services lead to:

- Unmet health needs
- Delays in receiving appropriate care
- Inability to get preventive services
- Hospitalizations that could have been prevented

Individual Behavior

Individual behavior also plays a role in health outcomes. For example, if an individual quits smoking, his or her risk of developing heart disease is greatly reduced.

Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country.

Examples of individual behavior determinants of health include:

- Diet
- Physical activity
- Alcohol, cigarette, and other drug use
- Hand washing

Some biological and genetic factors affect specific populations more than others. For example, older adults are biologically prone to being in poorer health then adolescents due to the physical and cognitive effects of aging.

Sickle cell disease is a common example of a genetic determinant of health. Sickle cell is a condition that people inherit when both parents carry the gene for sickle cell. The gene is most common in people with ancestors from West African countries, Mediterranean countries, South or Central American countries, Caribbean islands, India, and Saudi Arabia.

Examples of biological and genetic social determinants of health include:

- Age
- Sex
- HIV status
- Inherited conditions, such as sickle-cell anemia, hemophilia, and cystic fibrosis

- Carrying the BRCA1 or BRCA2 gene, which increases risk for breast and ovarian cancer
- Family history of heart disease

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1.4.1.11: Health Disparities

Although the term disparities is often interpreted to mean racial or ethnic disparities, many dimensions of disparity exist in the United States, particularly in health. If a health outcome is seen to a greater or lesser extent between populations, there is disparity. Race or ethnicity, sex, sexual identity, age, disability, socioeconomic status, and geographic location all contribute to an individual's ability to achieve good health. It is important to recognize the impact that social determinants have on health outcomes of specific populations. Healthy People strives to improve the health of all groups.

To better understand the context of disparities, it is important to understand more about the U.S. population. In 2008, the U.S. population was estimated at 304 million people.

- In 2008, approximately 33%, or more than 100 million people, identified themselves as belonging to a racial or ethnic minority population.
- In 2008, 51%, or 154 million people, were women.
- In 2008, approximately 12%, or 36 million people not living in nursing homes or other residential care facilities, had a disability.
- In 2008, an estimated 70.5 million people lived in rural areas (23% of the population), while roughly 233.5 million people lived in urban areas (77%).
- In 2002, an estimated 4% of the U.S. population ages 18 to 44 identified themselves as lesbian, gay, bisexual, or transgender.

During the past 2 decades, one of Healthy People's overarching goals has focused on disparities. In Healthy People 2000, it was to reduce health disparities among Americans. In Healthy People 2010, it was to eliminate, not just reduce, health disparities. In Healthy People 2020, that goal expanded even further: to achieve health equity, eliminate disparities, and improve the health of all groups.

Healthy People 2020 defines health equity as the "attainment of the highest level of health for all people. Achieving health equity requires valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices, and the elimination of health and health care disparities."

Healthy People 2020 defines a health disparity as "a particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage. Health disparities adversely affect groups of people who have systematically experienced greater obstacles to health based on their racial or ethnic group; religion; socioeconomic status; gender; age; mental health; cognitive, sensory, or physical disability; sexual orientation or gender identity; geographic location; or other characteristics historically linked to discrimination or exclusion."

Over the years, efforts to eliminate disparities and achieve health equity have focused primarily on diseases or illnesses and on health care services. However, the absence of disease does not automatically equate to good health. Powerful, complex relationships exist between health and biology, genetics, and individual behavior, and between health and health services, socioeconomic status, the physical environment, discrimination, racism, literacy levels, and legislative policies. These factors, which influence an individual or population's health, are known as determinants of health.

For all Americans, other influences on health include the availability of and access to:

- High-quality education
- Nutritious food
- Decent and safe housing
- Affordable, reliable public transportation
- Culturally sensitive health care providers
- Health insurance
- Clean water and non-polluted air

Throughout the next decade, Healthy People 2020 will assess health disparities in the U.S. population by tracking rates of illness, death, chronic conditions, behaviors, and other types of outcomes in relation to demographic factors including:

- Race and ethnicity

- Gender
- Sexual identity and orientation
- Disability status or special health care needs
- Geographic location (rural and urban)

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1.4.1.12: Risk Factors and Levels of Disease Prevention

What is a Risk Factor?

Part of learning how to take charge of one's health requires understanding risk factors for different diseases. Risk factors are things in life that increase your chances of getting a certain disease. Some risk factors are beyond your control. A person may be born with them or have exposure with no fault assigned.

Some risk factors that you have little or no control over include:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some controllable risk factors include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs

In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

A person can have one risk factor for a disease or he/she can have many. The more risk factors a person has, the more likely he/she will get the disease. For example, if people eat healthy, exercise on a regular basis, and control blood pressure, their chances of getting heart disease are less than those of diabetics, smokers, and sedentary people. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

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1.4.2: PSYCHOLOGICAL HEALTH

Psychological health is a level of psychological well-being or an absence of Psychological illness - the state of someone who is "functioning at a satisfactory level of emotional and behavioral adjustment". From the perspectives of positive psychology or of holism, Psychological health may include an individual's ability to enjoy life, and to create a balance between life activities and efforts to achieve psychological resilience. Psychological health includes "subjective well-being, perceived self-efficacy, autonomy, competence, inter-generational dependence, and self-actualization of one's intellectual and emotional potential, among others."

1.4.2.1: Intro to Psychological Health

1.4.2.2: Social Health

1.4.2.3: Developing and Protecting Individual Attributes

1.4.2.4: Supporting Families and Communities

1.4.2.5: Supporting Vulnerable Groups in Society

1.4.2.6: Mental Illness

1.4.2.7: Mood Disorders

1.4.2.8: Depression

1.4.2.9: Dysthymic Disorder

1.4.2.10: Bipolar Disorder

1.4.2.11: Factors That Influence Psychological Well-Being

1.4.2.12: Physiological Needs

1.4.2.13: The Causes of Depression (depressive disorders)

1.4.2.14: Treating Depression

1.4.2.15: Coping with Depression

1.4.2.16: 2.23 Anxiety Disorders

1.4.2.17: The Stigma of Mental Illness

1.4.2.18: Safety Needs

1.4.2.19: Social Belonging

1.4.2.20: Esteem

1.4.2.21: Self-Actualization

1.4.2.22: Self-Transcendence

1.4.2.23: Mental Health

1.4.2.24: Emotional Health

1.4.2.25: Spiritual Health

1.4.2.26: Managing Emotional and Mental Health

1.4.2.26.1: What is Mental Health?

1.4.2.26.2: Mental Illness

1.4.2.26.3: Challenges to our Mental Health

1.4.2.26.4: Mental Health Disorders

1.4.2.26.5: Developing and Protecting Individual Attributes

1.4.2.26.6: 2.11 Factors That Influence Psychological Well-Being
1.4.2.26.7: Mental Health - Risks, Causes, and Treatments
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1.4.2.26.9: Emotional and Mental Health- Optional Continued Learning

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1.4.2.1: Intro to Psychological Health

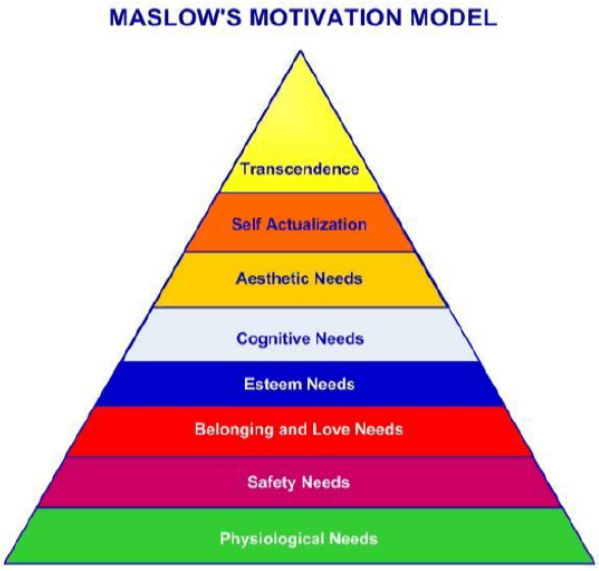


Figure 1.4.2.1.1 Maslow's Motivation Model

Maslow's hierarchy of needs is a theory in psychology proposed by Abraham Maslow in his 1943 paper "A Theory of Human Motivation" in Psychological Review. Maslow used the terms "physiological", "safety", "belonging" and "love", "esteem", "self-actualization", and "self-transcendence" to describe the pattern that human motivations generally move through. The goal of Maslow's Theory is to attain the sixth level of stage: self-transcendent needs.

Maslow's hierarchy of needs is often portrayed in the shape of a pyramid with the largest, most fundamental needs at the bottom and the need for self-actualization and self-transcendence at the top.

The most fundamental and basic four layers of the pyramid contain what Maslow called "deficiency needs" or "d-needs": esteem, friendship and love, security, and physical needs. If these "deficiency needs" are not met – with the exception of the most fundamental (physiological) need – there may not be a physical indication, but the individual will feel anxious and tense. Maslow's theory suggests that the most basic level of needs must be met before the individual will strongly desire (or focus motivation upon) the secondary or higher level needs.

The human brain is a complex system and has parallel processes running at the same time, thus many different motivations from various levels of Maslow's hierarchy can occur at the same time. Maslow spoke clearly about these levels and their satisfaction in terms such as "relative", "general", and "primarily". Instead of stating that the individual focuses on a certain need at any given time, Maslow stated that a certain need "dominates" the human organism. Thus Maslow acknowledged the likelihood that the different levels of motivation could occur at any time in the human mind, but he focused on identifying the basic types of motivation and the order in which they should be met.

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1.4.2.2: Social Health

The capacity for an individual to develop and flourish is deeply influenced by immediate social surroundings – including their opportunity to engage positively with family members, friends or colleagues, and earn a living for themselves and their families – and also by the socioeconomic circumstances in which said individual find himself/herself. Restricted or lost opportunities to gain an education and income are especially pertinent socio-economic factors.

Psychoneuroimmunology is defined as the examination of the interactions among psychological, behavioral, and social factors with immunological and neuroendocrine outcomes. It is now well established that psychological factors, especially chronic stress, can lead to impairments in immune system function in both the young and older adults. In several studies of older adults, those who are providing care for a relative with dementia report high levels of stress and exhibit significant impairments in immune system functioning when compared with non-caregivers. Stress-induced changes in the immune system may affect a number of outcomes, including slowing the wound healing process and increasing susceptibility to infections.

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1.4.2.3: Developing and Protecting Individual Attributes

At its core, mental health and well-being rests on the capacity of individuals to manage their thoughts, feelings and behavior, as well as their interactions with others. It is essential that these core attributes of self-control, resilience and confidence be allowed to develop and solidify in the formative stages of life, so that individuals are equipped to deal with the complex choices and potential adversities they will face as they grow older.

Alcohol, tobacco and drug use pose risks to mental and physical health, particularly among pregnant women and adolescents. Raising awareness about the health risks of substance use can be accompanied by implementation of a number of proven strategies for reducing their use, including fiscal measures (namely, increased excise taxes) and regulatory instruments (such as comprehensive restrictions on advertising, minimum age of use and restrictions on smoking in public places).

Maintaining a healthy diet and regular physical exercise are also protective factors for mental health and can be considered as part of a holistic approach to health promotion and protection in the population.

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1.4.2.4: Supporting Families and Communities

Individual-level mental health and well-being is strongly mediated by the immediate social context in which people live, work and carry out their day-to-day activities. The focus of family- and community-level attention is therefore to foster living and working conditions that enable psychosocial development (particularly among vulnerable persons) and promote positive interactions within and between families and social groups. Certain mental health promotion and protection strategies are targeted at specific groups, including: home-based interventions for socioeconomically disadvantaged families and for children with a mentally ill parent; prevention of intimate partner violence; school-based interventions for children and adolescents exhibiting emotional or behavioral problems; work-based interventions for adults looking for employment or struggling to cope at work; community-based interventions aimed at enhanced social participation of older adults; and psychosocial support for persons affected by conflict or disaster.

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1.4.2.5: Supporting Vulnerable Groups in Society

At the level of social and environmental determinants, key predictors of – and also consequences of – mental ill-health include lack of access to basic amenities and services, social exclusion, discrimination and exposure to violence, conflict or disasters. State-wide policy instruments that can address these failings and contribute towards social equality, inclusion and security include: anti-discrimination laws and campaigns; social protection for the poor; and elaboration of peaceful relations within and across national or ethnic boundaries.

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1.4.2.6: Mental Illness

We have all had some exposure to mental illness, but do we really understand it or know what it is? Many of our preconceptions are incorrect. A mental illness can be defined as a health condition that changes a person's thinking, feelings, or behavior (or all three) and that causes the person distress and difficulty in functioning. As with many diseases, mental illness is severe in some cases and mild in others. Individuals who have a mental illness don't necessarily look like they are sick, especially if their illness is mild. Other individuals may show more explicit symptoms such as confusion, agitation, or withdrawal.

Even if you or a family member has not experienced mental illness directly, it is very likely that you have known someone who has. Estimates are that at least one in four people is affected by mental illness either directly or indirectly.

Consider the following statistics to get an idea of just how widespread the effects of mental illness are in society:

- According to recent estimates, approximately 20 percent of Americans, or about one in five people over the age of 18, suffer from a diagnosable mental disorder in a given year.
- Four of the 10 leading causes of disability—major depression, bipolar disorder, schizophrenia, and obsessive-compulsive disorder—are mental illnesses.
- About 3 percent of the population have more than one mental illness at a time.
- About 5 percent of adults are affected so seriously by mental illness that it interferes with their ability to function in society. These severe and persistent mental illnesses include schizophrenia, bipolar disorder, other severe forms of depression, panic disorder, and obsessive-compulsive disorder.
- Approximately 20 percent of doctors' appointments are related to anxiety disorders such as panic attacks. Eight million people have depression each year.
- Two million Americans have schizophrenia disorders, and 300,000 new cases are diagnosed each year.

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1.4.2.7: Mood Disorders

Major mood disorders are depression, bipolar disorder, and dysthymic disorder. Like anxiety, depression might seem like something that everyone experiences at some point, and it is true that most people feel sad or “blue” at times in their lives. A true depressive episode, however, is more than just feeling sad for a short period. It is a long-term, debilitating illness that usually needs treatment to cure. And bipolar disorder is characterized by dramatic shifts in energy and mood, often affecting the individual’s ability to carry out day-to-day tasks. Bipolar disorder used to be called manic depression because of the way that people would swing between manic and depressive episodes.

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1.4.2.8: Depression

Depression, or depressive disorders, is a leading cause of disability in the United States as well as worldwide. It affects an estimated 9.5 percent of American adults in a given year. Nearly twice as many women as men have depression. Depression is more than just being in a bad mood or feeling sad. Everyone experiences these feelings on occasion, but that does not constitute depression. Depression is actually not a single disease; there are three main types of depressive disorders. They are major depressive disorder, dysthymia, and bipolar disorder (manic-depression).

While some of the symptoms of depression are common during a passing “blue mood,” major depressive disorder is diagnosed when a person has five or more of the symptoms nearly every day during a two-week period. Symptoms of depression include a sad mood, a loss of interest in activities that one used to enjoy, a change in appetite or weight, oversleeping or difficulty sleeping, physical slowing or agitation, energy loss, feelings of worthlessness or inappropriate guilt, difficulty concentrating, and recurrent thoughts of death or suicide.

When people have depression, their lives are affected severely: they have trouble performing at work or school, and they aren’t interested in normal family and social activities. In adults, an untreated major depressive episode lasts an average of nine months. At least half of the people who experience an episode of major depression will have another episode of depression at some point.

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1.4.2.9: Dysthymic Disorder

Dysthymia is less severe than major depressive disorder, but it is more chronic. In dysthymia, a depressed mood along with at least two other symptoms of depression persist for at least two years in adults, or one year in children or adolescents. These symptoms may not be as disabling, but they do keep affected people from functioning well or feeling good. Dysthymia often begins in childhood, adolescence, or early adulthood. On average, untreated dysthymia lasts four years in children and adolescents.

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1.4.2.10: Bipolar Disorder

A third type of depressive disorder is bipolar disorder, also called manic-depression. A person who has bipolar disorder alternates between episodes of major depression and mania (periods of abnormally and persistently elevated mood or irritability). During manic periods, the person will also have three or more of the following symptoms: overly inflated self-esteem, decreased need for sleep, increased talkativeness, racing thoughts, distractibility, increased goal-directed activity or physical agitation, and excessive involvement in pleasurable activities that have a high potential for painful consequences.

While in a manic phase, adolescents may engage in risky or reckless behaviors such as fast driving and unsafe sex. Bipolar disorder frequently begins during adolescence or young adulthood. Adults with bipolar disorder often have clearly defined episodes of mania and depression, with periods of mania every two to four years.

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1.4.2.11: Factors That Influence Psychological Well-Being

Infancy and Early Childhood

There is a strong body of evidence to show the importance of attachment by neonates to their mothers or other primary caregivers for subsequent social and emotional development. Separation from the primary caregiver - due for example to parental absence or rejection - leads to anxiety, stress and insecurity. Post-natal depression among new mothers can likewise contribute to sub-optimal attachment and development. Parents who have difficulties in bonding, have limited skills or exhibit negative attitudes place their children at increased risk of exposure to stress and behavioral problems. Other important risks to physical and cognitive development in infancy and early childhood include maltreatment and neglect (by parents and other caregivers), malnutrition and infectious or parasitic diseases.

Individual attributes and behaviors

These relate to a person's innate and learned ability to deal with thoughts and feelings and to manage him/herself in daily life ('emotional intelligence'). It is also the capacity to deal with the social world around by partaking in social activities, taking responsibilities or respecting the views of others ('social intelligence'). An individual's mental health state can also be influenced by genetic and biological factors; that is, determinants that persons are born or endowed with, including chromosomal abnormalities (e.g. Down's syndrome) and intellectual disability caused by prenatal exposure to alcohol or oxygen deprivation at birth.

Social and economic circumstances

The capacity for people to develop and flourish is deeply influenced by their immediate social surroundings – including their opportunity to engage positively with family members, friends or colleagues, and earn a living for themselves and their families – and also by the socioeconomic circumstances in which they find themselves. Restricted or lost opportunities to gain an education and income are especially pertinent socio-economic factors.

Environmental factors

The wider sociocultural and geopolitical environment in which people live can also affect an individual's, household's or community's mental health status, including levels of access to basic commodities and services (water, essential health services, the rule of law), exposure to predominating cultural beliefs, attitudes or practices, as well as by social and economic policies formed at the national level; for example, the on-going global financial crisis is expected to have significant mental health consequences, including increased rates of suicide and harmful alcohol use. Discrimination, social or gender inequality and conflict are examples of adverse structural determinants of mental well-being.

Personality

Personality measures turn out to be good predictors of your health, your sexual promiscuity, your likelihood of divorce, how happy you typically are—even your taste in paintings. Personality is a much better predictor of these things than social class or age. The origin of these differences is in part innate. That is to say, when people are adopted at birth and brought up by new families, their personalities are more similar to their blood relatives than to the ones they grew up with. The differences begin to emerge early in life and are surprisingly stable across the decades. This is not to say that people cannot change, but major change is the exception rather than the rule. Personality differences tend to manifest themselves through the quick, gut-feeling, intuitive, and emotional systems of thehuman mind. The slower, rational, deliberate systems show less variation in output from person to person. Deliberate rational strategies can be used to over-ride intuitive patterns of response, and this is how people wishing to change their personalities or feelings have to go about it.

So what are the major ways personalities can differ? The dominant approach is to think of the space of possible personalities as being defined by a number of dimensions. Each person can be given a location in the space by their scores on all the different

dimensions. Virtually all theories agree on two of the main dimensions, though they differ on how many additional ones they recognize.

Five factors

- Openness to experience: (inventive/curious vs. consistent/cautious). Appreciation for art, emotion, adventure, unusual ideas, curiosity, and variety of experience. Openness reflects the degree of intellectual curiosity, creativity and a preference for novelty and variety a person has. It is also described as the extent to which a person is imaginative or independent and depicts a personal preference for a variety of activities over a strict routine. High openness can be perceived as unpredictability or lack of focus. Moreover, individuals with high openness are said to pursue selfactualization specifically by seeking out in tense, euphoric experiences. Conversely, those with low openness seek to gain fulfillment through perseverance and are characterized as pragmatic and data-driven—sometimes even perceived to be dogmatic and closed-minded. Some disagreement remains about how to interpret and contextualize the openness factor.
- Conscientiousness: (efficient/organized vs. easy-going/careless). A tendency to be organized and dependable, show self-discipline, act dutifully, aim for achievement, and prefer planned rather than spontaneous behavior. High conscientiousness is often perceived as stubbornness and obsession. Low conscientiousness is associated with flexibility and spontaneity, but can also appear as sloppiness and lack of reliability.
- Extraversion: (outgoing/energetic vs. solitary/reserved). Energy, positive emotions, surgency, assertiveness, sociability and the tendency to seek stimulation in the company of others, and talkativeness. High extraversion is often perceived as attention-seeking, and domineering. Low extraversion causes a reserved, reflective personality, which can be perceived as aloof or self-absorbed.
- Agreeableness: (friendly/compassionate vs. challenging/detached). A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others. It is also a measure of one's trusting and helpful nature, and whether a person is generally well-tempered or not. High agreeableness is often seen as naive or submissive. Low agreeableness personalities are often competitive or challenging people, which can be seen as argumentativeness or untrustworthiness.
- Neuroticism: (sensitive/nervous vs. secure/confident). The tendency to experience unpleasant emotions easily, such as anger, anxiety, depression, and vulnerability. Neuroticism also refers to the degree of emotional stability and impulse control and is sometimes referred to by its low pole, "emotional stability". A high need for stability manifests itself as a stable and calm personality, but can be seen as uninspiring and unconcerned. A low need for stability causes a reactive and excitable personality, often very dynamic individuals, but they can be perceived as unstable or insecure.

Assess yourself! This is an interactive version of the IPIP Big-Five Factor Markers, a measure of the big five personality traits: Big 5 Personality Test

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1.4.2.12: Physiological Needs

Physiological needs are the physical requirements for human survival. If these requirements are not met, the human body cannot function properly and will ultimately fail. Physiological needs are thought to be the most important; they should be met first.

Air, water, and food are metabolic requirements for survival in all animals, including humans. Clothing and shelter provide necessary protection from the elements. While maintaining an adequate birth rate shapes the intensity of the human sexual instinct, sexual competition may also shape said instinct.

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1.4.2.13: The Causes of Depression (depressive disorders)

Depression, like other mental illnesses, is probably caused by a combination of biological, environmental, and social factors, but the exact causes are not yet known. For years, scientists thought that low levels of certain neurotransmitters (such as serotonin, dopamine, or norepinephrine) in the brain caused depression. However, scientists now believe that the interplay of factors leading to depression is much more complex. Genetic causes have been suggested from family studies that have shown that between 20 and 50 percent of children and adolescents with depression have a family history of depression and that children of depressed parents are more than three times as likely as children with nondepressed parents to experience a depressive disorder. Abnormal endocrine function, specifically of the hypothalamus or pituitary, may play a role in causing depression. Other risk factors for depressive disorders in youths include stress, cigarette smoking, loss of a parent, the breakup of a romantic relationship, attention disorders, learning disorders, abuse, neglect, and other trauma including experiencing a natural disaster.

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1.4.2.14: Treating Depression

A variety of antidepressant medications and psychotherapies are used to treat depression. The most effective treatment for most people is a combination of medication and psychotherapy. Many of us are aware that medications are available to treat depressive disorders—we see the ads on television and in magazines. Up to 70 percent of people with depression can be treated effectively with medication.

Medications used to treat depressive disorders usually act on the neurotransmission pathway. For example, some medications affect the activity of certain neurotransmitters, such as serotonin or norepinephrine. Different depressive disorders require different medication therapies. For example, individuals who have bipolar disorder are often treated with a mood-stabilizing drug, such as lithium, during their manic phase and a combination of mood-stabilizer and antidepressant medications during their depressive phase.

Medications usually lead to relief from the symptoms of depression within six to eight weeks. If one drug doesn't relieve symptoms, doctors can prescribe a different antidepressant drug. As with drugs to treat other mental illnesses, patients are monitored closely by their doctor for symptoms of depression and for side effects. Patients who continue to take their medication for at least six months after recovery from major depression are 70 percent less likely to experience a relapse. Psychotherapy helps patients learn more effective ways to deal with the problems in their lives. These therapies usually involve 6 to 20 weekly meetings. These treatment plans should be revised if there is no improvement of symptoms within three or four months.

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1.4.2.15: Coping with Depression

People who have depression (or another depressive disorder) feel exhausted, worthless, helpless, and hopeless. These negative thoughts and feelings that are part of depression make some people feel like giving up. As treatment takes effect, these thoughts begin to go away.

Some strategies that can help a person waiting for treatment to take effect include setting realistic goals in light of the depression and assuming a reasonable amount of responsibility; breaking large tasks into small ones, setting some priorities, and doing what one can as one can; trying to be with other people and to confide in someone—it is usually better than being alone and secretive; participating in activities that may make one feel better; getting some mild exercise, going to a movie or a ball game, or participating in religious, social, or other activities; expecting one's mood to improve gradually, not immediately (feeling better takes time); postponing important decisions until the depression has lifted and discussing big decisions with family or friends who have a more objective view of the situation; remembering that positive thinking will replace the negative thinking that is part of the depression as one's depression responds to treatment; and letting one's family and friends help.

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1.4.2.16: 2.23 Anxiety Disorders

Anxiety Disorders affect about 40 million American adults age 18 years and older (about 18%) in a given year, causing them to be filled with fearfulness and uncertainty. Unlike the relatively mild, brief anxiety caused by a stressful event (such as speaking in public or a first date), anxiety disorders last at least 6 months and can get worse if they are not treated.

Anxiety disorders commonly occur along with other mental or physical illnesses, including alcohol or substance abuse, which may mask anxiety symptoms or make them worse. In some cases, these other illnesses need to be treated before a person will respond to treatment for the anxiety disorder.

Panic Disorders

> "For me, a panic attack is almost a violent experience. I feel disconnected from reality. I feel like I'm losing control in a very extreme way. My heart pounds really hard, I feel like I can't get my breath, and there's an overwhelming feeling that things are crashing in on me."
>
> "It started 10 years ago, when I had just graduated from college and started a new job. I was sitting in a business seminar in a hotel and this thing came out of the blue. I felt like I was dying."
>
> "In between attacks there is this dread and anxiety that it's going to happen again. I'm afraid to go back to places where I've had an attack. Unless I get help, there soon won't be anyplace where I can go and feel safe from panic."

Panic disorder is a real illness that can be successfully treated. It is characterized by sudden attacks of terror, usually accompanied by a pounding heart, sweatiness, weakness, faintness, or dizziness. During these attacks, people with panic disorder may flush or feel chilled; their hands may tingle or feel numb; and they may experience nausea, chest pain, or smothering sensations. Panic attacks usually produce a sense of unreality, a fear of impending doom, or a fear of losing control.

A fear of one's own unexplained physical symptoms is also a symptom of panic disorder. People having panic attacks sometimes believe they are having heart attacks, losing their minds, or on the verge of death. They can't predict when or where an attack will occur, and between episodes many worry intensely and dread the next attack.

Panic attacks can occur at any time, even during sleep. An attack usually peaks within 10 minutes, but some symptoms may last much longer. Panic disorder affects about 6 million American adults and is twice as common in women as men. Panic attacks often begin in late adolescence or early adulthood, but not everyone who experiences panic attacks will develop panic disorder. Many people have just one attack and never have another. The tendency to develop panic attacks appears to be inherited.

Obsessive-Compulsive Disorder

> "I couldn't do anything without rituals. They invaded every aspect of my life. Counting really bogged me down. I would wash my hair three times as opposed to once because three was a good luck number and one wasn't. It took me longer to read because I'd count the lines in a paragraph. When I set my alarm at night, I had to set it to a number that wouldn't add up to a 'bad' number."
>
> "I knew the rituals didn't make sense, and I was deeply ashamed of them, but I couldn't seem to overcome them until I had therapy."
>
> "Getting dressed in the morning was tough, because I had a routine, and if I didn't follow the routine, I'd get anxious and would have to get dressed again. I always worried that if I didn't do something, my parents were going to die. I'd have these terrible thoughts of harming my parents. That was completely irrational, but the thoughts triggered more anxiety and more senseless behavior. Because of the time I spent on rituals, I was unable to do a lot of things that were important to me."

People with obsessive-compulsive disorder (OCD) have persistent, upsetting thoughts (obsessions) and use rituals (compulsions) to control the anxiety these thoughts produce. Most of the time, the rituals end up controlling them.

For example, if people are obsessed with germs or dirt, they may develop a compulsion to wash their hands over and over again. If they develop an obsession with intruders, they may lock and relock their doors many times before going to bed. Being afraid of social embarrassment may prompt people with OCD to comb their hair compulsively in front of a mirror-sometimes they get "caught" in the mirror and can't move away from it. Performing such rituals is not pleasurable. At best, it produces temporary relief from the anxiety created by obsessive thoughts.

Healthy people also have rituals, such as checking to see if the stove is off several times before leaving the house. The difference is that people with OCD perform their rituals even though doing so interferes with daily life and they find the repetition distressing. Although most adults with OCD recognize that what they are doing is senseless, some adults and most children may not realize that their behavior is out of the ordinary.

OCD affects about 2.2 million American adults, and the problem can be accompanied by eating disorders, other anxiety disorders, or depression. It strikes men and women in roughly equal numbers and usually appears in childhood, adolescence, or early adulthood. One-third of adults with OCD develop symptoms as children, and research indicates that OCD might run in families.

Post-Traumatic Stress Disorder

> "I was raped when I was 25 years old. For a long time, I spoke about the rape as though it was something that happened to someone else. I was very aware that it had happened to me, but there was just no feeling."
>
> "Then I started having flashbacks. They kind of came over me like a splash of water. I would be terrified. Suddenly I was reliving the rape. Every instant was startling. I wasn't aware of anything around me, I was in a bubble, just kind of floating. And it was scary. Having a flashback can wring you out."
>
> "The rape happened the week before Thanksgiving, and I can't believe the anxiety and fear I feel every year around the anniversary date. It's as though I've seen a werewolf. I can't relax, can't sleep, don't want to be with anyone. I wonder whether I'll ever be free of this terrible problem."

Post-traumatic stress disorder (PTSD) develops after a terrifying ordeal that involved physical harm or the threat of physical harm. The person who develops PTSD may have been the one who was harmed, the harm may have happened to a loved one, or the person may have witnessed a harmful event that happened to loved ones or strangers. PTSD was first brought to public attention in relation to war veterans, but it can result from a variety of traumatic incidents, such as mugging, rape, torture, being kidnapped or held captive, child abuse, car accidents, train wrecks, plane crashes, bombings, or natural disasters such as floods or earthquakes.

People with PTSD may startle easily, become emotionally numb (especially in relation to people with whom they used to be close), lose interest in things they used to enjoy, have trouble feeling affectionate, be irritable, become more aggressive, or even become violent. They avoid situations that remind them of the original incident, and anniversaries of the incident are often very difficult. PTSD symptoms seem to be worse if the event that triggered them was deliberately initiated by another person, as in a mugging or a kidnapping.

Most people with PTSD repeatedly relive the trauma in their thoughts during the day and in nightmares when they sleep. These are called flashbacks. Flashbacks may consist of images, sounds, smells, or feelings, and are often triggered by ordinary occurrences, such as a door slamming or a car backfiring on the street. A person having a flashback may lose touch with reality and believe that the traumatic incident is happening all over again.

Not every traumatized person develops full-blown or even minor PTSD. Symptoms usually begin within 3 months of the incident but occasionally emerge years afterward. They must last more than a month to be considered PTSD. The course of the illness varies. Some people recover within 6 months, while others have symptoms that last much longer. In some people, the condition becomes chronic.

PTSD affects about 7.7 million American adults, but it can occur at any age, including childhood. Women are more likely to develop PTSD than men, and there is some evidence that susceptibility to the disorder may run in families. PTSD is often accompanied by depression, substance abuse, or one or more of the other anxiety disorders.

Social Phobia (Social Anxiety Disorder)

> "In any social situation, I felt fear. I would be anxious before I even left the house, and it would escalate as I got closer

> to a college class, a party, or whatever. I would feel sick in my stomach-it almost felt like I had the flu. My heart would pound, my palms would get sweaty, and I would get this feeling of being removed from myself and from everybody else."
>
> "When I would walk into a room full of people, I'd turn red and it would feel like everybody's eyes were on me. I was embarrassed to stand off in a corner by myself, but I couldn't think of anything to say to anybody. It was humiliating. I felt so clumsy, I couldn't wait to get out."

Social phobia, also called social anxiety disorder, is diagnosed when people become overwhelmingly anxious and excessively self-conscious in everyday social situations. People with social phobia have an intense, persistent, and chronic fear of being watched and judged by others and of doing things that will embarrass them. They can worry for days or weeks before a dreaded situation. This fear may become so severe that it interferes with work, school, and other ordinary activities, and can make it hard to make and keep friends.

While many people with social phobia realize that their fears about being with people are excessive or unreasonable, they are unable to overcome them. Even if they manage to confront their fears and be around others, they are usually very anxious beforehand, are intensely uncomfortable throughout the encounter, and worry about how they were judged for hours afterward.

Social phobia can be limited to one situation (such as talking to people, eating or drinking, or writing on a blackboard in front of others) or may be so broad (such as in generalized social phobia) that the person experiences anxiety around almost anyone other than the family.

Physical symptoms that often accompany social phobia include blushing, profuse sweating, trembling, nausea, and difficulty talking. When these symptoms occur, people with social phobia feel as though all eyes are focused on them.

Social phobia affects about 15 million American adults. Women and men are equally likely to develop the disorder, which usually begins in childhood or early adolescence. There is some evidence that genetic factors are involved. Social phobia is often accompanied by other anxiety disorders or depression, and substance abuse may develop if people try to self-medicate their anxiety.

A specific phobia is an intense, irrational fear of something that poses little or no actual danger. Some of the more common specific phobias are centered around closed-in places, heights, escalators, tunnels, highway driving, water, flying, dogs, and injuries involving blood. Such phobias aren't just extreme fear; they are irrational fear of a particular thing. You may be able to ski the world's tallest mountains with ease but be unable to go above the 5th floor of an office building. While adults with phobias realize that these fears are irrational, they often find that facing, or even thinking about facing, the feared object or situation brings on a panic attack or severe anxiety.

Specific phobias affect an estimated 19.2 million adult Americans and are twice as common in women as men. They usually appear in childhood or adolescence and tend to persist into adulthood. The causes of specific phobias are not well understood, but there is some evidence that the tendency to develop them may run in families.

Generalized Anxiety Disorder (GAD)

> "I always thought I was just a worrier. I'd feel keyed up and unable to relax. At times it would come and go, and at times it would be constant. It could go on for days. I'd worry about what I was going to fix for a dinner party, or what would be a great present for somebody. I just couldn't let something go."
>
> "When my problems were at their worst, I'd miss work and feel just terrible about it. Then I worried that I'd lose my job. My life was miserable until I got treatment."
>
> "I'd have terrible sleeping problems. There were times I'd wake up wired in the middle of the night. I had trouble concentrating, even reading the newspaper or a novel. Sometimes I'd feel a little lightheaded. My heart would race or pound. And that would make me worry more. I was always imagining things were worse than they really were. When I got a stomachache, I'd think it was an ulcer."

People with generalized anxiety disorder (GAD) go through the day filled with exaggerated worry and tension, even though there is little or nothing to provoke it. They anticipate disaster and are overly concerned about health issues, money, family problems, or difficulties at work. Sometimes just the thought of getting through the day produces anxiety.

GAD is diagnosed when a person worries excessively about a variety of everyday problems for at least 6 months. People with GAD can't seem to get rid of their concerns, even though they usually realize that their anxiety is more intense than the situation warrants. They can't relax, startle easily, and have difficulty concentrating. Often they have trouble falling asleep or staying asleep. Physical symptoms that often accompany the anxiety include fatigue, headaches, muscle tension, muscle aches, difficulty swallowing, trembling, twitching, irritability, sweating, nausea, lightheadedness, having to go to the bathroom frequently, feeling out of breath, and hot flashes.

When their anxiety level is mild, people with GAD can function socially and hold down a job. Although they don't avoid certain situations as a result of their disorder, people with GAD can have difficulty carrying out the simplest daily activities if their anxiety is severe. GAD affects about 6.8 million American adults, including twice as many women as men. The disorder develops gradually and can begin at any point in the life cycle, although the years of highest risk are between childhood and middle age. There is evidence that genes play a modest role in GAD.

Other anxiety disorders, depression, or substance abuse often accompany GAD, which rarely occurs alone. GAD is commonly treated with medication or cognitive-behavioral therapy, but co-occurring conditions must also be treated using the appropriate therapies.

Treatment of Anxiety Disorders

In general, anxiety disorders are treated with medication, specific types of psychotherapy, or both. Treatment choices depend on the problem and the person's preference. Before treatment begins, a doctor must conduct a careful diagnostic evaluation to determine whether a person's symptoms are caused by an anxiety disorder or a physical problem. If an anxiety disorder is diagnosed, the type of disorder or the combination of disorders that are present must be identified, as well as any coexisting conditions, such as depression or substance abuse. Sometimes alcoholism, depression, or other coexisting conditions have such a strong effect on the individual that treating the anxiety disorder must wait until the coexisting conditions are brought under control.

People with anxiety disorders who have already received treatment should tell their current doctor about that treatment in detail. If they received medication, they should tell their doctor what medication was used, what the dosage was at the beginning of treatment, whether the dosage was increased or decreased while they were under treatment, what side effects occurred, and whether the treatment helped them become less anxious. If they received psychotherapy, they should describe the type of therapy, how often they attended sessions, and whether the therapy was useful.

Often people believe that they have "failed" at treatment or that the treatment didn't work for them when, in fact, it was not given for an adequate length of time or was administered incorrectly. Sometimes people must try several different treatments or combinations of treatment before they find the one that works for them.

Personality Disorders

Personality disorders are long-term patterns of thoughts and behaviors that cause serious problems with relationships and work. People with personality disorders have difficulty dealing with everyday stresses and problems. They often have stormy relationships with other people. The exact cause of personality disorders is unknown. However, genes and childhood experiences may play a role. Symptoms vary widely depending on the specific type of personality disorder. Treatment usually includes talk therapy and sometimes medicine.

Borderline Personality Disorder

Borderline personality disorder is a serious mental illness marked by unstable moods, behavior, and relationships. In 1980, the Diagnostic and Statistical Manual for Mental Disorders, Third Edition (DSM-III) listed borderline personality disorder as a diagnosable illness for the first time. Most psychiatrists and other mental health professionals use the DSM to diagnose mental illnesses. Because some people with severe borderline personality disorder have brief psychotic episodes, experts originally thought of this illness as atypical, or borderline, versions of other mental disorders. While mental health experts now generally agree that the name "borderline personality disorder" is misleading, a more accurate term does not exist yet. Most people who have borderline personality disorder suffer from:

- Problems with regulating emotions and thoughts

- Impulsive and reckless behavior
- Unstable relationships with other people

People with this disorder also have high rates of co-occurring disorders, such as depression, anxiety disorders, substance abuse, and eating disorders, along with self-harm, suicidal behaviors, and completed suicides. According to data from a subsample of participants in a national survey on mental disorders, about 1.6 percent of adults in the United States have borderline personality disorder in a given year. Borderline personality disorder is often viewed as difficult to treat. However, recent research shows that borderline personality disorder can be treated effectively, and that many people with this illness improve over time.

According to the DSM, Fourth Edition, Text Revision (DSM-IV-TR), to be diagnosed with borderline personality disorder, a person must show an enduring pattern of behavior that includes at least five of the following symptoms:

- Extreme reactions—including panic, depression, rage, or frantic actions—to abandonment, whether real or perceived
- A pattern of intense and stormy relationships with family, friends, and loved ones, often veering from extreme closeness and love (idealization) to extreme dislike or anger (devaluation)
- Distorted and unstable self-image or sense of self, which can result in sudden changes in feelings, opinions, values, or plans and goals for the future (such as school or career choices)
- Impulsive and often dangerous behaviors, such as spending sprees, unsafe sex, substance abuse, reckless driving, and binge eating.
- Recurring suicidal behaviors or threats or self-harming behavior, such as cutting Intense and highly changeable moods, with each episode lasting from a few hours to a few days
- Chronic feelings of emptiness and/or boredom. Inappropriate, intense anger or problems controlling anger
- Having stress-related paranoid thoughts or severe dissociative symptoms, such as feeling cut off from oneself, observing oneself from outside the body, or losing touch with reality.

Seemingly mundane events may trigger symptoms. For example, people with borderline personality disorder may feel angry and distressed over minor separations — such as vacations, business trips, or sudden changes of plans —from people to whom they feel close. Studies show that people with this disorder may see anger in an emotionally neutral face and have a stronger reaction to words with negative meanings than people who do not have the disorder.

Schizophrenia

Schizophrenia affects approximately 1 percent of the population, or 2.2 million U.S. adults. Men and women are equally affected. The illness usually emerges in young people in their teens or twenties. Although children over the age of five can develop schizophrenia, it is rare before adolescence. In children, the disease usually develops gradually and is often preceded by developmental delays in motor or speech development. Childhood-onset schizophrenia tends to be harder to treat and has a less favorable prognosis than does the adult-onset form.

The Symptoms of schizophrenia:

There are many myths and misconceptions about schizophrenia. Schizophrenia is not a multiple or split personality, nor are individuals who have this illness constantly incoherent or psychotic. Although the media often portray individuals with schizophrenia as violent, in reality, very few affected people are dangerous to others. In fact, individuals with schizophrenia are more likely to be victims of violence than violent themselves. Schizophrenia has severe symptoms. A diagnosis of schizophrenia requires that at least two of the symptoms below be present during a significant portion of a one-month period: delusions (false beliefs such as conspiracies, mind control, or persecution); hallucinations (usually voices criticizing or commenting on the person's behavior); disorganized speech (incomprehensible or difficult to understand); grossly disorganized or catatonic behavior; and negative symptoms such as flat emotions, lack of facial expressions, and inattention to basic self-care needs such as bathing and eating.

However, the presence of either one of the first two symptoms is sufficient to diagnose schizophrenia if the delusions are especially bizarre or if the hallucinations consist of one or more voices that keep a running commentary on the person's behavior or thoughts. The DSM-IV specifies additional criteria for a diagnosis of schizophrenia: occupational dysfunction, persistence of the disturbance for at least six months, exclusion of a mood disorder, exclusion of a substance-abuse or medical condition that causes similar symptoms, and consideration of a possible pervasive developmental disorder. The course of schizophrenia varies considerably from one individual to the next. Most people who have schizophrenia experience at least one, and usually more, relapses after their first psychotic episode. Relapses are periods of more intense symptoms of illness (hallucinations and delusions). During remissions, the negative symptoms related to emotion or personal care are usually still present. About 10

percent of patients remain severely ill for long periods of time and do not return to their previous state of mental functioning. Several long-term studies found that as many as one-third to one-half of people with schizophrenia improve significantly or even recover completely from their illness.

The Causes of Schizophrenia

Like the other mental illnesses discussed here, scientists are still working to determine what causes schizophrenia. Also like the other mental illnesses, genetic and environmental factors most likely interact to cause the disease. Several studies suggest that an imbalance of chemical neurotransmitter systems of the brain, including the dopamine, GABA, glutamate, and norepinephrine neurotransmitter systems, are involved in the development of schizophrenia. Family, twin, and adoption studies support the idea that genetics plays an important role in the illness. For example, children of people with schizophrenia are 13 times more likely, and identical twins are 48 times more likely, to develop the illness than are people in the general population. Scientists continue to look at genes that may play a role in causing schizophrenia. One gene of interest to scientists who study schizophrenia codes for an enzyme that breaks down dopamine in the synapse.

Treating Schizophrenia

There is no cure for schizophrenia; however, effective treatments that make the illness manageable for most affected people are available. The optimal treatment includes antipsychotic medication combined with a variety of psychotherapeutic interventions. Since the 1950s, doctors have used antipsychotic drugs, such as chlorpromazine and haloperidol, to relieve the hallucinations and delusions typical of schizophrenia. Recently, newer (also called atypical) antipsychotic drugs such as risperidone and clozapine have proven to be more effective. Early and sustained treatment that includes antipsychotic medication is important for long-term improvement of the course of the disease. Patients who discontinue medication are likely to experience a relapse of their illness. People who manage schizophrenia best combine medication with psychosocial rehabilitation (life-skills training). Therapies that combine family and community support, education, and behavioral and cognitive skills to address specific challenges help schizophrenic patients improve their functioning and the quality of their lives.

Suicide and Self-harm

Suicide is among the most common causes of death in the United States. People may consider suicide when they are hopeless and can't see any other solution to their problems. Often it's related to serious depression, alcohol or substance abuse, or a major stressful event.

People who have the highest risk of suicide are white men. But women and teens report more suicide attempts. If someone talks about suicide, you should take it seriously. Urge them to get help from their doctor or the emergency room, or call the **National Suicide Prevention Lifeline at 1-800-273-TALK (8255).**

Therapy and medicines can help most people who have suicidal thoughts. Treating mental illnesses and substance abuse can reduce the risk of suicide.

Suicidal behavior is complex. Some risk factors vary with age, gender, or ethnic group and may occur in combination or change over time. Suicide is a major, preventable public health problem. In 2007, it was the tenth leading cause of death in the U.S., accounting for 34,598 deaths. The overall rate was 11.3 suicide deaths per 100,000 people. An estimated 11 attempted suicides occur per every suicide death.

In 2007, suicide was the third leading cause of death for young people ages 15 to 24. As in the general population, young people were much more likely to use firearms, suffocation, and poisoning than other methods of suicide, overall. However, while adolescents and young adults were more likely to use firearms than suffocation, children were dramatically more likely to use suffocation.

There were also gender differences in suicide among young people, as follows:

- Nearly five times as many males as females ages 15 to 19 died by suicide.
- Just under six times as many males as females ages 20 to 24 died by suicide.

Research shows that risk factors for suicide include:

- depression and other mental disorders, or a substance-abuse disorder (often in combination with other mental disorders). More than 90 percent of people who die by suicide have these risk factors.

- prior suicide attempt
- family history of mental disorder or substance abuse
- family history of suicide
- family violence, including physical or sexual abuse
- firearms in the home, the method used in more than half of suicides
- incarceration
- exposure to the suicidal behavior of others, such as family members, peers, or media figures.

However, suicide and suicidal behavior are not normal responses to stress; many people have these risk factors, but are not suicidal. Research also shows that the risk for suicide is associated with changes in brain chemicals called neurotransmitters, including serotonin. Decreased levels of serotonin have been found in people with depression, impulsive disorders, and a history of suicide attempts, and in the brains of suicide victims. Public health approaches to preventing suicide include establishing telephone crisis hot lines, restricting access to suicide methods (for example, firearms), counseling media to reduce “copycat” suicides, screening teens for risk factors of suicide, and training professionals to improve recognition and treatment of mood disorders. Research about the effectiveness of these methods indicates that the screening and training strategies are more helpful for preventing suicides among young people than the other methods are.

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1.4.2.17: The Stigma of Mental Illness

Words can hurt. Many derogatory words and phrases are used in relation to mental illness. However, these words maintain the stereotyped image and not the reality about mental illness. Try not to use these words, and encourage students not to use them. It is more appropriate to refer to “a person who has a mental illness” when speaking about someone. “Mentally ill people are nuts, crazy, wacko.” “Mentally ill people are morally bad.” “Mentally ill people are dangerous and should be locked in an asylum forever.” “Mentally ill people need somebody to take care of them.” How often have we heard comments like these or seen these types of portrayals in movies, television shows, or books? We may even be guilty of making comments like them ourselves. Is there any truth behind these portrayals, or is that negative view based on our ignorance and fear?

Stigmas are negative stereotypes about groups of people. Common stigmas about people who are mentally ill are

- Individuals who have a mental illness are dangerous.
- Individuals who have a mental illness are irresponsible and can’t make life decisions for themselves.
- People who have a mental illness are childlike and must be taken care of by parents or guardians.
- People who have a mental illness should just get over it.

Each of those preconceptions about people who have a mental illness is based on false information. Very few people who have a mental illness are dangerous to society. Most can hold jobs, attend school, and live independently. A person who has a mental illness cannot simply decide to get over it any more than someone who has a different chronic disease such as diabetes, asthma, or heart disease can. A mental illness, like those other diseases, is caused by a physical problem in the body.

Stigmas against individuals who have a mental illness lead to injustices, including discriminatory decisions regarding housing, employment, and education. Overcoming the stigmas commonly associated with mental illness is yet one more challenge that people who have a mental illness must face. Indeed, many people who successfully manage their mental illness report that the stigma they face is in many ways more disabling than the illness itself. The stigmatizing attitudes toward mental illness held by both the public and those who have a mental illness lead to feelings of shame and guilt, loss of self-esteem, social dependence, and a sense of isolation and hopelessness. One of the worst consequences of stigma is that people who are struggling with a mental illness may be reluctant to seek treatment that, in most cases, would significantly relieve their symptoms.

Providing accurate information is one way to reduce stigmas about mental illness. Advocacy groups protest stereotypes imposed upon those who are mentally ill. They demand that the media stop presenting inaccurate views of mental illness and that the public stops believing these negative views. A powerful way of countering stereotypes about mental illness occurs when members of the public meet people who are effectively managing a serious mental illness: holding jobs, providing for themselves, and living as good neighbors in a community. Interaction with people who have mental illnesses challenges a person’s assumptions and changes a person’s attitudes about mental illness.

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1.4.2.18: Safety Needs

Once a person's physiological needs are relatively satisfied, his/her safety needs take precedence and dominate behavior. In the absence of physical safety – due to war, natural disaster, family violence, childhood abuse, etc. – people may (re-)experience post-traumatic stress disorder or transgenerational trauma. In the absence of economic safety – due to economic crisis and lack of work opportunities – these safety needs manifest themselves in ways such as a preference for job security, grievance procedures for protecting the individual from unilateral authority, savings accounts, insurance policies, disability accommodations, etc. This level is more likely to be found in children as they generally have a greater need to feel safe.

Safety and Security needs include:

- Personal security
- Financial security
- Health and well-being
- Safety net against accidents/illness and their adverse impacts

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1.4.2.19: Social Belonging

After physiological and safety needs are fulfilled, the third level of human needs is interpersonal and involves feelings of belongingness. This need is especially strong in childhood and it can override the need for safety as witnessed in children who cling to abusive parents. Deficiencies within this level of Maslow's hierarchy – due to hospitalism, neglect, shunning, ostracism, etc. – can adversely affect the individual's ability to form and maintain emotionally significant relationships in general, such as:

- Friendships
- Intimacy
- Family

According to Maslow, humans need to feel a sense of belonging and acceptance among their social groups, regardless whether these groups are large or small. For example, some large social groups may include clubs, co-workers, religious groups, professional organizations, sports teams, and gangs. Some examples of small social connections include family members, intimate partners, mentors, colleagues, and confidants. Humans need to love and be loved – both sexually and non-sexually – by others. Many people become susceptible to loneliness, social anxiety, and clinical depression in the absence of this love or belonging element. This need for belonging may overcome the physiological and security needs, depending on the strength of the peer pressure.

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1.4.2.20: Esteem

All humans have a need to feel respected; this includes the need to have self-esteem and self-respect. Esteem presents the typical human desire to be accepted and valued by others. People often engage in a profession or hobby to gain recognition. These activities give the person a sense of contribution or value. Low self-esteem or an inferiority complex may result from imbalances during this level in the hierarchy. People with low self-esteem often need respect from others; they may feel the need to seek fame or glory. However, fame or glory will not help the person to build their self-esteem until they accept who they are internally. Psychological imbalances such as depression can hinder the person from obtaining a higher level of self-esteem or self-respect. Most people have a need for stable self-respect and self-esteem. Maslow noted two versions of esteem needs: a "lower" version and a "higher" version. The "lower" version of esteem is the need for respect from others. This may include a need for status, recognition, fame, prestige, and attention. The "higher" version manifests itself as the need for self-respect. For example, the person may have a need for strength, competence, mastery, self-confidence, independence, and freedom. This "higher" version takes precedence over the "lower" version because it relies on an inner competence established through experience. Deprivation of these needs may lead to an inferiority complex, weakness, and helplessness.

Maslow states that while he originally thought the needs of humans had strict guidelines, the "hierarchies are interrelated rather than sharply separated". This means that esteem and the subsequent levels are not strictly separated; instead, the levels are closely related.

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1.4.2.21: Self-Actualization

"What a man can be, he must be."

This quotation forms the basis of the perceived need for self-actualization. This level of need refers to what a person's full potential is and the realization of that potential. Maslow describes this level as the desire to accomplish everything that one can, to become the most that one can be. Individuals may perceive or focus on this need very specifically. For example, one individual may have the strong desire to become an ideal parent. In another, the desire may be expressed athletically. For others, it may be expressed in paintings, pictures, or inventions. As previously mentioned, Maslow believed that to understand this level of need, the person must not only achieve the previous needs, but master them.

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1.4.2.22: Self-Transcendence

In his later years, Abraham Maslow explored a further dimension of needs, while criticizing his own vision on self-actualization. The self only finds its actualization in giving itself to some higher goal outside oneself, in altruism and spirituality, which is essentially the desire to reach infinite. "Transcendence refers to the very highest and most inclusive or holistic levels of human consciousness, behaving and relating, as ends rather than means, to oneself, to significant others, to human beings in general, to other species, to nature, and to the cosmos" (Farther Reaches of Human Nature, New York 1971, p. 269).

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1.4.2.23: Mental Health

According to the World Health Organization (WHO), mental health includes "subjective wellbeing, perceived self-efficacy, autonomy, competence, inter-generational dependence, and self-actualization of one's intellectual and emotional potential, among others." The WHO further states that the well-being of an individual is encompassed in the realization of their abilities, coping with normal stresses of life, productive work and contribution to their community. Cultural differences, subjective assessments, and competing professional theories all affect how "mental health" is defined. A widely accepted definition of health by mental health specialists is psychoanalyst Sigmund Freud's definition: the capacity "to work and to love".

Mental Health Issues Are Prevalent Among College Students

Mental health issues are a leading impediment to academic success among college students. Untreated mental illness in the college student population — including depression, anxiety and eating disorders — is associated with lower GPA and higher probability of dropping out of school. Treatment is effective and available yet because of an unnecessary shame surrounding these issues, mental health is not discussed and too many students are suffering in silence

- An estimated 26 percent of Americans ages 18 and older – or about 1 in 4 adults - live with a diagnosable mental health disorder.
- Half of all serious adult psychiatric illnesses – including major depression, anxiety disorders, and substance abuse – start by 14 years of age. Three-fourths of them are present by 25 years of age.
- Compared to older adults, the 18-24 year old age group shows the lowest rate of help-seeking.

Mental Health Issues Impact Students' Ability To Succeed:

- Almost one third of all college students report having felt so depressed that they had trouble functioning.
- Mental health issues in the college student population, such as depression, anxiety, and eating disorders, are associated with lower GPA and higher probability of dropping out of college.
- More than 80 percent of college students felt overwhelmed by all they had to do in the past year and 45 percent have felt things were hopeless.

Mental health issues can be deadly:

- Suicide is the 2nd leading cause of death among college students, claiming the lives of 1,100 students each year.
- 67% of college students tell a friend they are feeling suicidal before telling anyone else.
- More than half of college students have had suicidal thoughts and 1 in 10 students seriously consider attempting suicide. Half of students who have suicidal thoughts never seek counseling or treatment.
- 80-90% of college students who die by suicide were not receiving help from their college counseling centers

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1.4.2.24: Emotional Health

Emotional well-being is a term that has been used increasingly in recent decades. The implications of decreased emotional well-being are related to mental health concerns such as stress, depression, and anxiety. These in turn can contribute to physical ill-health such as digestive disorders, sleep disturbances, and general lack of energy.[1] The profile of a person prone to emotional distress is usually someone with low self-esteem, pessimistic, very self-critical, etc. and people who need to constantly assert themselves through their behavior. They also tend to be afraid, overly worried about the future, and focused on the past.

On the positive side, enhanced emotional well-being is seen to contribute to upward spirals in increasing coping ability, self-esteem, performance and productivity at work, and even longevity. Thoughts determine feelings, and thoughts are nothing more than firings of neurons. And those feelings that thoughts generate make the body release extremely addicting substances like adrenaline and cortisol. Like with any other addiction, the need to continually feed off these addicting substances tends to make the body think and feel in a certain way. When someone decides to disengage from these emotional addictions, he/she must learn to think differently.

Emotions and feelings are part of every step a person takes. A person must learn how to manage himself/herself in order to reach the maximum potential in all aspects of life. Good emotional health leads to better physical health, prevents diseases, and makes it possible to enjoy life and be happier. In this way you can become a “medicine person” through mirror neurons, those that lead to empathy and fire to imitate the emotions of others. Mirror neurons are what make you feel good when you’re with someone who is positive, cheerful and motivational. At the other extreme are the so-called “toxic people”, who make others around them feel bad.

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1.4.2.25: Spiritual Health

The spiritual dimension is understood to imply a phenomenon that is not material in nature, but belongs to the realm of ideas, beliefs, values and ethics that have arisen in the minds and conscience of human beings, particularly ennobling ideas. Ennobling ideas have given rise to health ideals, which have led to a practical strategy for Health for All that aims at attaining a goal that has both a material and non-material component. If the material component of the strategy can be provided to people, the non-material or spiritual one is something that has to arise within people and communities in keeping with their social and cultural patterns. The spiritual dimension plays a great role in motivating people's achievement in all aspects of life.

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1.4.2.26: MANAGING EMOTIONAL AND MENTAL HEALTH

Learning Outcomes

By the end of this chapter you will be able to:

- Describe what mental, emotional, and psychological health entails.
- Recognize warning signs of emotional distress
- Relate Maslow's Hierarchy of Needs to emotional health
- Recognize emotional defense mechanisms
- Describe types of anxiety disorders and treatments
- Explain incidence and signs of Depression

Do you feel you are living up to your potential?

Do you find opportunities throughout the day to focus on happiness?

Do you feel good about yourself?

Have you ever felt sad for a prolonged amount of time?

Have you, or do you know someone who has, felt depressed or had anxiety?

1.4.2.26.1: What is Mental Health?

1.4.2.26.2: Mental Illness

1.4.2.26.3: Challenges to our Mental Health

1.4.2.26.4: Mental Health Disorders

1.4.2.26.5: Developing and Protecting Individual Attributes

1.4.2.26.6: 2.11 Factors That Influence Psychological Well-Being

1.4.2.26.7: Mental Health - Risks, Causes, and Treatments

1.4.2.26.8: End-of-Chapter Material

1.4.2.26.9: Emotional and Mental Health- Optional Continued Learning

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1.4.2.26.1: What is Mental Health?

Mental health is a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community. Mental health includes our emotional, psychological, and social well-being. It affects how we think, feel, and act. It also helps determine how we handle stress, relate to others, and make choices. Mental health is important at every stage of life, from childhood and adolescence through adulthood. Mental health is fundamental to our collective and individual ability as humans to think, emote, interact with each other, earn a living and enjoy life. Although more emphasis is often placed on our physical wellness, mental and physical health are equally important components of overall health.

Although poor mental health and mental illness are terms that are often used interchangeably, poor mental health and mental illness are not the same. A person can experience poor mental health and not be diagnosed with a mental illness. Likewise, a person diagnosed with a mental illness can experience periods of physical, mental, and social well-being.

According to the World Health Organization:

- Mental health is more than the absence of mental disorders.
- Mental health is an integral part of health; indeed, there is no health without mental health.
- Mental health is determined by a range of socioeconomic, biological and environmental factors

Mental Health and Wellness

Your mental health is very important to your well-being. Just like we strive for to be physically healthy, we must also strive to be mentally, emotionally, and socially healthy.

Positive mental health allows people to:

- Cope with the stresses of life
- Be physically healthy
- Have good relationships
- Make meaningful contributions to your community
- Work productively
- Realize your full potential

Reaching Your Full Potential

What does it take to reach your full human potential, to become everything that you are capable of becoming? Is it important to have air, water, food, and shelter in order for you to strive to reach your human potential? Is it important to feel safe in order to reach your human potential?

In 1943 Abraham Maslow published one of the most cited theories of human behavior called Maslow's Hierarchy of Needs[1]. The purpose of the Hierarchy of Needs was to explain that there are levels of human needs and we need to focus on each of the levels in order to become everything that we are capable of becoming. Maslow's hierarchy of needs is often portrayed in the shape of a pyramid, with the most fundamental levels of needs at the bottom. Maslow developed the hierarchy with order of importance in mind, however noted that although it was observed that most people fulfilled their basic needs in the order of the hierarchy, there are some exceptions. The order of needs as categorized by Maslow from bottom to top are: physiological needs, safety, love and belonging, esteem, and self-actualization. Maslow acknowledged that many different levels of motivation are likely to be present in a human all at once. His focus in discussing the hierarchy was to identify the basic types of motivation and the order that they generally progress as lower needs are reasonably well met.

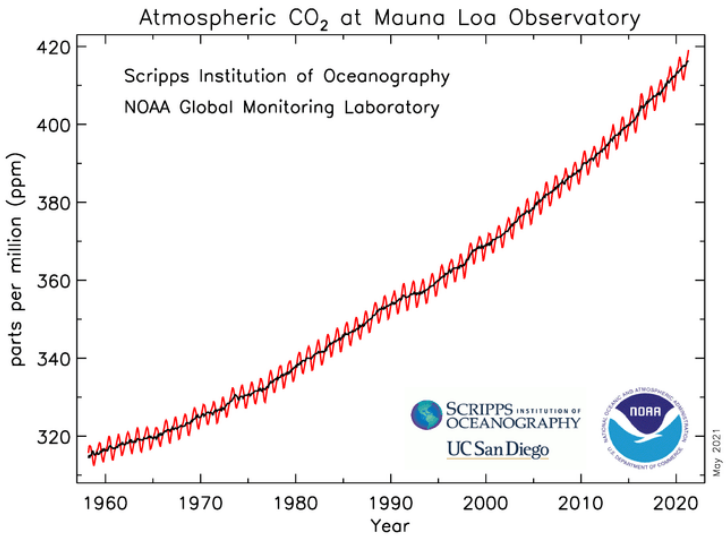


Figure 1.4.2.26.1.1: Maslow's Hierarchy of Needs

Physiological Needs

Physiological needs are generally obvious because they are required for survival. If requirements are not met, the body cannot continue to function. Air, water, food, clothing, and shelter are the basic physiological needs.

Safety Needs

Once physical needs are satisfied, individual safety takes precedence. Safety and Security needs include:

- Personal and family safety
- Financial security
- Health and well-being

Love/belonging Needs

After physiological and safety needs are fulfilled, the third layer of human needs are interpersonal. This involves feelings of belongingness. Humans need to feel a sense of belonging and acceptance, whether it comes from larger community affiliations or simply a few close friends. Without these connections, many people become susceptible to loneliness, social anxiety, and clinical depression. This need for belonging can sometimes overcome physiological and security needs. For example, an anorexic may ignore the need to eat and the security of health for a feeling of control and belonging. Deficiencies in interpersonal needs, due to neglect, shunning, ostracism, etc., can impact an individual's ability to form and maintain emotionally significant relationships.

Esteem

Esteem represents the normal human desire to be accepted and valued by others. People need to engage themselves to gain recognition and have an activity or activities that give the person a sense of contribution, to feel self-valued, be it in a profession or hobby. Imbalances at this level can result in low self-esteem or an inferiority complex. Many people with low self-esteem will not be able to improve their view of themselves simply by receiving fame, respect, and glory externally, but must first accept themselves internally. Psychological imbalances, such as depression, can prevent one from obtaining self-esteem on both levels.

Self-actualization

This level of need refers to what a person's full potential is and the realization of that potential. Maslow describes this level as the desire to accomplish everything that one can, to become the most that one can be. Individuals may perceive or focus on this need very specifically. For example, one individual may have the strong desire to become an ideal parent. In another, the desire may be expressed athletically. For others, it may be expressed in paintings, pictures, or inventions. Maslow believed that to acquire this level of need, the person must adequately achieve the previous needs.

Examples: The movie Cast Away

The movie, Cast Away, demonstrates Maslow's Hierarchy of Needs. When Tom Hanks character is marooned on a deserted island the first things he does find water and food. These actions satisfy his immediate physiological needs. Next he needs to find shelter for safety and security. To meet his love and belongingness needs he has "Wilson"

Positive Psychology: The Science of Happiness

Why study happiness? What does happiness have to do with well-being? For your well-being, is it more important to focus on being happy as a goal or focus on bringing positivity into your life? What do Denmark, Iceland, Switzerland, Finland, and Netherlands have in common?

Happiness has been linked to health with research indicating that being happy lowers disease risk, increases the likelihood of including positive behaviors in your life, and reduced the chance of all-cause mortality[2]. The science of happiness is just one area of what is called Positive Psychology[3]. Positive psychology is a relatively new field that shifted the discussion from a specific focus on what is wrong with someone (disease or illness) to what is right, by utilizing research to understand what contributes to a persons optimal functioning and helps them to flourish. This shift in focus is one factor that led to the publication of the World Happiness Report. Since 2012, the World Happiness Report has been published annually focusing on the state of global happiness for 156 countries by measuring how happy their citizens perceive themselves to be. Denmark, Iceland, Switzerland, Finland, and Netherlands are routinely shown to be the happiest countries in the world.

Studies show that focusing on positivity in your life is associated with overall happiness, life satisfaction, and psychological well-being, whereas a focus on seeking happiness or being happy is associated with negative feelings[4]. To increase happiness in your life, focus on bringing positivity into you life, which will lead to happiness. Just focusing on wanting to be happy will likely have a negative impact on your well-being.

Focus on your mental health

Ways to maintain positive mental health include:

- Getting professional help if you need it
- Connecting with others
- Staying positive
- Getting physically active
- Helping others
- Getting enough sleep
- Developing coping skills
- Developing a sense of meaning and purpose in life.
- Relaxation Techniques (meditation)
- Practice Mindfulness
- Practice Gratitude

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1.4.2.26.2: Mental Illness

We have all had some exposure to mental illness, but do we really understand it or know what it is? Many of our preconceptions are incorrect. A mental illness can be defined as a health condition that changes a person's thinking, feelings, or behavior (or all three) and that causes the person distress and difficulty in functioning. As with many diseases, mental illness is severe in some cases and mild in others. Individuals who have a mental illness don't necessarily look like they are sick, especially if their illness is mild. Other individuals may show more explicit symptoms such as confusion, agitation, or withdrawal.

Even if you or a family member has not experienced mental illness directly, it is very likely that you have known someone who has. Estimates are that at least one in four people is affected by mental illness either directly or indirectly.

Consider the following statistics to get an idea of just how widespread the effects of mental illness are in society:

- According to recent estimates, approximately 20 percent of Americans, or about one in five people over the age of 18, suffer from a diagnosable mental disorder in a given year.
- Four of the 10 leading causes of disability—major depression, bipolar disorder, schizophrenia, and obsessive-compulsive disorder—are mental illnesses.
- About 3 percent of the population have more than one mental illness at a time.
- About 5 percent of adults are affected so seriously by mental illness that it interferes with their ability to function in society. These severe and persistent mental illnesses include schizophrenia, bipolar disorder, other severe forms of depression, panic disorder, and obsessive-compulsive disorder.
- Approximately 20 percent of doctors' appointments are related to anxiety disorders such as panic attacks. Eight million people have depression each year.
- Two million Americans have schizophrenia disorders, and 300,000 new cases are diagnosed each year.

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1.4.2.26.3: Challenges to our Mental Health

Although it is important to focus on reaching your full potential and embracing positivity, this does not mean you will not have challenges to your mental health. Many factors contribute to mental health problems, including:

- Biological factors, such as genes or brain chemistry
- Life experiences, such as trauma or abuse
- Family history of mental health problems
- Experiences related to other ongoing (chronic) medical conditions, such as cancer or diabetes
- Use of alcohol or drugs
- Having feelings of loneliness or isolation

Mental Health Statistics

Mental illness is very common. It is so common that more than 50% of Americans will be diagnosed with a mental illness or disorder at some point in their lifetime, with 1 in 5 Americans experiencing a mental illness in any given year. Mental illness does no just effect adults, 1 in 5 children, either currently or at some point during their life, have had a seriously debilitating mental illness. Mental illness varies in degree of severity from mild to severe with about 1 in 25 Americans living with a serious mental illness, such as schizophrenia, bipolar disorder, or major depression.

The National Institute of Mental Health categorizes mental illness into two broad categories, Any Mental Illness (AMI) and Serious Mental Illness (SMI).

- **Any mental illness (AMI)** is defined as a mental, behavioral, or emotional disorder. AMI can vary in impact, ranging from no impairment to mild, moderate, and even severe impairment (e.g., individuals with serious mental illness as defined below).
  - In 2021, there were an estimated 57.8 million adults aged 18 or older in the United States with AMI. This number represented 22.0% of all U.S. adults.
  - The prevalence of AMI was higher among females (25.8%) than males (15.8%).
  - Young adults aged 18-25 years had the highest prevalence of AMI (30.6%) compared to adults aged 26-49 years (25.3%) and aged 50 and older (14.5%).
  - The prevalence of AMI was highest among the adults reporting two or more races (35.8%), followed by White adults (22.6%). The prevalence of AMI was lowest among Asian adults (13.9%).
- **Serious mental illness (SMI)** is defined as a mental, behavioral, or emotional disorder resulting in serious functional impairment, which substantially interferes with or limits one or more major life activities. The burden of mental illnesses is particularly concentrated among those who experience disability due to SMI.
  - In 2020, there were an estimated 14.2 million adults aged 18 or older in the United States with SMI. This number represented 5.6% of all U.S. adults.
  - The prevalence of SMI was higher among females (7.0%) than males (4.2%).
  - Young adults aged 18-25 years had the highest prevalence of SMI (9.7%) compared to adults aged 26-49 years (6.9%) and aged 50 and older (3.4%).
  - The prevalence of SMI was highest among the adults reporting two or more races (9.9%), followed by American Indian / Alaskan Native (AI/AN) adults (6.6%). The prevalence of SMI was lowest among Native Hawaiian / Other Pacific Islander (NH/OPI) adults (1.2%).

Warning Signs of Mental Illness

Not sure if you or someone you know is living with mental health problems? Experiencing one or more of the following feelings or behaviors can be an early warning sign of a problem:

- Eating or sleeping too much or too little
- Pulling away from people and usual activities
- Having low or no energy
- Feeling numb or like nothing matters

- Having unexplained aches and pains
- Feeling helpless or hopeless
- Smoking, drinking, or using drugs more than usual
- Feeling unusually confused, forgetful, on edge, angry, upset, worried, or scared
- Yelling or fighting with family and friends
- Experiencing severe mood swings that cause problems in relationships
- Having persistent thoughts and memories you can't get out of your head
- Hearing voices or believing things that are not true
- Thinking of harming yourself or others
- Inability to perform daily tasks like taking care of your kids or getting to work or school

Coping Mechanisms and Defense Mechanisms

When confronted with something that is challenging to our mental health or stress, many people respond with coping mechanisms[5] or defense mechanisms[6]. The main difference between coping mechanisms and defense mechanisms is that coping is something you consciously do and a defense mechanism is often employed unconsciously. Both actions are intended to manage a situation that is creating a problem for the person.

When confronted with a challenge, people might consciously employ problem-focused, emotion-focused, meaning-focused, or social-focused coping mechanisms. Many of these coping mechanisms can be helpful, however people might employee maladaptive coping mechanisms which could lead to poor mental health such as using drugs or alcohol to avoid a problem.

Table 1.4.2.26.3.1*: Coping Mechanisms*

Coping Mechanism Category	Description	Example
Problem-focused	An individual focuses on solving the problem	Active coping, problem-solving, planning, restraint coping, and suppression of competing activities.
Emotion-focused	An individual aims to reduce the negative emotions associated with the problem	Positive reframing, acceptance, and humor
Meaning-focused	An individual uses cognitive strategies to derive and manage the meaning of the situation	Focus on beliefs and values to support well-being
Social-focused	An individual reduces stress by seeking emotional or instrumental support from their community	Reach out to people

Good coping skills include:

- Practicing meditation and relaxation techniques
- Having time to yourself
- Engaging in physical activity or exercise
- Reading
- Spending time with friends
- Finding humor
- Spending time on your hobbies
- Engaging in spirituality
- Spending quality time with your pets
- Getting a good night's sleep
- Eating healthy.

Negative coping skills include:

- Using drugs
- Drinking alcohol excessively
- Engaging in self-mutilation
- Ignoring or bottling up feelings

- Taking sedatives
- Taking stimulants
- Working too much
- Avoiding your problems
- Being in denial.

Of the negative coping skills listed above, two of them are considered defense mechanisms, avoidance and denial. Defense mechanisms are psychological mechanisms aimed at reducing anxiety. They were first discussed by Sigmund Freud as part of his psychoanalytic theory and further developed by his daughter, Anna Freud. Often unconscious, defense mechanisms are used to protect an individual from psychological pain or anxiety.

Defense mechanisms include avoidance, repressions, regression, dispalcement, sublimation, reaction formation, projections, and rationalization as shown in the following Table.

Table 1.4.2.26.3.1*: Defense Mechanisms*

Defense Mechanism	Description	Example
Avoidance	Any behavior used to escape, distract, or avoid difficult thoughts, feelings, or situations.	Utilizing drugs or alcohol to numb feelings or making up excused to avoid attending social gatherings.
Repression	Unknowingly placing an unpleasant memory or thought in the conscious	Not remembering a traumatic event such as being sexually abused as a child.
Regression	Reverting back to an immature behavior from an earlier stage of development	Throwing temper tantrums as an adult when you don't get your way
Displacement	Redirecting feelings or actions from the intended source to a safer, substitute target	Taking your anger towards your boss out on family members by yelling at them in place of your boss.
Sublimation	Replacing socially unacceptable impulses with socially acceptable behavior	Channeling aggressiveness into playing football
Reaction formation	Overacting in the opposite way to one's true feelings.	Being overly protective of an unwanted child.
Projection	Attributing one's own unacceptable feelings and thoughts to others and not yourself	Accusing your boy/girlfriend of cheating on you because you have thoughts about cheating on him/her
Rationalization	Justifying actions, thoughts, or unwanted outcomes with excuses or faulty logic	Blaming the teaching style of a professor for why you failed an exam.

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1.4.2.26.4: Mental Health Disorders

Mental illness or disorders are often categorized into Mood Disorders, Anxiety Disorders, Psychotic Disorders, and Eating Disorders.

Mood disorders, also called affective disorders, affect your emotional state focusing on how you feel from extreme sadness to extreme happiness. Anxiety disorders occur when a person responds to something with fear or dread and has a severe stress response that may include physical reactions such as rapid heart rate, overwhelming worry, muscle tension, trouble sleeping, nausea, and diarrhea. Psychotic Disorders, also called thought disorders, involve distorted awareness or thinking.

Mood Disorders include:

- Depression
- Bipolar disorders
- Seasonal affective disorder

Anxiety Disorders include:

- General anxiety
- Specific phobias and Agoraphobia
- Post-traumatic stress disorder
- Panic disorder
- Social anxiety disorder

Psychotic Disorders include:

- Schizophrenia

Eating Disorders include

- Anorexia Nervosa
- Bulimia Nervosa
- Binge Eating

Depression

Depression (major depressive disorder or clinical depression) is the most common mood disorder characterized by severe symptoms that affect how you feel, think, and handle daily activities, such as sleeping, eating, or working. Depression is more than just feeling down or having a bad day. When a sad mood lasts for a long time and interferes with normal, everyday functioning, you may be clinically depressed.

It is estimated that about 1 out of every 6 adults will have depression at some time in their life. There are varying levels of depression and causes of depression. A person with persistent depressive disorder (also called dysthymia) means they have suffered from depressed mood that lasts for at least two years. A woman with perinatal depression has experienced full-blown major depression during pregnancy or after delivery (postpartum depression).

Symptoms of depression include:

- Feeling sad or anxious often or all the time
- Not wanting to do activities that used to be fun
- Feeling irritable, easily frustrated, or restless
- Having trouble falling asleep or staying asleep
- Waking up too early or sleeping too much
- Eating more or less than usual or having no appetite
- Experiencing aches, pains, headaches, or stomach problems that do not improve with treatment
- Having trouble concentrating, remembering details, or making decisions

- Feeling tired, even after sleeping well
- Feeling guilty, worthless, or helpless
- Thinking about suicide or hurting yourself

Not everyone who is depressed experiences every symptom. Some people experience only a few symptoms while others may experience many. Several persistent symptoms in addition to low mood are required for a diagnosis of major depression, but people with only a few – but distressing – symptoms may benefit from treatment of their "subsyndromal" depression. The severity and frequency of symptoms and how long they last will vary depending on the individual and his or her particular illness. Symptoms may also vary depending on the stage of the illness.

The national rise in anxiety and depression began around 2011. The generation born between 1995 and 2112 are growing up more slowly, have spent less time unsupervised, and have hit fewer developmental milestones on the path to autonomy (e.g., getting a job or a driver's license), compared with 18-year-olds in previous generations (Twenge, 2018). They have far higher rates of anxiety and depression. The increases for females are generally much larger than for males, as evidenced by rising hospital admission rates of self-harm and in rising suicide rates. The suicide rate of adolescent girls has doubled since 2007. The primary cause of the increase in mental illness is frequent use of smartphones and other electronic devices. **Less than two hours a day seems to have no deleterious effects, but adolescents who spend several hours a day interacting with screens, particularly if they start in their early teen years or younger, have worse mental health outcomes than do adolescents who use these devices less and who spend more time in face-to-face interaction (Lukianoff & Haidt, 2018).**

Girls may be suffering more than boys because they are more adversely affected by social comparisons (especially based on digitally enhanced beauty), by signals that they are being left out, and by relational aggression, all of which became easier to enact and harder to escape when adolescents have smartphones and social media (Lukianoff & Haidt, 2018).

Bipolar Disorder

Bipolar disorder is a mood disorder characterized by intense mood swings. Sometimes you may feel extremely "up," elated, irritable, or energized. This is called a manic episode. Other times you may feel "down," sad, indifferent, or hopeless. This is called a depressive episode. You may have both manic and depressive symptoms together. This is called a mixed episode.

Symptoms of Bipolar include:

- The symptoms of a manic episode can include
  - Feeling very up, high, or elated
  - Feeling jumpy or wired, more active than usual
  - Having a very short temper or seeming extremely irritable
  - Having racing thoughts and talking very fast
  - Needing less sleep
  - Feeling like you are unusually important, talented, or powerful
  - Do risky things that show poor judgment, such as eating and drinking too much, spending or giving away a lot of money, or having reckless sex
- The symptoms of a depressive episode can include
  - Feeling very sad, hopeless, or worthless
  - Feeling lonely or isolating yourself from others
  - Talking very slowly, feeling like you have nothing to say, or forgetting a lot
  - Having little energySleeping too much
  - Eating too much or too little
  - Lack of interest in your usual activities and being unable to do even simple things
  - Thinking about death or suicide
- The symptoms of a mixed episode include both manic and depressive symptoms together. For example, you may feel very sad, empty, or hopeless, while at the same time feeling extremely energized.

Seasonal Affective Disorder (SAD)

SAD is a specific type of Depression (a mood disorder) that comes and goes with the seasons.

Seasonal affective disorder is characterized by the onset of depression during the winter months, when there is less natural

sunlight. This depression generally lifts during spring and summer. Winter depression, typically accompanied by social withdrawal, increased sleep, and weight gain, predictably returns every year in seasonal affective disorder.

Symptoms of SAD include:

- Sadness
- Gloomy outlook
- Feeling hopeless, worthless, and irritable
- Loss of interest or pleasure in activities you used to enjoy
- Low energy
- Difficulty sleeping or oversleeping
- Carbohydrate cravings and weight gain
- Thoughts of death or suicide

General Anxiety

Generalized Anxiety Disorder is an anxiety disorder characterized by excessive worrying. People with GAD excessively worry about ordinary daily issues such as health, money, work, and family on most days for at least 6 months.

Symptoms of GAD include:

- Feeling restless, wound-up, or on-edge
- Being easily fatigued
- Having difficulty concentrating; mind going blank
- Being irritable
- Having muscle tension
- Difficulty controlling feelings of worry
- Having sleep problems, such as difficulty falling or staying asleep, restlessness, or unsatisfying sleep

Panic Disorder

Panic disorder is an anxiety disorder characterized by recurrent unexpected panic attacks, which are sudden periods of intense fear that may include palpitations, pounding heart, or accelerated heart rate; sweating; trembling or shaking; sensations of shortness of breath, smothering, or choking; and feeling of impending doom.

Symptoms of panic disorder include:

- Heart palpitations, a pounding heartbeat, or an accelerated heartrate
- Sweating
- Trembling or shaking
- Sensations of shortness of breath, smothering, or choking
- Feelings of impending doom
- Feelings of being out of control

People with panic disorder often worry about when the next attack will happen and actively try to prevent future attacks by avoiding places, situations, or behaviors they associate with panic attacks. Worry about panic attacks, and the effort spent trying to avoid attacks, cause significant problems in various areas of the person's life, including the development of agoraphobia.

Specific Phobias and Agoraphobia

A phobia is an anxiety disorder characterized by a strong, irrational fear of something that poses little or no real danger. There are many specific phobias such as the fear of heights which is called Acrophobia, or the fear of spiders termed Arachnophobia. A person who has a fear of public spaces is termed Agoraphobia. If you become anxious and extremely self-conscious in everyday social situations, you could have a social phobia, also referred to as a social anxiety disorder.

Symptoms of specific phobias include:

- May have an irrational or excessive worry about encountering the feared object or situation
- Take active steps to avoid the feared object or situation
- Experience immediate intense anxiety upon encountering the feared object or situation
- Endure unavoidable objects and situations with intense anxiety

Agoraphobia: People with agoraphobia have an intense fear of two or more of the following situations:

- Using public transportation
- Being in open spaces
- Being in enclosed spaces
- Standing in line or being in a crowd
- Being outside of the home alone

People with agoraphobia often avoid these situations, in part, because they think being able to leave might be difficult or impossible in the event they have panic-like reactions or other embarrassing symptoms. In the most severe form of agoraphobia, an individual can become housebound.

Social Anxiety Disorder (social phobia)

Social anxiety disorder is an anxiety disorder characterized by a general intense fear of, or anxiety toward, social or performance situations. They worry that actions or behaviors associated with their anxiety will be negatively evaluated by others, leading them to feel embarrassed.

Symptoms of Social Anxiety Disorder include:

- Feeling highly anxious about being with other people and having a hard time talking to them
- Feeling very self-conscious in front of other people and worried about feeling humiliated, embarrassed, or rejected, or fearful of offending others
- Being very afraid that other people will judge them
- Worrying for days or weeks before an event where other people will be
- Staying away from places where there are other people
- Having a hard time making friends and keeping friends
- Blushing, sweating, or trembling around other people
- Feeling nauseous or sick to your stomach when other people are around

Post-traumatic stress disorder

PTSD is an anxiety disorder that develops in some people who have experienced a shocking, scary, or dangerous event. The “fight of flight” reaction is a natural process meant to keep a person from harm when in traumatic experiences, however for those with PTSD the reaction continues for a long period of time or they experience the reaction even when they are not in danger.

Symptoms include:

- To be diagnosed with PTSD, an adult must have all of the following for at least 1 month:
  - At least one re-experiencing symptom
  - At least one avoidance symptom
  - At least two arousal and reactivity symptoms
  - At least two cognition and mood symptoms
- Re-experiencing symptoms include:
  - Flashbacks—reliving the trauma over and over, including physical symptoms like a racing heart or sweating
  - Bad dreams
  - Frightening thoughts

Schizophrenia

Schizophrenia is a psychotic disorder that affects how a person thinks, feels, and behaves. People with schizophrenia may seem like they have lost touch with reality, which causes significant distress for the individual, their family members, and friends. Schizophrenia is typically diagnosed in the late teen years to the early thirties and tends to emerge earlier in males (late adolescence – early twenties) than females (early twenties – early thirties).

Symptoms of Schizophrenia include:

- Psychotic Symptoms
  - Hallucinations, such as hearing voices or seeing things that aren't there
  - Delusions, which are firmly held beliefs not supported by objective facts (e.g., paranoia – irrational fears that others are "out to get you" or believing that the television, radio, or internet are broadcasting special messages that require some response)
- Negative Symptoms
  - Reduced motivation and difficulty planning, beginning, and sustaining activities
  - Diminished feelings of pleasure in everyday life
  - "Flat affect," or reduced expression of emotions via facial expression or voice tone
  - Reduced speaking
- Cognitive Symptoms
  - Difficulty processing information to make decisions
  - Problems using information immediately after learning it
  - Trouble focusing or paying attention

Eating Disorders and Mental Health

Eating disorders are not a choice, rather they are serious and often fatal illnesses that are associated with severe disturbances in people's eating behaviors and related thoughts and emotions. Researchers are finding that eating disorders are caused by a complex interaction of genetic, biological, behavioral, psychological, and social factors.

Review chapter 4 for more in-depth explanations of common eating disorders.

Suicide

Suicide is a major public health concern. In 2020, an estimated 12.2 million American adults seriously thought about suicide, 3.2 million planned a suicide attempt, 1.2 million attempted suicide, and 45,979 died by suicide. In 2020, suicide was among the top 9 leading causes of death for people ages 10-64 and the second leading cause of death for people ages 10-14 and 25-34. Depression, substance use disorders, and psychosis are the most relevant risk factors for suicide, with anxiety, personality, eating, and trauma-related disorders also contributing to risk of suicide. Most people, could be at least 90%, who have died by suicide have suffered from mental disorders[7]. Suicide is complicated and tragic but it is often preventable. Knowing the warning signs for suicide and how to get help can help save lives.

Harvard University and UC Berkeley found that 9 out of 10 people who attempt suicide and survive will not go on to die by suicide at a later date.

"One of the things that I've learned in this whole fight from the very beginning when I got into it was the power of the access restriction method," Muller says. "You don't have to have a degree in psychology to restrict access to lethal means. You may need nothing more than, for instance, gun locks. Reducing that access means you buy the suicidal individual more time and that gives them time for counseling treatment. It gives [professionals] an opportunity to pull them off the edge."

Suicidal thoughts or actions are a sign of extreme distress and should not be ignored.

Warning signs that someone may be at immediate risk for attempting suicide include:

- Talking about wanting to die or wanting to kill themselves
- Talking about feeling empty or hopeless or having no reason to live
- Talking about feeling trapped or feeling that there are no solutions

- Feeling unbearable emotional or physical pain
- Talking about being a burden to others
- Withdrawing from family and friends
- Giving away important possessions
- Saying goodbye to friends and family
- Putting affairs in order, such as making a will
- Taking great risks that could lead to death, such as driving extremely fast
- Talking or thinking about death often

Other serious warning signs that someone may be at risk for attempting suicide include:

- Displaying extreme mood swings, suddenly changing from very sad to very calm or happy
- Making a plan or looking for ways to kill themselves, such as searching for lethal methods online, stockpiling pills, or buying a gun
- Talking about feeling great guilt or shame
- Using alcohol or drugs more often
- Acting anxious or agitated
- Changing eating or sleeping habits
- Showing rage or talking about seeking revenge

Risk Factors for suicide

- Depression, other mental disorders, or substance use disorder
- Chronic pain
- A history of suicide attempts
- Family history of a mental disorder or substance use
- Family history of suicide
- Exposure to family violence, including physical or sexual abuse
- Presence of guns or other firearms in the home
- Having recently been released from prison or jail
- Exposure, either directly or indirectly, to others' suicidal behavior, such as that of family members, peers, or celebrities

How can you help? 5 Action Steps for Helping Someone in Emotional Pain

1. **Ask:** "Are you thinking about killing yourself?" It's not an easy question but studies show that asking at-risk individuals if they are suicidal does not increase suicides or suicidal thoughts.
2. **Keep them safe:** Reducing a suicidal person's access to highly lethal items or places is an important part of suicide prevention. While this is not always easy, asking if the at-risk person has a plan and removing or disabling the lethal means can make a difference.
3. **Be there:** Listen carefully and learn what the individual is thinking and feeling. Findings suggest acknowledging and talking about suicide may in fact reduce rather than increase suicidal thoughts.
4. **Help them connect with help**
    - Call the toll-free National Suicide Prevention Lifeline at 988, 24 hours a day, 7 days a week. The service is available to everyone.
    - You can also connect 24/7 to a crisis counselor by texting the Crisis Text Line.Text HOME to 741741.
    - The deaf and hard of hearing can contact the Lifeline via TTY at 1-800-799-4889.
    - You can also help make a connection with a trusted individual like a family member, friend, spiritual advisor, or mental health professional.
5. **Stay Connected:** Staying in touch after a crisis or after being discharged from care can make a difference. Studies have shown the number of suicide deaths goes down when someone follows up with the at-risk person.

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1.4.2.26.5: Developing and Protecting Individual Attributes

At its core, mental health and well-being rests on the capacity of individuals to manage their thoughts, feelings and behavior, as well as their interactions with others. It is essential that these core attributes of self-control, resilience and confidence be allowed to develop and solidify in the formative stages of life, so that individuals are equipped to deal with the complex choices and potential adversities they will face as they grow older.

Alcohol, tobacco and drug use pose risks to mental and physical health, particularly among pregnant women and adolescents. Raising awareness about the health risks of substance use can be accompanied by implementation of a number of proven strategies for reducing their use, including fiscal measures (namely, increased excise taxes) and regulatory instruments (such as comprehensive restrictions on advertising, minimum age of use and restrictions on smoking in public places).

Maintaining a healthy diet and regular physical exercise are also protective factors for mental health and can be considered as part of a holistic approach to health promotion and protection in the population. Getting enough sleep also makes a big difference. Taking care of your mental health means managing your time, commitments, and stress levels. Sometimes this may feel overwhelming, but you can do it! If you need help, please set up a free, confidential counseling appointment with our college's mental health & wellness professionals.

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1.4.2.26.6: 2.11 Factors That Influence Psychological Well-Being

Infancy and Early Childhood

There is a strong body of evidence to show the importance of attachment by neonates to their mothers or other primary caregivers for subsequent social and emotional development. Separation from the primary caregiver - due for example to parental absence or rejection - leads to anxiety, stress and insecurity. Post-natal depression among new mothers can likewise contribute to sub-optimal attachment and development. Parents who have difficulties in bonding, have limited skills or exhibit negative attitudes place their children at increased risk of exposure to stress and behavioral problems. Other important risks to physical and cognitive development in infancy and early childhood include maltreatment and neglect (by parents and other caregivers), malnutrition and infectious or parasitic diseases.

Individual attributes and behaviors

These relate to a person's innate and learned ability to deal with thoughts and feelings and to manage him/herself in daily life ('emotional intelligence'). It is also the capacity to deal with the social world around by partaking in social activities, taking responsibilities or respecting the views of others ('social intelligence'). An individual's mental health state can also be influenced by genetic and biological factors; that is, determinants that persons are born or endowed with, including chromosomal abnormalities (e.g. Down's syndrome) and intellectual disability caused by prenatal exposure to alcohol or oxygen deprivation at birth.

Social and economic circumstances

The capacity for people to develop and flourish is deeply influenced by their immediate social surroundings – including their opportunity to engage positively with family members, friends or colleagues, and earn a living for themselves and their families – and also by the socioeconomic circumstances in which they find themselves. Restricted or lost opportunities to gain an education and income are especially pertinent socio-economic factors.

Environmental factors

The wider sociocultural and geopolitical environment in which people live can also affect an individual's, household's or community's mental health status, including levels of access to basic commodities and services (water, essential health services, the rule of law), exposure to predominating cultural beliefs, attitudes or practices, as well as by social and economic policies formed at the national level; for example, the on-going global financial crisis is expected to have significant mental health consequences, including increased rates of suicide and harmful alcohol use. Discrimination, social or gender inequality and conflict are examples of adverse structural determinants of mental well-being.

Personality

Personality measures turn out to be good predictors of your health, your sexual promiscuity, your likelihood of divorce, how happy you typically are—even your taste in paintings. Personality is a much better predictor of these things than social class or age. The origin of these differences is in part innate. That is to say, when people are adopted at birth and brought up by new families, their personalities are more similar to their blood relatives than to the ones they grew up with. The differences begin to emerge early in life and are surprisingly stable across the decades. This is not to say that people cannot change, but major change is the exception rather than the rule. Personality differences tend to manifest themselves through the quick, gut-feeling, intuitive, and emotional systems of thehuman mind. The slower, rational, deliberate systems show less variation in output from person to person. Deliberate rational strategies can be used to over-ride intuitive patterns of response, and this is how people wishing to change their personalities or feelings have to go about it.

So what are the major ways personalities can differ? The dominant approach is to think of the space of possible personalities as being defined by a number of dimensions. Each person can be given a location in the space by their scores on all the different dimensions. Virtually all theories agree on two of the main dimensions, though they differ on how many additional ones they recognize.

Five factors

- Openness to experience: (inventive/curious vs. consistent/cautious). Appreciation for art, emotion, adventure, unusual ideas, curiosity, and variety of experience. Openness reflects the degree of intellectual curiosity, creativity and a preference for novelty and variety a person has. It is also described as the extent to which a person is imaginative or independent and depicts a personal preference for a variety of activities over a strict routine. High openness can be perceived as unpredictability or lack of focus. Moreover, individuals with high openness are said to pursue selfactualization specifically by seeking out in tense, euphoric experiences. Conversely, those with low openness seek to gain fulfillment through perseverance and are characterized as pragmatic and data-driven—sometimes even perceived to be dogmatic and closed-minded. Some disagreement remains about how to interpret and contextualize the openness factor.
- Conscientiousness: (efficient/organized vs. easy-going/careless). A tendency to be organized and dependable, show self-discipline, act dutifully, aim for achievement, and prefer planned rather than spontaneous behavior. High conscientiousness is often perceived as stubbornness and obsession. Low conscientiousness is associated with flexibility and spontaneity, but can also appear as sloppiness and lack of reliability.
- Extraversion: (outgoing/energetic vs. solitary/reserved). Energy, positive emotions, surgency, assertiveness, sociability and the tendency to seek stimulation in the company of others, and talkativeness. High extraversion is often perceived as attention-seeking, and domineering. Low extraversion causes a reserved, reflective personality, which can be perceived as aloof or self-absorbed.
- Agreeableness: (friendly/compassionate vs. challenging/detached). A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others. It is also a measure of one's trusting and helpful nature, and whether a person is generally well-tempered or not. High agreeableness is often seen as naive or submissive. Low agreeableness personalities are often competitive or challenging people, which can be seen as argumentativeness or untrustworthiness.
- Neuroticism: (sensitive/nervous vs. secure/confident). The tendency to experience unpleasant emotions easily, such as anger, anxiety, depression, and vulnerability. Neuroticism also refers to the degree of emotional stability and impulse control and is sometimes referred to by its low pole, "emotional stability". A high need for stability manifests itself as a stable and calm personality, but can be seen as uninspiring and unconcerned. A low need for stability causes a reactive and excitable personality, often very dynamic individuals, but they can be perceived as unstable or insecure.

Assess yourself! This is an interactive version of the IPIP Big-Five Factor Markers, a measure of the big five personality traits: Big 5 Personality Test

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1.4.2.26.7: Mental Health - Risks, Causes, and Treatments

Mental illnesses, in general, are thought to be caused by a variety of genetic and environmental factors, these include:

- **Inherited traits.** Mental illness is more common in people whose blood relatives also have a mental illness. Certain genes may increase your risk of developing a mental illness, and your life situation may trigger it.
- **Environmental exposures before birth.** Exposure to environmental stressors, inflammatory conditions, toxins, alcohol or drugs while in the womb can sometimes be linked to mental illness.
- **Brain chemistry.** Neurotransmitters are naturally occurring brain chemicals that carry signals to other parts of your brain and body. When the neural networks involving these chemicals are impaired, the function of nerve receptors and nerve systems change, leading to depression and other emotional disorders.

Certain factors may increase your risk of developing a mental illness, including:

- A history of mental illness in a blood relative, such as a parent or sibling
- Stressful life situations, such as financial problems, a loved one's death or a divorce
- An ongoing (chronic) medical condition, such as diabetes
- Brain damage as a result of a serious injury (traumatic brain injury), such as a violent blow to the head
- Traumatic experiences, such as military combat or assault
- Use of alcohol or recreational drugs
- A childhood history of abuse or neglect
- Few friends or few healthy relationships
- A previous mental illness

Treatment begins with getting a medical diagnosis to understand which mental illness may be causing your symptoms. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5), published by the American Psychiatric Association, is used for diagnosis. Treatment depends on the type of mental disorder and may include medications, physicians, psychotherapist, psychiatrists, and social workers or family members.

- Psychotherapy
  - Psychotherapy or "talk therapy" can help people with anxiety disorders. To be effective, psychotherapy must be directed at the person's specific anxieties and tailored to his or her needs. A typical "side effect" of psychotherapy is temporary discomfort involved with thinking about confronting feared situations.
- Cognitive Behavioral Therapy (CBT)
  - CBT is a type of psychotherapy that can help people with anxiety disorders. It teaches a person different ways of thinking, behaving, and reacting to anxiety-producing and fearful situations. CBT can also help people learn and practice social skills, which is vital for treating social anxiety disorder.
  - Two specific stand-alone components of CBT used to treat social anxiety disorder are cognitive therapy and exposure therapy. Cognitive therapy focuses on identifying, challenging, and then neutralizing unhelpful thoughts underlying anxiety disorders. Exposure therapy focuses on confronting the fears underlying an anxiety disorder in order to help people engage in activities they have been avoiding.
- Stress-Management Techniques
  - Stress management techniques and meditation can help people with anxiety disorders calm themselves and may enhance the effects of therapy. While there is evidence that aerobic exercise has a calming effect, the quality of the studies is not strong enough to support its use as treatment. Since caffeine, certain illicit drugs, and even some over-the-counter cold medications can aggravate the symptoms of anxiety disorders, avoiding them should be considered. Check with your physician or pharmacist before taking any additional medications.
  - The family can be important in the recovery of a person with an anxiety disorder. Ideally, the family should be supportive but not help perpetuate their loved one's symptoms. Talking with a trusted friend or member of the clergy can also provide support, but it is not necessarily a sufficient alternative to care from an expert clinician.
- Medication
  - Medication does not cure anxiety disorders but often relieves symptoms. Medication can only be prescribed by a medical doctor (such as a psychiatrist or a primary care provider), but a few states allow psychologists to prescribe psychiatric medications.
  - Medications are sometimes used as the initial treatment of an anxiety disorder, or are used only if there is insufficient response to a course of psychotherapy. In research studies, it is common for patients treated with a combination of

psychotherapy and medication to have better outcomes than those treated with only one or the other.
- The most common classes of medications used to combat anxiety disorders are antidepressants, anti-anxiety drugs, and beta-blockers. Be aware that some medications are effective only if they are taken regularly and that symptoms may recur if the medication is stopped.

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1.4.2.26.8: End-of-Chapter Material

Key Takeaways for this Chapter

- Mental health is just as important as physical health.
- Meeting our physiological needs is a necessary foundation to reaching our human potential.
- Focusing on happiness and positivity increases our overall health and wellness.
- Mental illness is very common.
- Understanding warning signs of mental illness can help yourself and others.
- Help is available. Our campus health center offers free and confidential counseling.

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1.4.2.26.9: Emotional and Mental Health- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

A new way to help young people with their mental health

Break the silence for suicide attempt survivors

Debunking the myths of OCD

How do antidepressants work?

How gratitude rewires your brain

How to discover your “why” in difficult times

How to protect your mental well-being online — from a Gen-Zer

The gift and power of emotional courage

The Housing First approach to homelessness

The psychology of post-traumatic stress disorder

The voices in my head

What causes panic attacks, and how can you prevent them?

What is bipolar disorder?

What makes a good life? Lessons from the longest study on happiness

What’s normal anxiety — and what’s an anxiety disorder?

What's your happiness score?

Why we get mad — and why it's healthy

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1.4.3: Healthy People

We want people to be healthy. A healthy population is a nations greatest resource, it means a productive population, a prosperous population, and a healthy economy. Your individual commitment to striving for personal wellness may contribute to our national goals for a healthy population!

Every decade since 1980, the U.S. Department of Health and Human Services (HHS) has published healthy goals for our U.S. population called the Healthy People initiative. Healthy People 2030 is the 5th iteration of the Healthy People initiative. The Healthy People initiative is designed to guide national health promotion and disease prevention efforts to improve the health of the nation.

The 2030 broad goals for this decade include the following:

- Attain healthy, thriving lives and well-being, free of preventable disease, disability, injury and premature death.
- Eliminate health disparities, achieve health equity, and attain health literacy to improve the health and well-being of all.
- Create social, physical, and economic environments that promote attaining full potential for health and well-being for all.
- Promote healthy development, healthy behaviors and well-being across all life stages.
- Engage leadership, key constituents, and the public across multiple sectors to take action and design policies that improve the health and well-being of all.

The five broad goals are further divided into over 400 objectives: 355 core objectives, 115 developmental objectives and 40 newly added research objectives. The science-based objectives include targets to monitor progress and motivate action. The Healthy People 2030 objectives were carefully chosen based on national data. The goal is to work together as a nation to achieve the achieve the objectives and goals to hopefully improve health and well-being nationwide.

Challenge: Healthy People Goals and You

How might you benefit from the work being done to achieve the Healthy People goals?

Go to the Healthy People website and browse the Healthy People Objectives

Your challenge is to find an objective that either impacts you or a loved one, or is something that you have been curious about.

Click on the objective and begin by reading the overview to gain a better understanding of what they are hoping to achieve and then navigate to the menu item titled Healthy People In Action to see how communities across the nation are working to achieve the goal. You can then review the Evidence Based Resources to see if you can locate helpful evidence-based resources to achieve the objective.

Health Literacy

The internet brought us the ability to have a wealth of information at our fingertips. Have you ever felt sick and googled your symptoms to try to self-diagnose your sickness? Have you been scrolling through your social media and an article popped up promising a cure to obesity with just one simple pill?

With so much information available to us, it is imperative that we understand how to critically evaluate information we see or hear. The need to be critical consumers of information is reflected in the Healthy People broad goal to “eliminate health disparities, achieve health equity, and attain health literacy to improve the health and well-being of all.” We need to increase our health literacy.

The CDC defines personal health literacy as the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others[7]. We must be critical

consumers of information which starts with evaluating the source of the information.

Evaluating and Finding Health Information

One strategy for assessing a website is to use the CRAAP[8] method which stands for Currency, Relevance, Authority, Accuracy, and Purpose.

As you read information critically, ask yourself the following questions:

Currency: The timeliness of the information.

- When was the information published or posted?
- Has the information been revised or updated?
- Does your topic of interest require current information, or will older sources work as well?
- Are the links functional?

Relevance: The importance of the information for your needs.

- Does the information relate to your topic or answer your question?
- Who is the intended audience?
- Is the information at an appropriate level (i.e. not too elementary or advanced for your needs)?
- Have you looked at a variety of sources before determining this is one you will use?
- Would you be comfortable citing this source in a research paper?

Authority: The source of the information.

- Who is the author/publisher/source/sponsor?
- What are the author's credentials or organizational affiliations?
- Is the author qualified to write on the topic?
- Is there contact information, such as a publisher or email address?
- Does the URL reveal anything about the author or source? examples: .com .edu .gov .org .net

Accuracy: The reliability, truthfulness and correctness of the content.

- Where does the information come from?
- Is the information supported by evidence?
- Has the information been reviewed or refereed?
- Can you verify any of the information in another source or from personal knowledge?
- Does the language or tone seem unbiased and free of emotion?
- Are there spelling, grammar or typographical errors?

Purpose: The reason the information exists.

- What is the purpose of the information? Is it to inform, teach, sell, entertain or persuade?
- Do the authors/sponsors make their intentions or purpose clear?
- Is the information fact, opinion or propaganda?
- Does the point of view appear objective and impartial?
- Are there political, ideological, cultural, religious, institutional or personal biases?

Examples of Trusted Source of Health Information

The following is a short list of websites that are most likely to pass the CRAAP test for health information:

- The Center for Disease Control and Prevention
- World Health Organization

- PubMed Central (PMC) is a free full-text archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM).
- MyHealthFinder is a prevention and wellness resource that includes evidence-based health information in English and Spanish that's actionable and easy to use.
- U.S. Department of Health and Human Services

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1.4.4: Healthy Population

How long would you like to live? What would you like to be able to do throughout life, especially into your later years? Striving for health by implementing wellness practices will impact both your quantity and quality of life.

Leading Causes of Death in the United States

Across the entire U.S. population, Cardiovascular Disease and Cancer are the top two causes of death. However, variation exists for age and ethnicities. For example, until age 44 the leading cause of death is unintentional injuries, then between 45-64 the leading cause of death is Cancer followed by Cardiovascular disease, and beginning at age 65 Cardiovascular Disease takes the number one rank[3].

Table includes the top ten causes of death for the years 1900, 1950, 2000, 2010, 2018, and 2020. 2018 was purposefully included to show the difference in causes of death pre-COVID. In 2020, the list of the top causes shows COVID* taking the spot for the third most deaths. As you review the data in Table , it is helpful to compare the leading cause of death with life expectancy. The life expectancy in 1900 was 48.3 years, by 1950 life expectancy increased to 71.1 years, and from 2010 to 2018 life expectancy remained fairly stable at 78.7 years. From 1900 to 2000, life expectancy almost doubled and the causes of death changed from causes predominantly related to infectious diseases and sickness, to causes of death highly related to lifestyle choices, like the choice to eat a healthy diet and stay physically active.

Table : Leading Cause of Death 1900, 1950, 2000, 2010, 2018, 2020. Mortality Data from the CDC

Rank	Cause of death 1900	Cause of death 1950	Cause of death in 2000	Cause of death in 2010	Cause of death in 2018	Cause of death in 2020
1	Pneumonia and Influenza: 40,362	Diseases of the heart: 535,705	Heart disease: 710,760	Heart disease: 597,689	Heart disease: 655,381	Heart disease: 696,962
2	Tuberculosis: 38,820	Malignant neoplasms, including neoplasms of lymphatic and hematopoietic tissues: 210,705	Cancer: 553,091	Cancer: 574,743	Cancer: 599,274	Cancer: 602,350
3	Diarrhea, enteritis, and ulceration of the intestines: 28,491	Vascular lesions affecting central nervous system: 156,751	Stroke (cerebrovascular diseases): 167,661	Accidents (unintentional injuries): 167,127	Accidents (unintentional injuries): 167,127	*COVID-19: 350,831
4	Diseases of the heart: 27,427	Accidents: 91,249	Chronic lower respiratory diseases: 122,009	Chronic lower respiratory diseases: 138,080	Chronic lower respiratory diseases: 159,486	Accidents (unintentional injuries): 200,955
5	Intracranial lesions of vascular origin: 21, 353	Certain diseases of early infancy: 60,989	Accidents (unintentional injuries): 97,900	Stroke (cerebrovascular diseases): 129,476	Stroke (cerebrovascular diseases): 147,810	Stroke (cerebrovascular diseases): 160,264
6	Nephritis: 17,699	Influenza and pneumonia, except pneumonia of newborn: 47,120	Diabetes: 69,301	Alzheimer's disease: 83,494	Alzheimer's disease: 122,019	Chronic lower respiratory diseases: 152,657

Rank	Cause of death 1900	Cause of death 1950	Cause of death in 2000	Cause of death in 2010	Cause of death in 2018	Cause of death in 2020
7	All accidents: 14,429	Tuberculosis: 33,959	Influenza and pneumonia: 65,313	Diabetes: 69,071	Diabetes: 84,946	Alzheimer's disease: 134,242
8	Cancer and other malignant tumors: 12,769	General arteriosclerosis: 30,734	Alzheimer's disease: 49,558	Nephritis, nephrotic syndrome, and nephrosis: 50,476	Influenza and pneumonia: 59,120	Diabetes: 102,188
9	Senility: 10,015	Nephritis: 24,677	Nephritis, nephrotic syndrome, and nephrosis: 37,251	Influenza and pneumonia: 50,097	Nephritis, nephrotic syndrome, and nephrosis: 51,386	Influenza and pneumonia: 53,544
10	Diphtheria: 8,056	Diabetes mellitus: 24,419	Intentional self-harm (suicide): 31,224	Intentional self-harm (suicide): 38,364	Intentional self-harm (suicide): 48,344	Nephritis, nephrotic syndrome, and nephrosis: 52,547
						Intentional self-harm (suicide): 45,855

Reflection: Quantity and Quality of Life Then and Now

Have you been able to trace your family tree? If you are able to trace your history back in time, something you might notice is how long each of your relatives lived. Did you know that those born in 1900 lived on average just 47.3 years and by 2000 on average Americans lived to 76.8 years[4]? Life expectancy almost doubled in just one century.

Life expectancy is often used a measurement of the overall health of a population. Life expectancy at birth represents the average number of years that a group of infants would live if the group were to experience the age-specific death rates present in the year of birth. Life expectancy averages vary based on many different demographics such as between males and females and regions of the world. Take a moment to review the world life expectancy charts provided by Our World in Data[5]

Have you thought about what actions took place, or healthy goals were achieved, to be able to double life expectancy?

In the early 1900's, the leading cause of death was infectious diseases, now the leading cause of death is two chronic diseases, cardiovascular disease and cancer. As a nation and world, several actions were implemented to reduce death from infectious diseases, these actions include clean drinking water, development of medications, development and requirement of vaccines, workplace safety such as wearing hard hats, vehicle safety such as wearing seatbelts.

Read about the Ten Great Public Health Achievements — United States, 2001–2010[6]

Reflection: Take a moment and think about how your life would have been different if you were born in 1900. What would your daily life be like? What challenges might you face? What might you wish you had that has not been developed yet? Ask yourself what you have now that you would not have had in the early 1900's that has increased your quantity and quality of life?

Your Choices, Your Risk: What is your risk factor?

Many of the risk factors for Cardiovascular Disease and Cancer are related to your lifestyle choices, thus the choices you make may impact your chances of being diagnosed with Cardiovascular Disease and Cancer. Part of learning how to take charge of

your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control, you may be born with them or exposed to them through no fault of your own.

Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some risk factors you can control include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs
- Whether you get good sleep

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

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1.4.5: Healthy People 2020

In December 2010, the Department of Health and Human Services launched Healthy People 2020, which has four overarching goals:

- Attain high-quality, longer lives free of preventable disease, disability, injury, and premature death;



- Achieve health equity, eliminate disparities, and improve the health of all groups;
- Create social and physical environments that promote good health for all; and
- Promote quality of life, healthy development, and healthy behaviors across all life stages.

Healthy People 2020 tracks approximately 1,200 objectives organized into 42 topic areas, each of which represents an important public health area. At the time of the December 2010 launch 911 objectives were measurable with baseline data and established targets. A few objectives that have achieved high levels of success are being tracked without a target for informational purposes. Targets will be set during the decade for these objectives if warranted. The rest of the objectives did not have baseline data and were considered developmental. Targets for the developmental objectives will be set when baseline data become available. Healthy People 2020 also includes a new Foundation section which addresses several important health topics: General Health Status, Health-Related Quality of Life and Well-Being, Determinants of Health, and Disparities.

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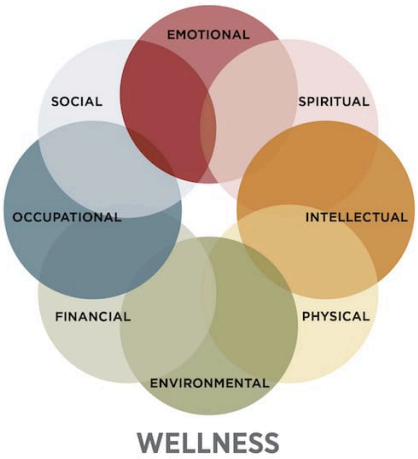
1.4.6: Dimensions of Wellness

What is Wellness?

Wellness is being in good physical and mental health. Because mental health and physical health are linked, problems in one area can impact the other. At the same time, improving your physical health can also benefit your mental health, and vice versa. It is important to make healthy choices for both your physical and mental well-being.

Remember that wellness is not just the absence of illness or stress. You can still strive for wellness even if you are experiencing these challenges in your life.

What are the Eight Dimensions of Wellness?



Learning about the Eight Dimensions of Wellness can help you choose how to make wellness a part of your everyday life. Wellness strategies are practical ways to start developing healthy habits that can have a positive impact on your physical and mental health.

The Eight Dimensions of Wellness are:

1. **Emotional**—Coping effectively with life and expressing emotions in an appropriate manner
2. **Environmental**—Occupying pleasant, healthy, and safe environments that support well-being; positively impacting the quality of our surroundings (including protecting and preserving nature)
3. **Financial**—Achieving satisfaction with current and future financial situations; handling finances wisely
4. **Intellectual**—Recognizing creative abilities and finding ways to expand knowledge and skills; being open-minded
5. **Occupational**—Personal fulfillment and enrichment from one's work and/or responsibilities
6. **Physical**—Recognizing the need for physical activity, healthy foods, and adequate sleep; avoiding unhealthy habits
7. **Social**—Developing a sense of connection, belonging, and sustained support system; having positive relationships
8. **Spiritual**—Having a sense of purpose and meaning in life; establishing peace, harmony, and balance in our lives

Learn more about the Eight Dimensions of Wellness by watching the video below:



A YouTube element has been excluded from this version of the text. You can view it online here: http://pb.libretexts.org/w/?p=26

Your Own Views on Health and Wellness

Reflect on the following questions:

- What does health mean to you?
- How important is health to you?
- What are some of your healthy habits?
- Which dimensions of wellness do you need to work on the most?

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1.4.7: PERSONAL HEALTH

Learning Objectives

Students will be able to:

- Define health
- Demonstrate understanding of the role of health in the practice of health promotion
- Discuss the concepts of health, health education, health promotion and some related terms
- Identify social determinants of health
- List the levels of disease prevention
- Know the two overarching goals of Healthy People 2010
- Identify the dimensions of health disparity as described in Healthy People 2010
- Provide a literal definition of the term “disparity”
- Interpret three definitions of health disparity
- Distinguish between the terms “health inequality” and “health inequity

1.4.7.1: Health and Disease, Influence of Family and Community

1.4.7.2: Three Levels of Health Promotion/Disease Prevention

1.4.7.3: Culture, Beliefs, Attitudes, and Stigmatized Illnesses

1.4.7.4: Determinants of Health, Risk Factors, and Prevention

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1.4.7.1: Health and Disease, Influence of Family and Community

Your Own Views on Health

Note down your responses to the following questions:

- What does health mean to you?
- How important is health to you?
- What do you do (if anything) to stay healthy?

Illness and Disease

Although clearly related, the concepts of illness and disease are distinct. People have illness and physicians diagnose and treat disease.

- Disease is an objective term which implies a malfunctioning of the body or part of the body. Disease is pathological and is diagnosed on the basis of recognizable signs and symptoms.
- Illness is the subjective experience of pain, discomfort or disorder.

Although it is mostly safe to say that illness is the subjective experience of disease, it is possible to experience illness without having a disease and it is possible to have a disease and not feel ill.

Learning Activity

Think of a time when you were ill.

- Can you think of an illness experience which is not disease related?
- Can you think of a disease which may not make you feel ill?

Health Education: Basic Principles

In this session you will learn about the nature of health, health education, health promotion and some related concepts. This will help you to understand the social, psychological and physical components of health.

Definition and Concepts of Health

In the Oxford English Dictionary health is defined as: ‘the state of being free from sickness, injury, disease, bodily conditions; something indicating good bodily condition.”

- Now stop for a moment and think about someone you think is healthy and someone else who you would consider to be not healthy.
  - Look at the definition of health again.
  - Is it similar to the things you thought about when you thought of a healthy and an unhealthy person?

This definition of health is a widely publicized one. But you may have thought of someone who has a disability or wondered about someone who looks OK but who you know does no exercise. Clearly health is not quite as simple as the definition implies.
The concept of health is wide and the way we define health also depends on individual perception, religious beliefs, cultural values, norms, and social class. Generally, there are two different perspectives concerning people’s own definitions of health: a narrow perspective and a broader perspective.

Narrow Perspectives of Health

People with a narrow perspective consider health as the absence of disease or disability or biological dysfunction. According to this view (or model), to call someone unhealthy or sick means there should be evidence of a particular illness. Social, emotional and psychological factors are not believed to cause unhealthy conditions. This model is narrow and limits the definition of health to the physical and physiological capabilities that are necessary to perform routine tasks.

According to this definition, the individual is healthy if all the body parts, cells, tissues and organ systems are functioning well and there is no apparent dysfunction of the body.

Using this model people view the human body in the same terms as a computer, or mechanical device when something is wrong you take it to experts who maintain it. Physicians, unlike behavioral experts, often focus on treatment and clinical interventions with medication rather than educational interventions to bring about behavior change.

Serena's Story

- About two months ago Serena lost her six month old twins. She is grief stricken. She was always slender but now she looks very thin. She cannot sleep, she cannot eat and she doesn't want to talk to anyone.
- Do you think the view of health you have just read about applies to Serena?

This view of health ignores many of the social and psychological causes of ill health. Serena's grief is not an illness but it is certainly affecting her health.

In the next section we will discuss the broader perspective of health which includes other factors in addition to physical ones.

Broader Perspectives of Health

In the previous section you read about a narrow definition of health. This section will help you understand the concept of health in a broader and more holistic way.

Defining Health

The most widely used of the broader definitions of health is that within the constitution of the World Health Organization (1948), which defines health as: A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. This classic definition is important, as it identifies the vital components of health. To more fully understand the meaning of health, it is important to understand each of its individual components.

Serena's Story

Think back to Serena.

- Describe her state of health.
- Serena is mentally distressed. She does not by any means have mental and social well-being.

Physical Health

To understand physical health you need to know what is considered to be physically *unhealthy* so that you can contrast the two. Physical health, which is one of the components of the definition of health, could be defined as the absence of diseases or disability of the body parts. Physical health could be defined as the ability to perform routine tasks without any physical restriction. The following examples can help you to understand someone who is physically unhealthy:

- A person who has been harmed due to a car accident
- A farmer infected by malaria and unable to do their farming duties
- A person infected by tuberculosis and unable to perform his or her tasks.

Think about someone with physical damage, perhaps due to a car accident.

According to the WHO definition, do you see them as healthy?

Also think about someone in your community who you would consider to be physically disabled.

While both of these people may be restricted in their movement and ability to do routine tasks they may still be in a state of physical and mental well-being.

Health is not limited to the biological integrity and the physiological functioning of the human body. Psychological health is also an important aspect of a health definition.

Psychological Health

- Think about people in the community who are showing behavior that may indicate they are going through a period of mental distress in their lives.
- Or think about Serena again.
- Do you think that everyone in distress shows the same sorts of symptoms?

Sometimes it can be really hard from the outside to tell if the person is struggling with mental health issues, but at other times they show symptoms that suggest a lack of self-awareness or personal identity, or an inability of rational and logical decision-making.

At other times it might be apparent that they are not looking after themselves and are without a proper purpose in their life. They may be drinking alcohol and have a non-logical response to any request. You may also notice that they have an inability to maintain their personal autonomy and are unable to maintain good relationships with people around them.

Social component

The social component of health is considered to be the ability to make and maintain 'acceptable' and 'proper' interactions and communicate with other people within the social environment. This component also includes being able to maintain satisfying interpersonal relationships and being able to fulfill a social role. Having a social role is the ability that people have to maintain their own identity while sharing, cooperating, communicating and enjoying the company of others. This is really important when participating in friendships and taking a full part in family and community life.

Which of the following examples could be considered to contribute to social health? Explain your answers.

1. Mourning when a close family member dies
2. Going to a football game or involvement in a community meeting
3. Celebrating traditional cultural events within your community
4. Shopping in the market
5. Creating and maintaining friendship.

In reality all these events could have a social component and help towards building people's social view of health. They all involve interacting with others and gaining support, friendship and in many instances joy from being with other people.

The World Health Organization in its Ottawa Charter said that health promotion is defined as the process of enabling people to increase control over, and to improve, their health. The aim of health promotion is to reduce the underlying causes of ill-health so that there is a long-term reduction in many diseases.

Summary

Health is a broad concept containing several different aspects. Physical and mental health issues are often interrelated and wellness is expressed through the integration of mental, physical, emotional, spiritual and social health components.

Self-Assessment Question

What do you understand by the following terms?

- Health
- Health promotion

Answer available at the end of this section.

Definitions of Health

If there are complexities in defining disease, there are even more in defining health. Definitions have evolved over time. In keeping with the biomedical perspective, early definitions of health focused on the theme of the body's ability to function; health was seen as a state of normal function that could be disrupted from time to time by disease. An example of such a definition of health is: "a state characterized by anatomic, physiologic, and psychological integrity; ability to perform personally valued family, work, and community roles; ability to deal with physical, biologic, psychological, and social stress."

Just as there was a shift from viewing disease as a state to thinking of it as a process, the same shift happened in definitions of health. Again, the WHO played a leading role when it fostered the development of the health promotion movement in the 1980s. This brought in a new conception of health, not as a state, but in dynamic terms of resiliency, in other words, as "a resource for living." The 1984 WHO revised definition of health defined it as "the extent to which an individual or group is able to realize aspirations and satisfy needs, and to change or cope with the environment. Health is a resource for everyday life, not the objective of living; it is a positive concept, emphasizing social and personal resources, as well as physical capacities. Thus, health referred to the ability to maintain homeostasis and recover from insults. Mental, intellectual, emotional, and social health referred to a person's ability to handle stress, to acquire skills, to maintain relationships, all of which form resources for resiliency and independent living.

Wellness

Many practitioners have expanded their focus to include wellness at the positive end of the health continuum. Some distinguish two interacting dimensions: disease versus non-disease and well-being versus ill-being; others expand the number of dimensions to include spiritual, emotional, social, and mental. Last commented that wellness is "a word used by behavioral scientists to describe a state of dynamic physical, mental, social, and spiritual well-being that enables a person to achieve full potential and an enjoyable life."

But with so much disease to treat, should physicians concern themselves with wellness? Is it appropriate for medicine to seek ways to promote positive health states? Some academics distinguish between a medical care system and a health care system, arguing that, to constrain costs, public funding should be limited to treating illness and restoring the patient's functional capacity. Others note that activities such as counseling and educating healthy individuals on diet and exercise promote wellness and resiliency, and so fall within the scope of normal practice as a part of preventive medicine. Some go further and argue that physicians should advocate for improved work and environmental conditions, such as promoting walking and cycling rather than driving, and should advocate for policies that redistribute income, limit access to unhealthy foods, and support children's programs.

As concepts of health and disease continue to broaden, there will no doubt be pressure for physicians to expand their role to include the promotion of positive health states in their patients. Reflecting this trend, clinical trials evaluating new pharmaceuticals must now include improved quality of life as an outcome, which obviously extends beyond simply improving biomedical indicators of pathology.

Discussions of wellness eroded the hold of the biomedical model. In its place, ecological models of health appeared; these recognize the complex interactions among people, their personal characteristics and the environment, and how these influence health.

Questions to Ponder

1. If no symptoms are produced, is it a disease?
2. Are health and disease different entities or merely different points along a continuum?
3. If so, should we abandon the notion of disease and think only of different levels of health, changing from a categorical to a dimensional model?

Disease or Syndrome?

As we learn more about the biological basis for a patient's illness, it may be reclassified as a disease. For example, constant feelings of tiredness became accepted as the medical condition of chronic fatigue syndrome. Sometimes when a doctor formally labels (diagnoses) a patient's complaint, the complaint is legitimized and this may reassure the patient. Often, however, a set of signs and symptoms eludes biomedical understanding. If the set is frequent enough to be a recognized pattern, it is termed a syndrome instead of a disease.

A syndrome refers to a complex of symptoms that occur together more often than would be expected by chance alone. Whereas diseases often receive explanatory labels (such as hemorrhagic stroke), syndromes are often given purely descriptive labels (e.g., Restless Leg Syndrome). Confusingly, the label 'syndrome' often persists long after the cause is discovered, as with Down syndrome, AIDS (Acquired Immunodeficiency Syndrome) or SARS (Severe Acute Respiratory Syndrome). Meanwhile, Chronic Fatigue Syndrome, Fibromyalgia, Irritable Bowel Syndrome, and Restless Leg Syndrome remain syndromic conditions which, so far, are not well explained by conventional biomedical models.

Watch the videos on Population Health

Well-being Concepts

Well-being is a positive outcome that is meaningful for people and for many sectors of society, because it tells us that people perceive that their lives are going well. Good living conditions (e.g., housing, employment) are fundamental to well-being. Tracking these conditions is important for public policy. However, many indicators that measure living conditions fail to measure what people think and feel about their lives, such as the quality of their relationships, their positive emotions and resilience, the realization of their potential, or their overall satisfaction with life—i.e., their "well-being." Well-being generally includes global judgments of life satisfaction and feelings ranging from depression to joy.

Why is well-being useful for public health?

- Well-being integrates mental health (mind) and physical health (body) resulting in more holistic approaches to disease prevention and health promotion.
- Well-being is a valid population outcome measure beyond morbidity, mortality, and economic status that tells us how people perceive their life is going from their own perspective.
- Well-being is an outcome that is meaningful to the public.
- Advances in psychology, neuroscience, and measurement theory suggest that well-being can be measured with some degree of accuracy.
- Results from cross-sectional, longitudinal and experimental studies find that well-being is associated with:
  - Self-perceived health
  - Longevity
  - Healthy behaviors
  - Mental and physical illness
  - Social connectedness
  - Productivity
  - Factors in the physical and social environment

Well-being can provide a common metric that can help policy makers shape and compare the effects of different policies (e.g., loss of greenspace might impact well-being more so than commercial development of an area).

Measuring, tracking and promoting well-being can be useful for multiple stakeholders involved in disease prevention and health

promotion.

Well-being is associated with numerous health-, job-, family-, and economically-related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities.

Previous research lends support to the view that the negative affect component of well-being is strongly associated with neuroticism and that positive affect component has a similar association with extraversion. This research also supports the view that positive emotions—central components of well-being—are not merely the opposite of negative emotions, but are independent dimensions of mental health that can, and should be fostered. Although a substantial proportion of the variance in well-being can be attributed to heritable factors, environmental factors play an equally if not more important role.

How does well-being relate to health promotion?

Health is more than the absence of disease; it is a resource that allows people to realize their aspirations, satisfy their needs and to cope with the environment in order to live a long, productive, and fruitful life. In this sense, health enables social, economic and personal development fundamental to well-being. Health promotion is the process of enabling people to increase control over, and to improve their health. Environmental and social resources for health can include: peace, economic security, a stable ecosystem, and safe housing. Individual resources for health can include: physical activity, healthful diet, social ties, resiliency, positive emotions, and autonomy. Health promotion activities aimed at strengthening such individual, environmental and social resources may ultimately improve well-being.

How is well-being defined?

There is no consensus around a single definition of well-being, but there is general agreement that at minimum, well-being includes the presence of positive emotions and moods (e.g., contentment, happiness), the absence of negative emotions (e.g., depression, anxiety), satisfaction with life, fulfillment and positive functioning. In simple terms, well-being can be described as judging life positively and feeling good. For public health purposes, physical well-being (e.g., feeling very healthy and full of energy) is also viewed as critical to overall well-being. Researchers from different disciplines have examined different aspects of well-being that include the following:

- Physical well-being
- Economic well-being
- Social well-being
- Development and activity
- Emotional well-being
- Psychological well-being
- Life satisfaction
- Domain specific satisfaction
- Engaging activities and work

How is well-being measured?

Because well-being is subjective, it is typically measured with self-reports. The use of self-reported measures is fundamentally different from using objective measures (e.g., household income, unemployment levels, neighborhood crime) often used to assess well-being. The use of both objective and subjective measures, when available, are desirable for public policy purposes.

There are many well-being instruments available that measure self-reported well-being in different ways, depending on whether one measures well-being as a clinical outcome, a population health outcome, for cost-effectiveness studies, or for other purposes. For example, well-being measures can be psychometrically-based or utility-based. Psychometrically-based measures are based on the relationship between, and strength among, multiple items that are intended to measure one or more domains of well-being. Utility-based measures are based on an individual or group's preference for a particular state, and are typically anchored between 0 (death) to 1 (optimum health). Some studies support use of single items (e.g., global life satisfaction) to measure well-being parsimoniously. Peer reports, observational methods, physiological methods, experience sampling methods, ecological momentary assessment, and other methods are used by psychologists to measure different aspects of well-being.

What are some correlates and determinants of individual-level well-being?

There is no sole determinant of individual well-being, but in general, well-being is dependent upon good health, positive social relationships, and availability and access to basic resources (e.g., shelter, income).
Numerous studies have examined the associations between determinants of individual and national levels of well-being. Many of these studies have used different measures of well-being (e.g., life satisfaction, positive affect, psychological well-being), and different methodologies resulting in occasional inconsistent findings related to well-being and its predictors. In general, life satisfaction is dependent more closely on the availability of basic needs being met (food, shelter, income) as well as access to modern conveniences (e.g., electricity). Pleasant emotions are more closely associated with having supportive relationships.

Note

Optional: Watch this video about how America's culture of consumerism undermines our well-being.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Some general findings on associations between well-being and its associations with other factors are as follows:

Genes and Personality

At the individual level, genetic factors, personality, and demographic factors are related to well-being. For example, positive emotions are heritable to some degree, suggesting that there may be a genetically determined set-point for emotions such as happiness and sadness. However, the expression of genetic effects are often influenced by factors in the environment implying that circumstances and social conditions do matter and are actionable from a public policy perspective. Longitudinal studies have found that well-being is sensitive to life events (e.g., unemployment, marriage). Additionally, genetic factors alone cannot explain differences in well-being between nations or trends within nations.
Some personality factors that are strongly associated with well-being include optimism, extroversion, and self-esteem. Genetic factors and personality factors are closely related and can interact in influencing individual well-being.
While genetic factors and personality factors are important determinants of well-being, they are beyond the realm of public policy goals.

Age and Gender

Depending on which types of measures are used (e.g., life satisfaction vs. positive affect), age and gender also have been shown to be related to well-being. In general, men and women have similar levels of well-being, but this pattern changes with age, and has changed over time. There is a U-shaped distribution of well-being by age younger and older adults tend to have more well-being compared to middle-aged adults.

Income and Work

The relationship between income and well-being is complex. Depending on which types of measures are used and which comparisons are made, income correlates only modestly with well-being. In general, associations between income and well-being (usually measured in terms of life satisfaction) are stronger for those at lower economic levels, but studies also have found effects for those at higher income levels. Paid employment is critical to the well-being of individuals by conferring direct access to resources, as well as fostering satisfaction, meaning and purpose for some. Unemployment negatively affects well-being, both in the short- and long-term.

Relationships

Having supportive relationships is one of the strongest predictors of well-being, having a notably positive effect.

What are some correlates of well-being at the national level?

Countries differ substantially in their levels of well-being. Societies with higher well-being are those that are more economically developed, have effective governments with low levels of corruption, have high levels of trust, and can meet citizens' basic needs for food and health. Cultural factors (e.g., individualism vs. collectivism, social norms) also play a role in national estimates of well-being.

What is the difference between health-related quality of life, well-being, flourishing, positive mental health, optimal health, happiness, subjective well-being, psychological well-being, life satisfaction, hedonic well-being, and other terms that exist in the literature?

Subjective well-being typically refers to self-reports contrasted with objective indicators of well-being. The term, "positive mental health" calls attention to the psychological components that comprise well-being from the perspective of individuals interested primarily in the mental health domain. From this perspective, positive mental health is a resource, broadly inclusive of psychological assets and skills essential for well-being. But, the latter generally excludes the physical component of well-being. "Hedonic" well-being focuses on the "feeling" component of well-being (e.g., happiness) in contrast to "eudaimonic" well-being which focuses on the "thinking" component of well-being (e.g., fulfillment). People with high levels of positive emotions, and those who are functioning well psychologically and socially are described by some as having complete mental health, or as "flourishing."

In summary, positive mental health, well-being and flourishing refer to the presence of high levels of positive functioning—primarily in the mental health domain (inclusive of social health). However, in its broadest sense, well-being encompasses physical, mental, and social domains.

Learning Activity: Mapping the Nation's Well Being

Go to the Mapping the Nation's Well Being webpage to find out how well being differs by location.

1. Click on each of the items under Composite Index.
2. Roll your cursor over the various places on the map where you have lived.
3. Compare the well-being of all the places where you have lived or visited.

Public and Population Health

While public health is a familiar term, it can be difficult to give it a single precise definition. Its general focus is on preventing disease and protecting health: "Public health is defined as the organized efforts of society to keep people healthy and prevent injury, illness, and premature death." But this definition does not give us a clear picture of what is, and what is not, included. In part the difficulty arises because public health does not concern a specific organ system, type of disease or therapeutic approach, but employs a variety of approaches to address whatever health issues are most pressing in each place and time. The discipline has seen a succession of names as it wrestled with whether environmental factors, or individual behavior, or societal policies should form the main focus of interventions.
This debate gave rise to the population health perspective, which holds that, while fostering individual responsibility for health, we must also address underlying social determinants, such as poverty or lack of access to care, that constrain people's ability to achieve real gains in health.

Blaming the Victim

As population health is a relatively new concept, uncertainties remain over details of how, precisely, it differs from public health. Both are concerned with patterns of health and illness in groups of people rather than in individuals; both monitor health trends, examine their determinants, propose interventions at the population level to protect and promote health, and discuss options for delivering these interventions. The distinction is subtle, but population health is seen as broader, as offering a unifying paradigm that links disciplines from the biological to the sociological. It provides a rational basis for allocating health resources that

balances health protection and promotion against illness prevention and treatment, while also making a significant contribution to basic science.
When public health tackles a health issue, its interventions are focused on maintaining health or preventing disease.

- For example, the **public health approach** to childhood obesity might advocate education for parents and children, subsidized healthy school lunch programs, banning soft drinks in school vending machines, tougher regulations on marketing of junk food to children, promoting physical activity, etc.
- A population health approach would tackle childhood obesity in a broader context. A population health approach might be to consider the food system itself: How do agricultural subsidies affect the price of food? Can city planning policies prevent the problem of urban food deserts where significant areas of the population lack access to a grocery store?

Public health focuses on prevention and health protection services, whereas the population health approach is somewhat broader. It still values "health" as a key outcome, but views issues from a broader perspective and tends to include additional considerations, such as economics, environmental sustainability, social justice, etc.

Learning Activity: Influences on Your Health

Draw a circular diagram with yourself at the center. Position the factors that influence your health around the circle.

- If the link to your health is indirect use dotted lines and if there is a direct link use thicker lines.
- Use distance to denote effect: the closer, the stronger the impact.

Does your diagram support the argument that health and ill-health are influenced – or determined – by a wide range of factors and forces?

- How many different influences did you include?
- Are there any patterns in terms of which factors connected directly and which indirectly?

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1.01: Health and Disease Influence of Family and Community

Exercise

1. How can family history influence an individual's risk of developing certain diseases?
2. Describe one way community resources can support health and wellness.
3. What is the difference between acute and chronic diseases?

Answers

Self-Assessment Question

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- 6.2: Cellular Respiration (Instructor Materials Preparation) has no license indicated.

1.4.7.2: Three Levels of Health Promotion/Disease Prevention

Levels of Prevention

Three broad categories of determinants of human behavior will be discussed in this study session and you will have an opportunity to learn about the influence of these factors in determining human behavior.

Prevention, as it relates to health, is really about avoiding disease before it starts. It has been defined as the plans for, and the measures taken, to prevent the onset of a disease or other health problem before the occurrence of the undesirable health event. There are three distinct levels of prevention.

Primary prevention—those preventive measures that prevent the onset of illness or injury before the disease process begins.

- Examples include immunization and taking regular exercise.

Secondary prevention—those preventive measures that lead to early diagnosis and prompt treatment of a disease, illness or injury to prevent more severe problems developing. Here health educators such as Health Extension Practitioners can help individuals acquire the skills of detecting diseases in their early stages.

- Examples include screening for high blood pressure and breast self-examination.

Tertiary prevention—those preventive measures aimed at rehabilitation following significant illness. At this level health services workers can work to retrain, re-educate and rehabilitate people who have already developed an impairment or disability.

Read the list of the three levels of prevention again. Think about your experience of health education, whether as an educator or recipient of health education.

- How do you think health education can help with the prevention of disease?
- Do you think it will operate at all these levels?
- Note an example of possible health education interventions at each level where you think health education can be applied.

Health Education can be applied at all three levels of disease prevention and can be of great help in maximizing the gains from preventive behavior**.**

- For example at the primary prevention level — you could educate people to practice some of the preventive behaviors, such as having a balanced diet so that they can protect themselves from developing diseases in the future.
- At the secondary level, you could educate people to visit their local health center when they experience symptoms of illness, such as fever, so they can get early treatment for their health problems.
- At the tertiary level, you could educate people to take their medication appropriately and find ways of working towards rehabilitation from significant illness or disability.

You have learned that:

- Primary prevention includes those preventive measures that come before the onset of illness or injury and before the disease process begins. Examples include immunization and taking regular exercise to prevent health problems developing in the future.
- Secondary prevention includes those preventive measures that lead to early diagnosis and prompt treatment of a disease, illness or injury. This should limit disability, impairment or dependency and prevent more severe health problems developing in the future.
- Tertiary prevention includes those preventive measures aimed at rehabilitation following significant illness. At this level health educators work to retrain, re-educate and rehabilitate the individual who has already had an impairment or disability.

Summary

- Primary prevention includes those measures that prevent the onset of illness *before* the disease process begins. Immunization against infectious disease is a good example.
- Secondary prevention includes those measures that lead to early diagnosis and prompt treatment of a disease. Breast self-examination is a good example of secondary prevention.
- Tertiary prevention involves the rehabilitation of people who have already been affected by a disease, or activities to prevent an established disease from becoming worse.

Make sure that you are comfortable with the difference between primary prevention activities and secondary prevention activities. Remember that primary prevention activities will actually stop the illness happening, while secondary activities stop the illnesses getting worse.

Learning Activity

1. Go to Take a Look at Health to find out the major health issues facing Americans are today.
2. Click on various risk factors, demographics, diseases and conditions to see graphic comparisons.
    - What are some of the most common conditions, and how are they related to one another?
    - What can we do to improve our health?

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1.4.7.3: Culture, Beliefs, Attitudes, and Stigmatized Illnesses

Cultural Lens and How Culture Influences Your Perceptions

Cultural Awareness, Sensitivity, and Safety

Culture can be defined in terms of the shared knowledge, beliefs, and values that characterize a social group. Humans have a strong drive to maintain the sense of identity that comes from membership in an identifiable group. In primeval and nomadic times, a person's survival likely benefited from establishing strong bonds with an in-group of trusted relatives or clan-mates with whom one co-operated and shared, versus an out-group against which there was competition for scarce resources. Within the intermixing of modern society, many of us seek to retain a sense of cultural identity and may often refer to our cultural roots, or use double-barreled descriptions such as Asian-American. It is important that we are all aware of our own cultural influences and how these may affect our perceptions of others, especially in the doctor-patient encounter. In many subtle ways, the cultural identities of both doctor and patient affect their interaction, and in a diverse country this can form an exciting challenge.

Culture and individual

We all perceive others through the filter or perspective of our own cultural upbringing, often without being aware of it: communication can go wrong without our understanding why. The clinician must become culturally aware and sensitive, then culturally competent so that she or he can practice in a manner that is culturally safe.

Cultural awareness

Cultural competency in medical practice requires that the clinician respects and appreciates diversity in society. Culturally competent clinicians acknowledge differences but do not feel threatened by them. "Culturally competent communication leaves our patients feeling that their concerns were understood, a trusting relationship was formed and, above all, that they were treated with respect." While a clinician will often be unfamiliar with the culture of a particular patient, the direct approach is often the best: ask the patient what you need to understand about her culture and background in order to be able to help her. A direct approach helps establish mutual respect and tailor the best and most appropriate care for each patient.

Awareness of one's own culture is an important step towards awareness of, and sensitivity to, the culture and ethnicity of other people. Clinicians who are not aware of their own cultural biases may unconsciously impose their cultural values on other people. "As physicians, we must make multiple communication adjustments each day when interacting with our patients to provide care that is responsive to the diverse cultural backgrounds of patients in our highly multicultural nation."

Cultural safety refers to a doctor-patient encounter in which the patient feels respected and empowered, and that their culture and knowledge has been acknowledged. Cultural safety refers to the patient's feelings in the health care encounter, while cultural competence refers to the skills required by a practitioner to ensure that the patient feels safe.

To practice in a manner that is culturally safe, practitioners should reflect on the power differentials inherent in health service delivery. Taking a culturally safe approach also implies acting as a health advocate: working to improve access to care; exposing the social, political, and historical context of health care; and interrupting unequal power relations. Given that the patient exists simultaneously within several caring systems, influenced by their family, community, and traditions, the culturally safe practitioner allows the patient to define what is culturally safe for them.
Our culture influences the way we perceive virtually everything around us, often unconsciously. Several useful concepts describe issues that can arise:

- *Ethnocentrism*. The sense that one's own beliefs, values, and ways of life are superior to, and more desirable than, those of others. For example, you may be trained in Western medicine, but your patient insists on taking a herbal remedy. You may be tempted to say "So, why are you consulting me, then?" Ethnocentrism is often unconscious and implicit in a person's behavior. Personal reflection is a valuable tool for physicians to critically examine their own ethnocentric views and behaviors.
- *Cultural blindness*. This refers to attempts (often well-intentioned) to be unbiased by ignoring the fact of a person's race. It is illustrated in phrases such as 'being color blind', or 'not seeing race'. However, ignoring cultural differences may make

people from another culture feel discounted or ignored; what may be transmitted is the impression that race or culture are unimportant, and that values of the dominant culture are universally applicable. Meanwhile, the person who is culturally blind may feel they are being fair and unprejudiced, unaware of how they are making others feel. Cultural blindness becomes, in effect, the opposite of cultural sensitivity.

- *Culture shock*. Most physicians come from middle-class families and have not experienced poverty, homelessness or addictions. Exposure to such realities in their patients therefore requires great adaptations and can be distressing. This is a common experience in those who have visited a slum in a developing country, but may also arise at home in confronting abortion, infanticide, or female circumcision.
- *Cultural conflict*. Conflict generated when the rules of one's own culture are contradicted by the rules of another.
- *Cultural imposition (or cultural assimilation or colonialism)*. The imposition of the views and values of your own culture without consideration of the beliefs of others.
- *Stereotyping and generalization*. What may be true of a group need not apply to each individual. Hence, talking about cultures can lead to dangerously prejudicial generalizations. Prejudice is the tendency to use preconceived notions about a group in pre-judging one of the group's members, so applying cultural awareness to individuals can be hazardous. Yet, on the other hand, ignoring culture (cultural blindness) can be equally detrimental. The key is to acknowledge and be respectful of differences, and to ask patients to explain their perspective when in doubt

The Relevance of Culture for Health

Culture influences health through many channels:

1. *Positive or negative lifestyle behaviors*. While we often focus on the negative influences of lifestyle behavior—such as drug cultures, or the poor diet of some teen cultures, for example—we should not neglect the positive cultural influences on behaviors and practices. For example, Mormons and Seventh Day Adventists have been found to live longer than the general population, in part because of their lifestyle including the avoidance of alcohol and smoking, but also because of enhanced social support.
2. *Health beliefs and attitudes*. These include what a person views as illness that requires treatment, and which treatments and preventive measures he or she will accept, as with the Jehovah's Witness prohibition on using whole blood products.
3. *Reactions to being sick*. A person's adoption of the sick role (and, hence, how he or she or he reacts to being sick) is often guided by his or her cultural roots. For instance, "machismo" may discourage a man from seeking prompt medical attention, and culture may also influence from whom a person will accept advice.
4. *Communication patterns,* including language and modes of thinking. Beyond these, however, culture may constrain some patients from expressing an opinion to the doctor, or may discourage a wife from speaking freely in front of her husband, for example. Such influences can complicate efforts to establish a therapeutic relationship and, thereby, to help the patient.
5. *Status*. The way in which one culture views another may affect the status of entire groups of people, placing them at a disadvantage. The resulting social inequality or even exclusion forms a health determinant. For example, women in some societies have little power to insist on condom use.

What elements of a patient's culture should a health care provider consider when deciding how best to manage a case?

Cultural influences may affect a patient's reaction to the disease, to suggested therapy, and to efforts to help them prevent recurrences by changing risk factors. Therefore, it may be important for health care providers to find out about such possibilities; they can explain that they need them to tell about their family's and community's feelings about health recommendations. Health care providers should explain that they are not familiar with their community and want them to tell if they may have beliefs or obligations that the health care provider should be aware of, such as any restrictions on diet, medications, etc., if these could be relevant.

Difference between cultural competence and cultural safety

Cultural competence is included within cultural safety, but safety goes beyond competence to advocate actively for the patient's perspective, to protect their right to hold the views they do. When a patient knows that you will honor and uphold their perspective and not try to change it, they will be more likely to accept your recommendations. A physician who practices culturally safe care has reflected on her own cultural biases recognizes them and ensures that her biases do not impact the care that the patient receives. This pattern of self-reflection, education and advocacy is also practiced at the organizational level.

Example: Breast Cancer in Asian Women

Asian women, in general, and Vietnamese women, in particular, have been identified as ethnic groups that are not participating in breast cancer screening programs in the U.S. The reasons are complex and Vietnamese women may be especially vulnerable due to cultural variances in beliefs, health practices, language barriers, lack of access to care due to socio-economic factors, as well as the long term effects of the migration that occurred at the close of the Vietnam war.

Learning Activity

Find out about how culture impacts health decisions and access by visiting each of the websites linked in the list below:

- Hispanic-Latino Culture
- Chinese Culture
- Iraqi Culture
- Vietnamese Culture
- Lesbian, Gay, Bisexual, and Transgender Health Issues

What are some of the positive and/or negative ways that culture impacts an individual's health care decisions and access?

Answer available at the end of this section.

Stigmatized Illnesses and Health Care

Being disabled because of a disease or injury can lead to benefits – for example, a parking space that is close by. In some instances, the benefits are very attractive but, in most countries of the world, the disabled have no access to any governmental help, and insurance premiums are so high that only a minority of the population can participate in disability compensations schemes. In some situations, disability due to a war injury or to some other situation that confers hero status can also bring social respect and moral prestige to the disabled person.

For the vast majority of disabled people, however, the disadvantages of disability are much more important than its advantages. A restriction of the possibility of participation in normal social life and limitations in the pursuit of personal happiness are often grave and depressing for the person with an impairment that causes a disability.

When the disease or the situation that has produced impairment is stigmatized, the limitations of functions are aggravated and the possibility of compensating disability is significantly reduced. There are a number of diseases that are stigmatized—mental disorders, AIDS, venereal diseases, leprosy, and certain skin diseases. People who have such diseases are discriminated in the health care system, they usually receive much less social support than those who have non-stigmatizing illnesses and—what is possibly worst—they have grave difficulties in organizing their life if their disease has caused an impairment that can lead to disability and handicaps.

Mental disorders probably carry more stigma (and consequent discrimination) than any other illness. The stigma does not stop at the persons who are suffering from a stigmatized illness. Their immediate and even remote families often experience significant social disadvantages. The institutions that provide mental health care are stigmatized. Stigma reduces the value of the persons who have a mental disorder in the eyes of the community and the government.

Medications that are needed in the treatment of mental disorders, for example, are considered expensive even when their cost is much lower than the cost of drugs used in the treatment of other illnesses: they are not considered expensive because of their cost but because they are meant to be used in the treatment of people who are not considered to be of much value to the society.

The awareness of the fact that stigmatization is one of the major—if not the major—obstacles to the improvement of care for people with stigmatized illnesses is gradually growing. In a number of countries governments, non-governmental organizations, and health institutions have launched campaigns to reduce stigma related to illness. They display posters and distribute leaflets, as well as organize radio and television programs.

There is, however, an important sector employing many individuals that does not participate very actively in the reduction of stigma and in efforts to eliminate the discrimination that follows it. It is the health sector—which, by its definition, could gain

from the reduction of stigma almost as much as the individuals who have the stigmatized illness. The managements of general hospitals, as well as heads of various medical departments often refuse to have a department of psychiatry and, if they accept it, they usually assign the worst accommodation for it—in a remote corner of the hospital grounds, for example, or in the lowest (sometimes partly underground) floor. In the order of priority for maintenance or renovation work departments of psychiatry come last although they are often in a pitiful state. Doctors who are not involved in mental health care participate and sometimes excel in making fun of the mentally ill, of psychiatrists, and of mental illness. They will often refuse to deal with physical illness in a person with a mental disorder and send such patients to their psychiatrist, although they are better placed to deal with the physical illness than the psychiatrist.

Nor are the psychiatrists and other mental health care staff doing as much as they should about the reduction of stigma. They seem unaware of the stigmatizing effects of their use of language—they speak of schizophrenics when they should say a person with schizophrenia and about misbehavior or lack of discipline when they should make it clear that behavioral abnormalities are part of the illness they are supposed to recognize and treat. In some countries they requested and received longer holidays or somewhat higher salaries saying that they deserve this because they deal with dangerous patients—although they have publicly proclaimed that mental illness is a disease like any other. They often disregard complaints about the physical health of people with mental disorders and do not do much about them, thus providing sub-optimal care and contributing to the tendency to dismiss whatever people with mental illness may be saying. In their teaching activities, stigmatization as well as the prevention of discrimination and its other consequences often receive only minimal attention.

Perhaps it is impossible for the health care workers themselves to launch large anti-stigma programs: what, however, they should and can do is to examine their own behavior and activity to ensure that they do not contribute to stigmatization and consequent discrimination. They should also participate in the efforts of others to reduce stigma or initiate such efforts whenever possible. Doing nothing about stigma and discrimination that follows it is no longer an acceptable option.

The Cultural Meaning of Illness

Our culture, not our biology, dictates which illnesses are stigmatized and which are not, which are considered disabilities and which are not, and which are deemed contestable (meaning some medical professionals may find the existence of this ailment questionable) as opposed to definitive (illnesses that are unquestionably recognized in the medical profession) (Conrad and Barker 2010). For instance, sociologist Erving Goffman (1963) described how social stigmas hinder individuals from fully integrating into society. The stigmatization of illness often has the greatest effect on the patient and the kind of care he or she receives. Many contend that our society and even our health care institutions discriminate against certain diseases—like mental disorders, AIDS, venereal diseases, and skin disorders (Sartorius 2007). Facilities for these diseases may be sub-par; they may be segregated from other health care areas or relegated to a poorer environment. The stigma may keep people from seeking help for their illness, making it worse than it needs to be. Contested illnesses are those that are questioned or questionable by some medical professionals. Disorders like fibromyalgia or chronic fatigue syndrome may be either true illnesses or only in the patients' heads, depending on the opinion of the medical professional. This dynamic can affect how a patient seeks treatment and what kind of treatment he or she receives.

In terms of constructing the illness experience, culture and individual personality both play a significant role. For some people, a long-term illness can have the effect of making their world smaller, more defined by the illness than anything else. For others, illness can be a chance for discovery, for re-imaging a new self (Conrad and Barker 2007). Culture plays a huge role in how an individual experiences illness. Widespread diseases like AIDS or breast cancer have specific cultural markers that have changed over the years and that govern how individuals—and society—view them.

Today, many institutions of wellness acknowledge the degree to which individual perceptions shape the nature of health and illness. Regarding physical activity, for instance, the Centers for Disease Control (CDC) recommends that individuals use a standard level of exertion to assess their physical activity. This Rating of Perceived Exertion (RPE) gives a more complete view of an individual's actual exertion level, since heart-rate or pulse measurements may be affected by medication or other issues (Centers for Disease Control 2011a). Similarly, many medical professionals use a comparable scale for perceived pain to help determine pain management strategies.

Answers

Learning Activity

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1.4.7.4: Determinants of Health, Risk Factors, and Prevention

Determinants of Health

- What makes some people healthy and others unhealthy?
- How can we create a society in which everyone has a chance to live long healthy lives?

The range of personal, social, economic, and environmental factors that influence health status are known as determinants of health.

Determinants of health fall under several broad categories:

- Social factors
- Health services
- Individual behavior
- Biology and genetics

It is the interrelationships among these factors that determine individual and population health. Because of this, interventions that target multiple determinants of health are most likely to be effective. Determinants of health reach beyond the boundaries of traditional health care and public health sectors; sectors such as education, housing, transportation, agriculture, and environment can be important allies in improving population health.

Policymaking

Policies at the local, State, and Federal level affect individual and population health. Increasing taxes on tobacco sales, for example, can improve population health by reducing the number of people using tobacco products.

Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. For example, the 1966 Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the Federal Government to set and regulate standards for motor vehicles and highways. This led to an increase in safety standards for cars, including seat belts, which in turn, reduced rates of injuries and deaths from motor vehicle accidents.

Social

Social determinants of health reflect social factors and the physical conditions in the environment in which people are born, live, learn, play, work and age. Also known as social and physical determinants of health, they impact a wide range of health, functioning and quality of life outcomes.

Examples of social determinants include:

- Availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods
- Exposure to crime, violence, and social disorder, such as the presence of trash
- Social support and social interactions
- Exposure to mass media and emerging technologies, such as the Internet or cell phones
- Socioeconomic conditions, such as concentrated poverty
- Quality schools
- Transportation options
- Public safety
- Residential segregation

Examples of physical determinants include:

- Natural environment, such as plants, weather, or climate change
- Built environment, such as buildings or transportation

- Worksites, schools, and recreational settings
- Housing, homes, and neighborhoods
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities
- Aesthetic elements, such as good lighting, trees, or benches

Poor health outcomes are often made worse by the interaction between individuals and their social and physical environment.

For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with State and national averages. Poor air quality can worsen asthma symptoms, especially in children.[2]

Health Services

Both access to health services and the quality of health services can impact health. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas.

Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment.[3]

Barriers to accessing health services include:

- Lack of availability
- High cost
- Lack of insurance coverage
- Limited language access

These barriers to accessing health services lead to:

- Unmet health needs
- Delays in receiving appropriate care
- Inability to get preventive services
- Hospitalizations that could have been prevented

Individual Behavior

Individual behavior also plays a role in health outcomes. For example, if an individual quits smoking, his or her risk of developing heart disease is greatly reduced.

Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country.

Examples of individual behavior determinants of health include:

- Diet
- Physical activity
- Alcohol, cigarette, and other drug use
- Hand washing

Biology and Genetics

Some biological and genetic factors affect specific populations more than others. For example, older adults are biologically prone to being in poorer health than adolescents due to the physical and cognitive effects of aging.

Sickle cell disease is a common example of a genetic determinant of health. Sickle cell is a condition that people inherit when both parents carry the gene for sickle cell. The gene is most common in people with ancestors from West African countries, Mediterranean countries, South or Central American countries, Caribbean islands, India, and Saudi Arabia.

Examples of biological and genetic social determinants of health include:

- Age
- Sex
- HIV status
- Inherited conditions, such as sickle-cell anemia, hemophilia, and cystic fibrosis
- Carrying the BRCA1 or BRCA2 gene, which increases risk for breast and ovarian cancer
- Family history of heart disease

Social Determinants of Health

Social determinants of health are economic and social conditions that influence the health of people and communities. These conditions are shaped by the amount of money, power, and resources that people have, all of which are influenced by policy choices. Social determinants of health affect factors that are related to health outcomes. Factors related to health outcomes include:

- How a person develops during the first few years of life (early childhood development)
- How much education a persons obtains
- Being able to get and keep a job
- What kind of work a person does
- Having food or being able to get food (food security)
- Having access to health services and the quality of those services
- Housing status
- How much money a person earns
- Discrimination and social support

What are determinants of health and how are they related to social determinants of health?

Determinants of health are factors that contribute to a person's current state of health. These factors may be biological, socioeconomic, psychosocial, behavioral, or social in nature. Scientists generally recognize five determinants of health of a population:

- Genes and biology: for example, sex and age
- Health behaviors: for example, alcohol use, injection drug use (needles), unprotected sex, and smoking
- Social environment or social characteristics: for example, discrimination, income, and gender
- Physical environment or total ecology: for example, where a person lives and crowding conditions
- Health services or medical care: for example, access to quality health care and having or not having insurance

Other factors that could be included are culture, social status, and healthy child development. Scientists do not know the precise contributions of each determinant at this time.

In theory, genes, biology, and health behaviors together account for about 25% of population health. Social determinants of health represent the remaining three categories of social environment, physical environment/total ecology, and health services/medical care. These social determinants of health also interact with and influence individual behaviors as well. More specifically, social determinants of health refer to the set of factors that contribute to the social patterning of health, disease, and illness.

Why is addressing the role of social determinants of health important?

Addressing social determinants of health is a primary approach to achieving health equity. Health equity is "when everyone has the opportunity to 'attain their full health potential' and no one is 'disadvantaged from achieving this potential because of their social position or other socially determined circumstance." Health equity has also been defined as "the absence of systematic disparities in health between and within social groups that have different levels of underlying social advantages or disadvantages—that is, different positions in a social hierarchy." Social determinants of health such as poverty, unequal access to health care, lack of education, stigma, and racism are underlying, contributing factors of health inequities.

Learning Activity

Go to the Your Health Profile webpage and answer the questions.

- What conditions do people with your health profile most frequently experience?
- Are you under- or overweight?

Risk Factors

What is a risk factor?

Risk factors are things in your life that increase your chances of developing a condition or disease. They can include things like family history, exposures to things in the environment, being a certain age or sex, being from a certain ethnic group, or already having a health condition. If you do have risk factors, your doctor or nurse will most likely want you to be screened or immunized at a younger age or more often than what is recommended. Check with your doctor or nurse to find out if you need to have specific health screenings and how often you will need them.

Understanding Risk Factors

Part of learning how to take charge of your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control. You may be born with them or exposed to them through no fault of your own. Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender—male or female
- Ancestry

Some risk factors you can control include

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you use illegal drugs
- Whether you use your seat belt

In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

Learning Activity: Find Out about Your Own Health Risks

Fill out the questionnaire at Keep Me Well to get the following results:

- Scorecard: An easy-to-read summary of your results that will show you where to focus your efforts to best improve your health.
- My Report: A more detailed report that provides feedback and links to trusted health information websites that will help you take action to lower your risk for chronic disease.
- Local Community Supports and Programs: A list of resources in your area that can help you take action to improve your health.

Having more than one risk factor

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

Inheriting risk—your family health history

Rarely, you can inherit a mutated gene that alone causes you to get a disease. Genes control chemical reactions in our bodies. If you inherit a faulty gene, your body may not be able to carry out an important chemical reaction. For instance, a faulty gene may make your blood unable to clot. This problem is at the root of a rare bleeding disorder. More often, you can inherit genes from one or both of your parents that put you at higher risk of certain diseases. But having a gene for a certain disease does not always mean you will get it. There are many unknown factors that may raise or lower your chances of getting the disease. People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early.

People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run. Your family's health history could be important for determining health risks for you and your children. Learn more about how to document your family's health history and share it with your doctor. It is important to talk to your doctor or nurse about your individual health risks, even if you have to bring it up yourself. And it's important for your doctor to know not just about your health, but your family health history as well. Come to health care visits armed with information about you, your children, siblings, parents, grandparents, aunts and uncles, and nieces and nephews, including

- Major medical conditions and causes of death
- Age of disease onset and age at death
- Ethnic background
- General lifestyle information like heavy drinking and smoking

Family Health History

Family health history can help your doctor make a diagnosis if you or your children shows signs of a disorder. It can reveal whether you or your children have an increased risk for a disease; if so, the doctor might suggest screening tests. Many genetic disorders first become obvious in childhood, and knowing about a family health history of a genetic condition can help find and treat the condition early.

Update your family health history information regularly and share new information with your doctor. Remember that relatives can be newly diagnosed with conditions between doctor's visits.

The best way to learn about your family health history is to ask questions. Talk at family gatherings and record your family's health information—it could make a difference in your child's life.

Learning Activity: My Family Health Portrait

Use the US Surgeon General's online tool for collecting family health histories, called My Family Health Portrait. (If you are not able to do this activity with your own birth family, you can do this activity for someone else who does know his/her family health history.)

- Enter your family health history.
- Record the names of your close relatives from both sides of the family: parents, siblings, grandparents, aunts, uncles, nieces, and nephews. Include conditions each relative has or had and at what age the conditions were first diagnosed.
- For relatives who are deceased, include the cause of death and the age at death.
- Print your family health history to share with family or your health care worker.

- Save your family health history so you can update it over time.
- Talk with your health care worker about your family health history

Optional Learning Activity: Healthier You

Complete a personal health risk assessment and family health history. Determine what you can do to enhance your own health and decrease your health risks.

Check out these resources to find out more about Family Health History

- NIH Senior Health: Creating a Family Health History
- Family Health History

Examples of actions to take:

- Bring your weight and BMI to normal levels
- Stop smoking
- Bring your cholesterol levels to a healthy level
- Increase your aerobic, muscle-strengthening, and bone-strengthening activities
- Reduce your consumption of alcohol

Factors Affecting Human Health

Risk factors are those inherited, environmental and behavioral influences which are considered to increase the likelihood of physical or mental health problems in the future. After studying this session you will be able to describe health risk factors and explain their association with human health.

Health and human behavior

Behavior is an action that has a specific frequency, duration and purpose whether conscious or unconscious. It is what we do and how we act.

Health behaviors are those personal behavior patterns, actions and habits that people perform in order to stay healthy, in order to restore their health when they get sick and in order to improve their health status.

Types of health behaviors

In this section, you will learn about six different types of health behavior that people may perform — from the initial stages of preventing diseases up to their actions that may be associated with attempts to rehabilitate themselves after a bout of illness.

- *Preventive health behaviors*: These are actions that healthy people undertake to keep themselves or others healthy and prevent disease or detect illness when there are no symptoms. Examples include handwashing with soap, using insecticide treated mosquito nets and exclusive breastfeeding to age six months.
- *Illness behaviors:* These include any activities undertaken by individuals who perceive themselves to be ill. This would include recognition of early symptoms and prompt self referral for treatment.
- *Sick-role behaviors:* These include any activity undertaken by individuals who consider themselves to be ill, for the purpose of getting well. It includes receiving treatment from medical providers and generally involves a whole range of potentially dependent behaviors. It may lead to some degree of exemption from one's usual responsibilities. For example a person who feels that he is ill might visit the nearby health center and receive tablets to be taken home, and might then not do as much work as normal.
- *Compliance behaviors:* This means the person will be following a course of prescribed treatment according to the instructions that the health worker has given them.
- *Utilization behaviors:* This is the sort of behavior that is described when people use their health services such as antenatal care, family planning, immunization, taking a sick person for treatment, etc.
- *Behavior* is an action that has a specific frequency, duration and purpose whether conscious or unconscious. It is what we

do and how we act. People stay healthy or become ill often as a result of their own actions or behavior.

Preventive health behaviors are actions that healthy people undertake to keep themselves or others healthy. Examples include good nutrition and exclusive breastfeeding until the age of six months.

- *Illness behaviors* include any activities undertaken by an individual who perceives him or herself to be ill.
- *Compliance behaviors* are to do with following a course of prescribed treatment regimes.
- *Utilization behaviors* involve the utilization of health services such as antenatal care or family planning.
- *Rehabilitation behaviors* are the ways that people behave after a serious illness to get themselves better again.
- *Determinants of health* are the biological, environmental, behavioral, organizational, political and social factors that contribute either positively or negatively to the health status of individuals, groups and communities.
- *Risk factors* are those inherited, environmental and behavioral influences which are known or thought to increase the likelihood of physical or mental health problems. Risk factors increase the probability of morbidity and premature mortality, but do not guarantee that people with the risk factors will suffer the consequences.
- *Non-modifiable (non-changeable or non-controllable) risk factors* include factors such as age, sex and inherited genes — things that individuals cannot change or do not have control over.

Learning Activity

Choose one healthy lifestyle habit that you would like to adopt or improve.

- What habit do you want to change or improve?
- Why did you choose this habit?
- Try using the online Health Month game to track your progress.

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1.4.8: TAKING CHARGE OF YOUR HEALTH

The choices you make each day can impact your quality and quantity of life. At the beginning of this chapter you were invited to reflect on your health across the Nine Dimensions of Wellness by giving yourself a score from 1-10 that would reflect your health in each dimension from low to high. You were also invited to identify possible behaviors you could change that would positively impact your health in each dimension. This is a very helpful activity for helping you to identify what you can do to stay healthy throughout life. The first step in any behavior change is to recognize what you can and should change.

Are you ready to change your behaviors?

You may be able to quickly identify behaviors your could change to increase your wellness, but you might not be able to quickly begin implementing the change. Are you ready to change your unhealthy behaviors?

The Stages of Change, also called the Transtheoretical model of behavior change, was developed by Prochaska and DiClemente to help understand the stages a person goes through when trying to make changes in their life. It assesses an individual's readiness to implement a healthier behavior, and provides insight into the decision-making process that leads to action. The five stages include: precontemplation, contemplation, preparation, action, and maintenance. You might not go through the stages linearly, rather you might find yourself moving between them, and regressing. For example, you might first believe you are in the Preparation Stage and then realize you are actually in the Contemplation stage. Or you might jump into the Action stage beginning the change, and then discontinue with your plan stepping back into the Preparation or Contemplation stage.

As you review the five stages of the Stages of Change, along with characteristics and strategies[9], think about a behavior you'd like to change and identify which stage you are currently in and what you could do to move to the next stage:

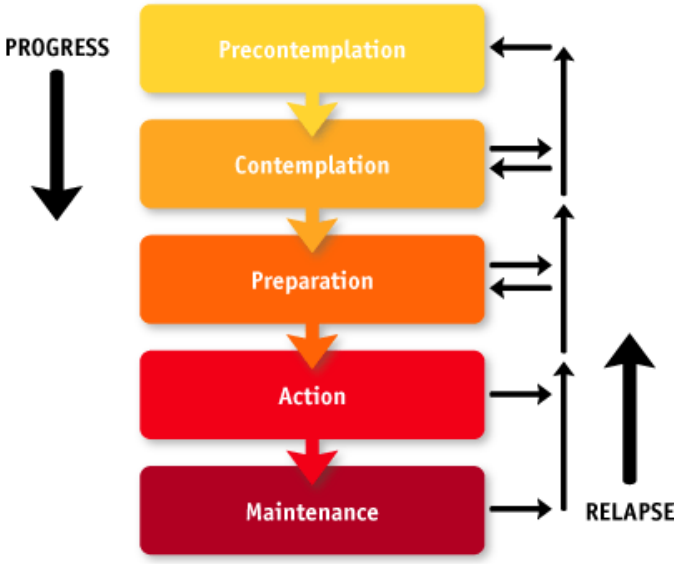


Figure1.1.1.1 : Stages of Change

Precontemplation Stage (not ready to change):

People in the precontemplation stage are not intending to take action in the foreseeable future, are not interested in getting help, and can be unaware or do not believe that their behavior is problematic.

- Characteristics: Ignoring or ignorance of the problem, or denying the problem exists.
- Strategies to move to next stage: Identify the risks to your life if you do not change and take time to analyze or rethink your behaviors and action.

Contemplation Stage (getting ready to change):

People in the contemplation stage are beginning to recognize that their behavior is problematic, be more aware of the consequences of their behavior, and start to look at the pros and cons of either continuing or changing their behavior. They be more accepting or receptive to information about their unhealthy behavior and more open to learn about ways they could change.

- Characteristics: Being doubtful or ambivalence of the change, or having conflicted emotions about the change.
- Strategies to move to next stage: Make a list of the pros and cons of changing your behavior, identify barriers to changing and strategies you could use to overcome the barriers, lastly look for resources that could help you make the change.

Preparation Stage (ready to change):

People in the Preparation stage are intending to take action in the immediate future, they are committed to making changes, and may begin taking small steps toward behavior change by researching to find resources or strategies to help them with their change. This stage likely includes the development of a behavior change plan.

- Characteristics: Experimenting with small changes and collecting information about the change.
- Strategies to move to next stage: Write down your goals, prepare a plan of action, and make a list of motivating statements.

Action Stage (actively changing):

People in the action stage believe they can change and are actively changing their behaviors. They are open to help, seek support, and work to overcome barriers to stay committed.

    - Characteristics: Direct action toward goal.
    - Strategies to move to next stage: Reward your successes and seek out social support.

Maintenance Stage (maintain change):

People in the maintenance stage have been able to sustain action for at least six months and are working to prevent relapse into previous unhealthy behaviors.

    - Characteristics: Maintenance of the new behavior and avoiding temptations.
    - Strategies to prevent relapse: Developing positive coping strategies for overcoming temptations and remember to continue to reward yourself.

Making the Change with SMART Goal Setting

Have you ever tried to change your behaviors? Maybe you set a New Years Resolution? How did it go?

If you have been successful at changing your behaviors it is highly likely that you followed a very specific plan. If you haven't been successfully, you likely followed a path similar to what many people do around January first each year which is make broad statements such as "I am going to lose weight this year" or "this is the year I am going to work out" or "I am going to get healthy." Each of these statements have a good intent, but are lacking an actual goal or target to achieve. It is like saying you are taking a vacation but haven't made any plans, haven't decided where to go, or how you will get there.

Setting SMART goals can help you to have a better chance at being successful with behavior change by giving you direction and a target to achieve. SMART stands for Specific, Measurable, Attainable/Achievable, Realistic, Time-oriented.

Setting a SMART goal requires the goal setter to think about the factors involved in achieving their goal. Defining each of the five characteristics can help to define a pathway to reaching the goal. The more well-defined that pathway becomes, the easier it is to follow.



Figure:

Specific

Create a goal that has a focused and clear path for what you actually need to do. The goal needs to be concrete, detailed, and well defined so that you know where you are going and what to expect when you arrive. What do you want to accomplish? Why have you set this goal?

Measurable

Create a goal that provides means of measurement and comparison by using numbers and quantities, this enables you to track your progress. Including measurement lets you know whether or not you have met your goal. How will you measure your progress? How will you know when you have successfully achieved your goal?

Attainable/Achievable

Make sure that your goal is within your capabilities and not too far out of reach. For example, if you have not been physically active for a number of years, it would be highly unlikely that you would be able to achieve a goal of running a marathon within the next month. Your goal must be feasible and easy to put into action. Do you have the skills, abilities, or time needed to achieve your goal?

Realistic/Relevant

When deciding on your goal considers constraints such as resources, personnel, and cost. Try to ensure that your goal is something you will be able to continue doing and incorporate as part of your regular routine/lifestyle. For example, if you made a goal to kayak 2 times each week, but don't have the financial resources to purchase or rent the equipment, no way to transport it, or are not close enough to a body of water in which to partake in kayaking, then this is not going to be feasible. Why do want to achieve the goal? Is your goal in line with your lifestyle?

Time-Oriented/Time-Bound/Timely

A time frame helps to set boundaries around the objective. Give yourself a target date or deadline in which the goal needs to be met. This will keep you on track and motivated to reach the goal, while also evaluating your progress. What is your timeline to change?

Moving from Broad to SMART Goals

Here's are examples of changing from a vague goal to a SMART goal:

- Change “I will workout” to “I will engage in 30 minutes of aerobic physical activity 5 days a week for the next 4 weeks.”
- Change “I will lose weight” to “I will lose weight by tracking my calories every day for the next 2 months and reducing my calorie intake by 10% each week beginning week 1 with 2,000 calories/day intake, week 2 calorie intake 1,800 calories/day, week 3 calorie intake 1,620 calories/day, etc.”
- Change “I will be happier” to “I will increase my happiness by incorporating positive affirmations into my daily life. For the next two months I will begin week 1 with choosing one positive affirmation that I will repeat to myself five times a day. Each subsequent week I will add another affirmation so that by week 8 I am repeating 8 positive affirmations five times a day.”
- Change “I will go to the gym” to “I will increase my physical activity by doing cardio and weight training at the gym four times a week for the next 10 weeks. I will track my progress by keeping a workout log. I will increase cardio time and weight training reps/sets each week by 5-10%”

Practice Setting SMART Goals

What is a broad goal you would like to achieve? For example, have you said to yourself or others, “I want to lose weight,” or “I want to eat better.”

Identify a broad goal you would like to achieve and practice changing it to a SMART goal that is Specific, Measurable, Attainable/Achievable, Realistic/Relevant, and Time-oriented/time-bound.

Use might find the following template helpful for developing your SMART goals:

“I will [what is your goal?] by [what will you do? where will you do it? when will you do it?]. I will track my progress by [how will you measure the goal?] for [how long will you do this?].”

1.4.8.1: Taking Charge of your health - Making Healthy Changes

1.4.8.2: Taking Charge of your health - Making Healthy Changes

1.4.8.3: Key takeaways for this chapter

1.4.8.4: End-of-Chapter Material

1.4.8.4.1: End-of-Chapter Material

1.4.8.5: Promoting Health- Optional Continued Learning

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1.4.8.1: Taking Charge of your health - Making Healthy Changes

Increase Your Opportunity for Successful Change

Behavior change is hard for many reasons. Here are some strategies to help increase your chances of successfully achieving your health and wellness goals.

Set approach goals instead of avoidance goals[10]

Approach goals are goals where you are taking actions to meet a desired outcome, whereas avoidance goals are focused on not taking actions. Research has shown that we are more successful when we set approach goals rather than avoidance goals. For example, rather than setting an avoidance goal such as “I will not drink soda” the focus could be “I will drink water instead of soda.”

Set mastery (learning) goals instead of performance goals[11]

A performance goal might be to lose 20 pounds, whereas a mastery (learning) goal would focus on the actions you are taking to lose weight, such as focusing on your nutrition or exercise. A mastery skill involves increasing existing abilities or learning new skills. Performance goals may be less effective than mastery goals. It is ok to set a performance goal, but it should always be accompanied by a mastery goal.

Find Your Why

Take a moment to think about why you want to change. How will this change make your life better? How will this change help you feel better, have better relationships with yourself and others, or help your family or friends? You might like to refer to this as finding or discovering your why.

Your Daily Action Plan

If you think about your SMART goal as your destination, how will you get there and what are the directions or what route will you take? Developing an action plan is a helpful strategy to increase your motivation. An action plan specifies the what (always a behavior), how much, how often, and usually when (which days and times), in other words it is the steps by which the SMART goal will be achieved. Your action plan provides you with your goal for each day allowing you to focus on your day-to-day actions rather than just on your long term goal. This allows you to be successful each day that you complete your stated actions in your action plan.

Boost Your Self Efficacy

Implementing a carefully and thoughtfully crafted action plan can help to improve health and build your self efficacy[12]. Self-Efficacy is the confidence in one’s ability to achieve a specific goal, it is the belief in oneself that you can do it. Implementing and meeting the goals of your action plan is a great strategy for building your self-efficacy, which in turn builds your motivation to change.

A Positive Mindset

Having a positive mindset can also help to increase your self-efficacy. This might include focusing on positive self-talk whereby purposefully telling yourself that you can complete your goals. A positive mindset may also take the form of finding enjoyment in your changes. When the thought of your change brings you enjoyment, you are more likely to engage in the behavior change and stick to it[13].

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1.4.8.3: Key takeaways for this chapter

- Your health is your state of well-being.
- Wellness is the active process of achieving health through growth and change.
- Wellness is a broad concept and encompasses nine dimensions: Physical, Emotional, Social, Environmental, Financial, Intellectual, Occupational, Spiritual, and Cultural.
- A healthy population is a nations greatest resource, it means a productive population, a prosperous population, and a healthy economy.
- The top causes of death, cardiovascular disease and cancer, are highly impacted by your lifestyle choices.
- Increasing health literacy is an important skill to ensure people can find, understand, and use valid reliable information to make healthy decisions.
- Everyone is at a different readiness to change and can take steps to actively change unhealthy behaviors.
- Use SMART goal setting to change broad health goals into action oriented goals that you can achieve.

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1.4.8.4: END-OF-CHAPTER MATERIAL

Key takeaways for this Chapter

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1.4.8.5: Promoting Health- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

Fun Theory- Piano Stairs

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

How to change your behavior for the better

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

The best career path isn't always a straight line

Interactive Content

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this Interactive Content online



The rise of predatory scams — and how to prevent them

Interactive Content

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View this Interactive Content online



Try something new for 30 days

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online



Why some people find exercise harder than others

Interactive Content

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View this Interactive Content online



Lessons from the longest study on human development

Interactive Content

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this Interactive Content online



How humanity doubled life expectancy in a century

Interactive Content

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View this Interactive Content online



Your genes are not your fate

YouTube Video

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View this YouTube Video online



The 1-minute secret to forming a new habit

Interactive Content

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this Interactive Content online



The moral bias behind your search results

Interactive Content

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this Interactive Content online

A simple way to break a bad habit

Interactive Content

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this Interactive Content online

5 tips to improve your critical thinking

Interactive Content

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2: HEALTH AND FITNESS



2.1: Exercise and Nutrition (Markell, Peterson, and Johnson)

2.1.1: Healthy Behaviors and Wellness

2.1.1.1: Why Study Wellness?

2.1.1.2: Dimensions of Wellness

2.1.1.3: Health Problems in the United States

2.1.1.4: Behaviors That Promote Wellness

2.1.1.5: Behavior Modification

2.1.1.6: Lifestyle Modification Barriers

2.1.1.7: Fostering Wellness in Your Life

2.1.1.8: Start with “Why?”

2.1.1.9: Test Your Knowledge

2.1.2: Fitness Principles

2.1.2.1: Exercise- Not a Passing Fad

2.1.2.2: What are Physical Activity and Exercise?

2.1.2.3: Components of Health-Related Fitness

2.1.2.4: Principles of Adaptation to Stress

2.1.2.5: FITT

2.1.2.6: Specificity

2.1.2.7: Rest, Recovery, and Periodization

2.1.2.8: Reversibility

2.1.2.9: Individual Differences

2.1.2.10: Creating a Successful Fitness Plan

2.1.2.11: Additional Safety Concerns

2.1.2.12: Test Your Knowledge

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2.1.1: HEALTHY BEHAVIORS AND WELLNESS

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2.1.1.1: Why Study Wellness?

As most college students do, you have probably set goals. Obviously, your individual goals differ from those of your fellow classmates, but everyone's goals share one common attribute: their intention to improve individual wellbeing. However, there are as many ideas about how to do that as there are individuals. Do your goals involve making more money, achieving better health, improving your relationships? Holistic wellness involves all those aspects of life and more. This chapter explains the importance of overall wellness, which is about more than being physically and mentally healthy, free from illness and disease. In fact, the study of wellness incorporates all aspects of life. Achieving overall wellness means living actively and fully. People in this state exude confidence, optimism, and self-efficacy; they have the energy reserves to do what needs to be done today and to plan for a better tomorrow. The most effective and transformative goals are those designed to achieve the highest level of personal wellness.

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2.1.1.2: Dimensions of Wellness

Wellness is a familiar term, but what is its true definition? Is it simply the absence of disease? This chapter will define all the components of holistic wellness and describe the factors that contribute to not only a person's physical and mental health, but also their ability to develop, thrive, succeed, enjoy life, and meet challenges head on with confidence and resolve.

To achieve optimal wellness, a person must be healthy in nine interconnected dimensions of wellness: physical, emotional, intellectual, spiritual, social, environmental, occupational, financial, and cultural. A description of each dimension follows.

The Nine Dimensions of Wellness

1. Physical Wellness

People who are physically well actively make healthy decisions on a daily basis. They eat a nutritionally balanced diet, they get an adequate amount of sleep, they deal with stress and visit the doctor routinely. They make a habit of exercising three to five times per week, they have the ability to identify their personal needs and are aware of their body's limitations. They maintain positive interpersonal relationships and make healthy sexual decisions that are consistent with their personal values and beliefs.

2. Emotional Wellness

An emotionally well person successfully expresses and manages an entire range of feelings, including anger, doubt, hope, joy, desire, fear, and many others. People who are emotionally well maintain a high level of self-esteem. They have a positive body-image and the ability to regulate their feelings. They know where to seek support and help regarding their mental health, including but not limited to, seeking professional counseling services.

3. Intellectual Wellness

Those who enjoy intellectual wellness engage in lifelong learning. They seek knowledge and activities that further develop their critical thinking and heighten global awareness. They engage in activities associated with the arts, philosophy, and reasoning.

4. Spiritual Wellness

People who can be described as spiritually well have identified a core set of beliefs that guide their decision making, and other faith- based endeavors. While firm in their spiritual beliefs, they understand others may have a distinctly different set of guiding principles. They recognize the relationship between spirituality and identity in all individuals.

5. Social Wellness

A socially well person builds healthy relationships based on interdependence, trust, and respect. Those who are socially well have a keen awareness of the feelings of others. They develop a network of friends and co-workers who share a common purpose, and who provide support and validation.

6. Environmental Wellness

An environmentally well person appreciates the external cues and stimuli that an environment can provide. People who have achieved environmental wellness recognize the limits to controlling an environment and seek to understand the role an individual plays in the environment.

7. Occupational Wellness

An occupationally well person enjoys the pursuit of a career which is fulfilling on a variety of levels. This person finds satisfaction

and enrichment in work, while always in pursuit of opportunities to reach the next level of professional success.

8. Financial Wellness

Those who are financially well are fully aware of their current financial state. They set long- and short-term goals regarding finances that will allow them to reach their personal goals and achieve self-defined financial success.

9. Cultural Wellness

Culturally well people are aware of their own cultural background, as well as the diversity and richness present in other cultural backgrounds. Cultural wellness implies understanding, awareness and intrinsic respect for aspects of diversity. A culturally well person acknowledges and accepts the impact of these aspects of diversity on sexual orientation, religion, gender, racial and ethnic backgrounds, age groups, and disabilities.

For more information on the nine dimensions of wellness, click on the link below:

Nine Dimensions of Wellness

To watch a video about the nine dimensions of wellness, click on the following link:

Video on the Nine Dimensions of Wellness

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2.1.1.3: Health Problems in the United States

Americans today experience health problems that people who lived 100 years ago did not encounter. What are the factors that account for these health problems that have arisen over the past 100 years?

Most health problems faced by people in the U.S. are chronic diseases that are preventable and caused by everyday choices and unhealthy lifestyles.

The link below provides more information about the leading causes of death in the United States:

Leading Causes of Death

To see a 2021 chart that shows the leading cause of death by age group, click on the link below:

Leading Cause of Death by Age Group

In the video linked below, you will learn about the determinants of health as outlined by Healthy People 2020. Healthy People 2020 is a federal advisory committee comprised of non-federal, independent subject matter experts who gather data and provide advice on how to promote health and prevent disease in America:

Healthy People 2020 and Determinants of Health

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2.1.1.4: Behaviors That Promote Wellness

Bad habits are hard to break, but choosing to eat healthier and exercise more provides benefits that go far beyond a more ideal body weight and shape. Being physically fit can stave off many of the diseases and medical conditions discussed in the previous section, including heart disease, the number 1 killer in America. Exercise reduces stress and eases depression. Healthier employees are also more productive. Being physically fit nurtures the mind, body, and spirit and is the cornerstone of wellness. The links below provide information about behaviors within your control that contribute to an improved quality of life and increased wellness.

Six Behaviors That Contribute to Wellness

Lifestyle Choices and Their Effect on Wellbeing

Behaviors that Contribute to Wellness Presentation

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2.1.1.5: Behavior Modification

Making permanent lifestyle changes is one of the greatest challenges a person can face. This section will explore how changes to behavior occur, the psychological barriers that hamper efforts to change, and tips for making lasting change.

How Changes in Behavior Occur

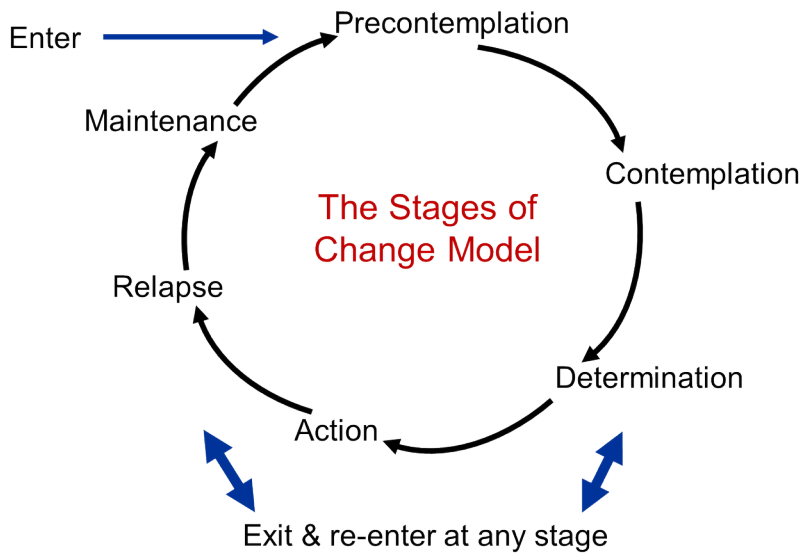
The Transtheoretical Model, also called the **Stages of Change Model**, was developed by James Prochaska and Carlo DiClemente in the late 1970s. Considered the dominant model for describing how behavior changes occur, it evolved through studies examining the experiences of smokers who quit on their own and comparing them with the experiences of those requiring further treatment. The goal of those studies was to understand why some people were capable of quitting on their own. It was determined that people quit smoking if they were ready to do so. Thus, the Transtheoretical Model (TTM) focuses on the decision-making of the individual and is a model of intentional change. The TTM operates on the assumption that people do not change behaviors quickly and decisively. Rather, change in behavior, especially habitual behavior, occurs continuously through a cyclical process. The TTM is not a theory but a model; different behavioral theories and constructs can be applied to various stages of the model where they may be most effective.

The TTM posits that individuals move through six stages of change: precontemplation, contemplation, preparation, action, maintenance, and termination. Termination was not part of the original model and is less often used in application of stages of change for health-related behaviors. For each stage of change, different intervention strategies are most effective at moving the person to the next stage of change and subsequently through the model to maintenance, the ideal stage of behavior.

Six Stages of Change:

Stage 1: Precontemplation

> In this stage, people do not intend to take action in the foreseeable future (defined as within the next 6 months). People are often unaware that their behavior is problematic or produces negative consequences. People in this stage often underestimate the pros of changing behavior and place too much emphasis on the cons of changing behavior.



Stage 2: Contemplation

In this stage, people are intending to start the healthy behavior in the foreseeable future (defined as within the next 6 months). People recognize that their behavior may be problematic, and a more thoughtful and practical consideration of the pros and cons of changing the behavior takes place, with equal emphasis placed on both. Even with this recognition, people may still feel ambivalent toward changing their behavior.

Stage 3: Preparation (Determination)

In this stage, people are ready to take action within the next 30 days. People start to take small steps toward the behavior change, and they believe changing their behavior can lead to a healthier life.

Stage 4: Action

In this stage, people have recently changed their behavior (defined as within the last 6 months) and intend to keep moving forward with that behavior change. People may exhibit this by modifying their problem behavior or acquiring new healthy behaviors.

Stage 5: Maintenance

In this stage, people have sustained their behavior change for a while (defined as more than 6 months) and intend to maintain the behavior change going forward. People in this stage work to prevent relapse to earlier stages.

Stage 6: Termination

In this stage, people have no desire to return to their unhealthy behaviors and are sure they will not relapse. Since this is rarely reached, and people tend to stay in the maintenance stage, this stage is often not considered in health promotion programs.

Goal Setting:

One of the most effective tools for changing behavior is goal setting. The link below provides information on how to set goals effectively to achieve greater success in goal attainment.

Video on S.M.A.R.T. Goals



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2.1.1.6: Lifestyle Modification Barriers

Dr. James M. Olson, a psychology professor at the University of Western Ontario, London, has identified several psychological barriers that commonly prevent people from taking action, even when inaction poses a threat to their health. These barriers occur during 3 stages of behavior modification: admission of the problem, initial attempts to change, and long-term change as outlined below:

Barriers to Admission of the Problem

The first step in lasting change is admitting a problem exists. People often fail to change behavior that poses a risk to their health because they deny a risk exists, trivialize their personal risk, feel invulnerable, make a faulty conceptualization, (i.e., they attribute early warning signs to a benign cause), or experience debilitating emotions when contemplating preventative measures.

Barriers to Initial Attempts to Change

At this stage, people acknowledge the need to change but struggle to accomplish their goals. This failure is a result of lack of knowledge, low self-efficacy (the belief in one's own ability to succeed at change), and dysfunctional attitudes.

Barriers to Long-term Change

Just because a person has experienced success in changing a behavior, that doesn't mean the change is permanent. Barriers to long-term change include cognitive and motivational drift (diminishing enthusiasm for the need to change), lack of perceived improvement, lack of social support, and lapses.

To read more about these barriers to change, including strategies for overcoming these barriers, read Dr. Olson's article linked below:

Psychological Barriers to Behavior Change

A presentation on overcoming barriers to change by the National Institute for Health and Clinical Excellence (NHS) is linked below:

Overcoming Barriers to Change

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2.1.1.7: Fostering Wellness in Your Life

You are once again feeling motivated to eat better, exercise more, drink less caffeine or make any number of the positive lifestyle changes you have been telling yourself you want to make. You have tried before—probably declaring another attempt as a New Year's resolution—but without experiencing much success. Making a lifestyle change is challenging, especially when you want to transform many things at once. This time, think of those changes not as a resolution, but as an evolution.

Lifestyle changes are a process that take time and require support. Once you are ready to make a change, the difficult part is committing and following through. So do your research and make a plan that will prepare you for success. Careful planning means setting small goals and taking things one step at a time.

Here are five tips from the American Psychological Association (APA) that will assist you in making lasting, positive lifestyle and behavior changes:

Make a plan that will stick.

Your plan is a map that will guide you on this journey of change. You can even think of it as an adventure. When making your plan, be specific. Want to exercise more? Detail the time of day when you can take walks and how long you will walk. Write everything down, and ask yourself if you are confident that these activities and goals are realistic for you. If not, start with smaller steps. Post your plan where you will most often see it as a reminder.

Start small.

After you've identified realistic short-term and long-term goals, break down your goals into small, manageable steps that are specifically defined and can be measured. Is your long-term goal to lose 20 pounds within the next five months? A good weekly goal would be to lose one pound a week. If you would like to eat healthier, consider as a goal for the week replacing dessert with a healthier option, like fruit or yogurt. At the end of the week, you will feel successful knowing you met your goal.

Change one behavior at a time.

Unhealthy behaviors develop over the course of time, so replacing unhealthy behaviors with healthy ones requires time. Many people run into problems when they try to change too much too fast. To improve your success, focus on one goal or change at a time. As new healthy behaviors become a habit, try to add another goal that works toward the overall change you are striving for.

Involve a buddy.

Whether it be a friend, co-worker or family member, someone else on your journey will keep you motivated and accountable. Perhaps it can be someone who will go to the gym with you or someone who is also trying to stop smoking. Talk about what you are doing. Consider joining a support group. Having someone with whom to share your struggles and successes makes the work easier and the mission less intimidating.

Ask for support.

Accepting help from those who care about you and will listen strengthens your resilience and commitment. If you feel overwhelmed or unable to meet your goals on your own, consider seeking help from a psychologist. Psychologists are uniquely trained to understand the connection between the mind and body, as well as the factors that promote behavior change. Asking for help does not mean a lifetime of therapy; even just a few sessions can help you examine and set attainable goals or address the emotional issues that may be getting in your way.

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2.1.1.8: Start with “Why?”

Making changes in habitual behavior requires a deep and abiding belief that change is needed. Your desire to change may be motivated by personal goals, or it may be the result of the impact your improved wellness will have on those you love. Nietzsche said, “He who has a strong enough *why* can bear almost any *how*.”

Once you have a compelling reason to change, develop a plan and commit to that plan. If you experience a moment of weakness, do not waste time on self-condemnation. Revisit your compelling reason and reaffirm your commitment to change. The health, peace, and sense of wellbeing inherent in the highest level of your own personal wellness is more than worth the effort required to change

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2.1.1.9: Test Your Knowledge

1. Health is defined as

a. Having health insurance

b. Absence or presences of disease or injury

c. Absence or presence of optimal wellness

d. Not having to see a doctor

2. Health and Wellness mean the same thing

a. True

b. False

3. Which of the following is the least likely to affect a college student's wellness?

a. Retirement income

b. School

c. Screen time

d. Drugs

4. Before changing your behavior, what must you do first?

a. Find help

b. Learn where resources are located that will help you change your behavior

c. Nothing you just start changing your behavior

d. Pick a behavior that you want to change

5. Visualization is

a. Picturing a pro-con list

b. Seeing yourself laying on the beach

c. Seeing yourself accomplish a goal

d. Picturing yourself falling asleep

6. What is the first step in the transtheoretical model?

a. Relapse

b. Precontemplation

c. Action

d. Preparation

Answers: 1.B, 2.B, 3.A, 4.D, 5.C, 6.B

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2.1.2: FITNESS PRINCIPLES

2.1.2.1: Exercise- Not a Passing Fad

2.1.2.2: What are Physical Activity and Exercise?

2.1.2.3: Components of Health-Related Fitness

2.1.2.4: Principles of Adaptation to Stress

2.1.2.5: FITT

2.1.2.6: Specificity

2.1.2.7: Rest, Recovery, and Periodization

2.1.2.8: Reversibility

2.1.2.9: Individual Differences

2.1.2.10: Creating a Successful Fitness Plan

2.1.2.11: Additional Safety Concerns

2.1.2.12: Test Your Knowledge

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2.1.2.1: Exercise- Not a Passing Fad

The benefits of physical activity and exercise are universally recognized—and have been for far longer than one might think. Our Paleolithic ancestors regularly engaged in physical activity to survive. Rather than chasing after a soccer ball to win a game or taking a leisurely stroll down a tree-lined path, they "worked out" by chasing after their next meal. For them, no exercise meant no food. How's that for a health benefit!

With the advent of sedentary agriculture some 10,000 years ago, that same level of peak performance was no longer necessary. As our ancestors continued to devise more advanced means of acquiring food, physical activity declined. It wasn't until the fourth century BCE, that the Greek physician Herodicus, recognized the importance of being physically active outside of a hunter-gatherer society. He practiced gymnastic medicine, a branch of Greek medicine that relied on vigorous exercise as a treatment. During that same time period, Hippocrates, who is often referred to as the Father of Modern Medicine, asserted, "If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health." In the 12 century CE, the Jewish philosopher Rabbi Moses ben Maimon, a physician to the Sultan of Egypt, stated, "Anyone who lives a sedentary life and does not exercise, even if he eats good foods and takes care of himself according to proper medical principles, all his days will be painful ones and his strength will wane." The 15th century theologian and scholar Robert Burton went so far as to declare that *not* exercising, or "idleness" as he referred to it in his widely read tome, *The Anatomy of Melancholy*, was the "bane of body and mind." Burton also warned that the lack of exercise was the sole cause of melancholy (the name given depression at that time) and "many other maladies." Burton claimed that idleness was one of the seven deadly sins, as well as "the nurse of naughtiness," and the "chief author of mischief." For Burton, exercise was not only essential for good health, but a means of avoiding eternal damnation.

By the 16th century, the benefits of exercise were widely accepted, at least among the wealthy and the educated, who had access to leisure. During this time period, H. Mercuralis defined exercise as "the deliberate and planned movement of the human frame, accompanied by breathlessness, and undertaken for the sake of health or fitness." This definition is still widely used today.

Beyond the physical health benefits, there are affective benefits associated with group games and activities. Ancient Mayans organized the first team game called the Ball Game. It consisted of two teams trying to get a ball through a hoop mounted approximately 23 feet on a wall. The rules were to get the ball through the hoop using certain parts of the body. In some cases the captain of the losing team gave himself as a human sacrifice to the winning team, an act that was believed by the Mayans to be a vital part of prosperity.

American Indians are thought to have founded the modern game of lacrosse, as well as other stick games. Lacrosse, which received its name from French settlers, was more than a form of recreation. It was a cultural event used to settle disputes between tribes.



Figure 1. Ball Players. George Catlin. Date unknown.

The outcome of the game, as well as the choosing of teams, was thought to be controlled supernaturally. As such, game venues and equipment were prepared ritualistically.

From Ancient History to Modern Times

In retrospect, the perceived benefits of exercise have changed very little since Herodicus or the American Indians. Mounting research supports historical assertions that exercise is vital to sustaining health and quality of life. Culturally, sports play a huge role in growth and development of youth and adults. Physically, there is indisputable evidence that regular exercise promotes healthy functioning of the brain, heart, and the skeletal and muscular systems. Exercise also reduces risk for chronic diseases, such as cancer, diabetes, and obesity. Regular exercise can even improve emotional health and overall wellbeing.

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2.1.2.2: What are Physical Activity and Exercise?

Physical activity is defined as any movement carried out by skeletal muscle that requires energy and is focused on building health. Health benefits include improved blood pressure, blood-lipid profile, and heart health. Acceptable physical activity includes yard work, house cleaning, walking the dog, or taking the stairs instead of the elevator. Physical activity does not have to be done all it once. It can be accumulated through various activities throughout the day. Although typing on a phone or laptop or playing video games does involve skeletal muscle and requires a minimal amount of energy, the amount required is not sufficient to improve health.

Despite the common knowledge that physical activity is tremendously beneficial to one's health, rates of activity among Americans continue to be below what is needed. According to the Center for Disease Control (CDC), only 1 in 5 (21%) of American adults meet the recommended physical activity guidelines from the Surgeon General. Less than 3 in 10 high school students get 60 minutes or more of physical activity per day. Non-Hispanic whites (26%) are more active than their Hispanic (16%) and Black counterparts (18%) as is the case for males (54%) and females (46%). Those with more education and those whose household income is higher than poverty level are more likely to be physically active.

The word *exercise* , although often used interchangeably with the phrase *physical activity* , denotes a sub-category of physical activity. **Exercise** is a planned, structured, and repetitive movement pattern intended to improve fitness. As a positive side-effect, it significantly improves health as well. Fitness improvements include the heart's ability to pump blood, increased muscle size, and improved flexibility.

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2.1.2.3: Components of Health-Related Fitness

In order to carry out daily activities without being physically overwhelmed, a minimal level of fitness is required. To perform daily activities without fatigue, it is necessary to maintain health in five areas: cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition. These five areas are called the components of health-related fitness. Development of these areas will improve your quality of life, reduce your risk of chronic disease, and optimize your health and well-being. Each of these 5 areas will be explored in depth at a later time. Below is a brief description of each.

1. **Cardiorespiratory endurance** is the ability to carry out prolonged, large muscle, dynamic movements at a moderate to high level of intensity. This relates to your heart's ability to pump blood and your lungs' ability to take in oxygen.

2. **Muscular strength** is the ability of the muscles to exert force over a single or maximal effort.

3. **Muscular endurance** is the ability to exert a force over a period of time or repetitions.

4. **Flexibility** is the ability to move your joints through a full range of motion.

5. **Body Composition** is the relative amount of fat mass to fat-free mass.

As previously stated, these areas are significant in that they influence your quality of life and overall health and wellness.

Skill-Related Components of Fitness

In addition to the 5 health-related components, there are 6 skill-related components that assist in developing optimal fitness: speed, agility, coordination, balance, power, and reaction time. Although important, these areas do not directly affect a person's health. A person's ability to perform ladder drills (also known as agility drills) is not related to his/her long term heart health. However, coordination of muscle movements may be helpful in developing muscular strength through resistance training. As such, they may indirectly affect the 5 areas associated with health-related fitness. Skill-related components are more often associated with sports performance and skill development.

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2.1.2.4: Principles of Adaptation to Stress

The human body adapts well when exposed to stress. The term *stress*, within the context of exercise, is defined as an exertion above the normal, everyday functioning. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. For example, a secretary who sits at a desk all day may push his/her cardiorespiratory system to its limits simply by walking up several flights of stairs. For an avid runner, resistance training may expose the runner's muscles to muscular contractions the athlete is not accustomed to feeling. Although stress is relative to each individual, there are guiding principles in exercise that can help individuals manage how much stress they experience to avoid injury and optimize their body's capacity to adapt. Knowing a little about these principles provides valuable insights needed for organizing an effective fitness plan.

Overload Principle

Consider the old saying, "No pain, no gain." Does exercise really have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even increased sweating for temperature regulation. As these subsequent adaptations occur, the stress previously experienced during the same activity, feels less stressful in future sessions. As a result of the adaptation, more stress must be applied to the system in order to stimulate improvements, a principle known as the **overload principle**.

For example, a beginning weightlifter performs squats with 10 repetitions at 50 pounds. After 2 weeks of lifting this weight, the lifter notices the 50 pounds feels easier during the lift and afterwards causes less fatigue. The lifter adds 10 pounds and continues with the newly established stress of 60 pounds. The lifter will continue to get stronger until his/her maximum capacity has been reached, or the stress stays the same, at which point the lifter's strength will simply plateau. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

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2.1.2.5: FITT

In exercise, the amount of stress placed on the body can be controlled by four variables: **F**requency, **I**ntensity, **T**ime (duration), and **T**ype, better known as FITT. The FITT principle, as outlined by the American College of Sports Medicine (ACSM) falls under the larger principle of overload.

Frequency and Time

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A beginner may determine that 2–3 exercise sessions a week are sufficient enough to stimulate improvements. On the other hand, a seasoned veteran may find that 2–3 days is not enough to adequately stress the system. According to the overload principle, as fitness improves, so must the stress to ensure continued gains and to avoid plateauing.

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon.

Although independent of one another, frequency and time are often combined into the blanket term, **volume**. The idea is that volume more accurately reflects the amount of stress experienced. This can be connected to the **progression principle**. For example, when attempting to create a jogging plan, you may organize 2 weeks like this:

- Week 1: three days a week at 30 minutes per session
- Week 2: four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, the aggressive nature of the progression is revealed. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes, equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burnout, severe fatigue, and injury. The progression principle relates to an optimal overload of the body by finding an amount that will drive adaptation without compromising safety.

Intensity

Intensity, the degree of difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the other components, intensity drives adaptation. Because of its importance, it is imperative for those beginning a fitness program to quantify intensity, as opposed to estimating it as hard, easy, or somewhere in between. Not only will this numeric value provide a better understanding of the effort level during the exercise session, but it will also help in designing sessions that accommodate individual goals.

How then can intensity be measured? Heart rate is one of the best ways to measure a person's effort level for cardiorespiratory fitness. Using a percentage of maximum lifting capacity would be the measure used for resistance training.

Type of Exercise

Simply put, the type of exercise performed should reflect a person's goals. In cardiorespiratory fitness, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. As such, these activities can be used to build lung capacity and improve cellular and heart function.

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2.1.2.6: Specificity

The more specific the exercise to individual training goals, the better. While vigorous ballroom dancing will certainly help develop the cardiorespiratory system, it will unlikely improve a person's 10k time. To improve performance in a 10k, athletes spend the majority of their time training by running, as they will have to do in the actual 10k. Cyclists training for the Tour de France, spend up to six hours a day in the saddle, peddling feverishly. These athletes know the importance of training the way they want their body to adapt. This concept, called the **principle of specificity**, should be taken into consideration when creating a training plan.

In this discussion of the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity and requires energy (ATP) to be produced primarily through anaerobic pathways, that is, pathways not requiring oxygen to produce ATP. Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces requires aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter, so the energy systems will adequately adapt.

Likewise, **force stress** accounts for the amount of force required during an activity. In weightlifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers, which are unable to generate as much force as the fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory systems. As an adaptation to the heat, the amount of sweating increases as does plasma volume, making it much easier to keep the body at a normal temperature during exercise. The only way to adapt is through heat exposure, which can take days to weeks to properly adapt.

In summary, to improve performance, being specific in your training, or training the way you want to adapt, is paramount.

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2.1.2.7: Rest, Recovery, and Periodization

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The **principle of rest and recovery (or principle of recuperation)** suggests that rest and recovery from the stress of exercise must take place in proportionate amounts to avoid too much stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without overstressing the athlete. This training principle, called **periodization**, is especially important to serious athletes but can be applied to most exercise plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest.

Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macrocycles, respectively. An example of this might be:
[table id=1 /]
As this table shows, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be “stress” weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as **overtraining syndrome**. Overtraining syndrome is not well understood. However, experts agree that a decline in performance resulting from psychological and physiological factors cannot be fixed by a few days’ rest. Instead, weeks, months, and sometimes even years are required to overcome the symptoms of overtraining syndrome. Symptoms include the following: weight loss, loss of motivation, inability to concentrate or focus, feelings of depression, lack of enjoyment in activities normally considered enjoyable, sleep disturbances, change in appetite.

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2.1.2.8: Reversibility

Chronic adaptations are not permanent. As the saying goes, “Use it or lose it.”

The **principle of reversibility** suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called **detraining**, adaptations will recede.

In cardiorespiratory endurance, key areas, such as VO_{2max}, stroke volume, and cardiac output all declined with detraining while submaximal heat rate increased. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase, VO_{2max} had fallen by 27% and stroke volume and cardiac output had fallen by 25%. The most well-trained subjects in the study had to train for nearly 40 days following bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in the blood after a 2-minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid was dramatically affected.

Not only is endurance training affected, but muscular strength, muscular endurance, and flexibility all show similar results after a period of detraining.

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2.1.2.9: Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their VO_{2max}, increasing their time to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen was seen by individuals and families. Those who saw the most improvements saw similar percentage improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

In addition to genes, other factors can affect the degree of adaptation, such as a person's age, gender, and training status at the start of a program. As one might expect, rapid improvement is experienced by those with a background that includes less training, whereas those who are well trained improve at a slower rate.

Activity Guidelines

Below is a link to the physical activity guidelines provided by the US Department of Health and Human Services. As you review these recommendations, notice how closely they follow the FITT pattern described earlier in the chapter.

NIH Recommendations for Physical Activity

Fitness Guidelines

The recommendations linked above pertain to physical activity only. While they can be applied to fitness, more specific guidelines have been set to develop fitness. As stated previously, physical activity is aimed at improving health; exercise is aimed at improving health and fitness. These guidelines will be referenced often as each health-related component of fitness is discussed.

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2.1.2.10: Creating a Successful Fitness Plan

Often, the hardest step in beginning a new routine is simply starting the new routine. Old habits, insufficient motivation, lack of support, and time constraints all represent common challenges when attempting to begin a new exercise program. Success, in this case, is measured by a person's ability to consistently participate in a fitness program and reap the fitness benefits associated with a long-term commitment.

Think Lifestyle

Beginning a fitness program is a daunting task. To illustrate the concept of lifestyle, consider attendance at fitness centers during the month of January. Attendance increases dramatically, driven by the number 1 New Year's resolution in America: losing weight. Unfortunately, as time marches on, most of these new converts do not. By some estimates, as many as 80% have stopped coming by the second week in February. As February and March approach, attendance continues to decline, eventually falling back to pre-January levels.

Why does this occur? Why aren't these new customers able to persist and achieve their goal of a healthier, leaner body? One possible explanation: patrons fail to view their fitness program as a lifestyle. The beginning of a new year inspires people to make resolutions, set goals, as they envision a new and improved version of themselves. Unfortunately, most of them expect this transformation to occur in a short period of time. When this does not happen, they become discouraged and give up.

Returning to teen level weight and/or fitness may be an alluring, well-intended goal, but one that is simply unrealistic for most adults. The physical demands and time constraints of adulthood must be taken into consideration for any fitness program to be successful. Otherwise, any new fitness program will soon be abandoned and dreams of physical perfection fade, at least until next January.

Like any other lifestyle habit, optimal health and fitness do not occur overnight. Time and, more importantly, consistency, drive successful health and fitness outcomes. The very term *lifestyle* refers to changes that are long term and become incorporated into a person's daily routine. Unlike many fad diets and quick fixes advertised on television, successful lifestyle changes are also balanced and reasonable. They do not leave you feeling depressed and deprived after a few days. Find a balance between what you want to achieve and what you are realistically able to do. Finally, you must do more than simply change your behaviors. You must also modify your mental perception to promote long-term health. Find a compelling reason for incorporating healthier behaviors into your daily routine.

The steps below will guide you through this process. Before beginning a fitness program, you should understand the safety concerns associated with exercise.

Safety First: Assessing Your Risk

The physical challenges of beginning a new exercise program increase the risk of injury, illness, or even death. Results from various studies suggest vigorous activity increases the risk of acute cardiac heart attacks and/or sudden cardiac death. While that cautionary information appears contradictory to the previously identified benefits of exercise, the long-term benefits of exercise unequivocally outweigh its risks. In active young adults (younger than 35), incidence of cardiac events are still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 experience a cardiac event.

Of those rare cardiac incidents that do occur, the presence of preexisting heart disease is the common thread, specifically, atherosclerosis. **Atherosclerosis** causes arteries to harden and become clogged with plaque, which can break apart, move to other parts of the body, and clog smaller blood vessels. As such, it is important to screen individuals for risk factors associated with heart disease before they begin an exercise program.

The American College of Sports Medicine recommends a thorough pre-screening to identify any risk of heart disease. The 7 major risk factors associated with increased risk of heart disease are identified below.

1. **Family history** – Having a father or first-degree male relative who has experienced a cardiac event before the age of 55, or a mother or first-degree female relative who has experienced a cardiac event before age 65, could indicate a genetic predisposition to heart disease.

2. **Cigarette smoking** – The risk of heart disease is increased for those who smoke or have quit in the past 6 months.
3. **Hypertension**– Having blood pressure at or above 140 mm/HG systolic, 90 mm/Hg diastolic is associated with increased risk of heart disease.
4. **Dyslipidemia** – Having cholesterol levels that exceed recommendations (LDL above 130 mg/dL, HDL below 40 mg/dL), or total cholesterol of greater than 200 mg/dL increases risk.
5. **Impaired fasting glucose (diabetes)**– Blood sugar should be within the recommended ranges.
6. **Obesity**– Body mass index greater than 30, waist circumference of larger than 102 cm (40") for men and larger than 88 cm (34.5") for women, or waist to hip ratio of greater than 0.95 for men, or greater than 0.86 for women increases risk of heart disease.
7. **Sedentary lifestyle**– Persons not meeting physical activity guidelines set by US Surgeon General's Report have an increased risk of heart disease.

In addition to identifying your risk factors, you should also complete a Physical Activity Readiness Questionnaire (PAR-Q) before beginning an exercise program. The PAR-Q asks yes or no questions about symptoms associated with heart disease. Based on your responses on the PAR-Q, you will be placed into a risk category: low, moderate, high.

- **Low risk persons** include men younger than 45, and women younger than 55, who answer no to all of the PAR-Q questions and have one or no risk factors. Although further screening is a good idea, such as getting physician's approval, it isn't necessary.
- **Moderate risk persons** are men of or greater than 45, women 55 or those who have two or more risk factors. Because of the connection between cardiac disease, the seven risk factors, and risk during exercise, it is recommended you get a physician's approval before beginning an exercise program.
- **High risk persons** answer yes to one or more of the questions on the PAR-Q. Physician's approval is required before beginning a program.

Once you have determined your ability to safely exercise, you are ready to take the next steps in beginning your program. Additional safety concerns, such as where you walk and jog, how to be safe during your workout, and environmental conditions, will be addressed at a later time.

As you review the remaining steps, a simple analogy may help to better conceptualize the process.

Imagine you are looking at a map because you are traveling to a particular location and you would like to determine the best route for your journey. To get there, you must first determine your current location and then find the roads that will take you to your desired location. You must also consider roads that will present the least amount of resistance, provide a reasonably direct route, and do not contain any safety hazards along the way. Of course, planning the trip, while extremely important, is only the first step. To arrive at your destination, you must actually drive the route, monitoring your car for fuel and/or malfunction, and be prepared to reroute should obstacles arise.

Preparing yourself for an exercise program and ultimately, adopting a healthier lifestyle, requires similar preparation. You will need to complete the following steps:

1. **Assess your current fitness:** Where are you on the map?
2. **Set goals:** What is your destination's location?
3. **Create a plan:** What route will you choose?
4. **Follow through:** Start driving!

Assess Your Condition

To adequately prepare, you will need to take a hard look at your current level of fitness. With multiple methods of assessing your fitness, you should select the one that most closely applies to you. Obtaining a good estimate will provide you a one-time glance at your baseline fitness and health and provide a baseline measurement for gauging the efficacy of your fitness program in subsequent reassessments.

Assessments are specific to each health-related component of fitness. You will have the opportunity to assess each one in the near future.

Set Goals

Using the map analogy, now that you know your current location, you must determine your destination and the best route for getting there. You can start by setting goals.

In his bestselling book, *The 7 Habits of Highly Effective People*, author Stephen Covey suggests you should "Begin with the end in mind."[7] While Covey's words may not be directly aimed at those seeking to complete a fitness program, his advice is useful to anyone making a significant lifestyle change. To be successful, you must develop a clear vision of your destination. Setting specific goals about how you want to feel and look, increases your chances of success. Without specific goals to measure the success of your efforts, you could possibly exceed your target and believe you failed.

The art of setting goals includes stating them in a clearly defined and measurable way. Consider exactly what you would like to accomplish, make certain your goals can be measured, and establish a reasonable timeframe in which to achieve your goals. Goals that meet these guidelines are referred to as S.M.A.R.T. goals.

Specific: Be as specific and detailed as possible in creating your goal.

Measurable: If your goal cannot be measured, you will not know when you have successfully completed the goal.

Attainable: Consider whether you have the resources—such as time, family support, and financial means—to obtain your goal.

Realistic: While your goal should be challenging, it should not exceed reasonable expectations.

Timeframe: Set a deadline to accomplish your goal.

Well-Stated Goals

A well-stated goal contains all of the SMART components listed above. Take a look at the well-stated example: *I will improve my 12-minute distance by 10% within 2 months of the first assessment.*

Note, all the ingredients of a well-stated goal are present. It is specific (improve 12-minute distance by 10%), measurable (10% improvement), attainable and realistic (the degree of improvement is reasonable in that time frame), and includes a time frame (a clear deadline of 2 months).

Less Effective Goals

Less effective goals would be stated like this: *I will run farther next time I assess my fitness; I want to jog faster; I will lose weight.*

And a common one: *I will exercise 3 days a week at 60% max heart rate for 45 minutes per session for 2 months.*

At a closer glance, none of these examples contain all of the ingredients of a well-stated goal. How can "faster" be measured? "Farther" is not specific enough, nor is "lose weight." In the last example, this is not a goal at all. It is a plan to achieve a goal that has not been stated.

In the end, setting up well-stated goals will give you the best chance to convert good intentions into a healthier lifestyle.

To complete this step, write down 2-3 personal goals, stated in the SMART format, and put them in a place you will see them frequently.

Create a Plan

Once you know exactly what you want to achieve, generate a strategy that will help you reach your goals. As you strategize, your goal is to determine the frequency, the intensity, and the duration of your exercise sessions. While doing this, it is imperative to keep in mind a few key principles.

First, use your goals as the foundation for your program. If your goal is related to weight loss, this should drive the frequency, duration, and intensity of your daily workouts as these variables will influence your body's use of fat for fuel and the number of calories burned. If you feel more interested in improving your speed, you will need to dedicate more workout time to achieving those results.

Another key principle is the importance of safety. The importance of designing a program that is safe and effective cannot be overstated. You can minimize any risks by relying on the expert recommendations of the US Department of Health and Human Services previously outlined and linked here. These highly reputable organizations have conducted extensive research to discover the optimal frequency, intensity, and duration for exercise.

Follow Through

Once you have assessed your current fitness levels, set goals using the SMART guidelines, and created your personalized fitness plan, you should feel very proud of yourself! You have made significant progress toward achieving a healthier lifestyle. Now is when the "rubber hits the road." (Literally so, if your plan includes walking or jogging.) Now that you have invested time and energy to develop a thoughtful, well-designed fitness program, it is time to reap the returns of good execution. The assessment, planning and preparation are really the hardest parts. Once you know what to do and how to do it, success is simply a matter of doing it.

Unfortunately, the ability to stick with a program proves difficult for most. To prevent getting derailed from your program, identify barriers that may prevent you from consistently following through. One of the most common challenges cited is a shortage of time. Work schedules, school, child care, and the activities of daily living can leave you with little time to pursue your goals. Make a list of the items that prevent you from regularly exercising and then analyze your schedule and find a time for squeezing in your exercise routine. Regardless of when you schedule your exercise, be certain to exercise consistently. Below are a few additional tips for achieving consistency in your daily fitness program:

- **Think long term; think lifestyle.** The goal is to make exercise an activity you enjoy every day throughout your life. Cultivating a love for exercise will not occur overnight and developing your ideal routine will take time. Begin with this knowledge in mind and be patient as you work through the challenges of making exercise a consistent part of your life.
- **Start out slowly.** Again, you are in this for the long haul. No need to overdo it in the first week. Plan for low intensity activity, for 2–3 days per week, and for realistic periods of time (20–30 minutes per session).
- **Begin with low Intensity/low volume.** As fitness improves, you will want to gradually increase your efforts in terms of quantity and quality. You can do this with more time and frequency (called volume) or you can increase your intensity. In beginning a program, do not change both at the same time.
- **Keep track.** Results from a program often occur slowly, subtly, and in a very anti-climactic way. As a result, participants become discouraged when immediate improvements are not visible. Keeping track of your consistent efforts, body composition, and fitness test results and seeing those subtle improvements will encourage and motivate you to continue.
- **Seek support.** Look for friends, family members, clubs, or even virtual support using apps and other online forums. Support is imperative as it provides motivation, accountability, encouragement, and people who share a common interest, all of which are factors in your ability to persist in your fitness program.
- **Vary your activities from time to time.** Your overall goals are to be consistent, build your fitness, and reap the health benefits associated with your fitness program. Varying your activities occasionally will prevent boredom. Instead of walking, play basketball or ride a bike. Vary the location of your workout by discovering new hiking trails, parks or walking paths.
- **Have fun.** If you enjoy your activities, you are far more likely to achieve a lasting lifestyle change. While you cannot expect to be exhilarated about exercising every day, you should not dread your daily exercise regimen. If you do, consider varying your activities more, or finding a new routine you find more enjoyable.
- **Eat healthier.** Nothing can be more frustrating than being consistent in your efforts without seeing the results on the scale. Eating a balanced diet will accelerate your results and allow you to feel more successful throughout your activities.

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2.1.2.11: Additional Safety Concerns

As activity rates among Americans increase, specifically outdoor activities, safety concerns also rise. Unfortunately, the physical infrastructure of many American cities does not accommodate active lifestyles. Limited financial resources and de-emphasis on public health means local and state governments are unlikely to allocate funds for building roads with sidewalks, creating walking trails that surround parks, or adding bike lanes. In addition, time constraints and inconvenience make it challenging for participants to travel to areas where these amenities are available. As a result, exercise participants share roads and use isolated trails/pathways, inherently increasing the safety risks of being active.

A key principle in outdoor safety is to recognize and avoid the extremes. For example, avoid roads that experience heavy traffic or are extremely isolated. Avoid heavy populated areas as well as places where no one is around. Do not exercise in the early morning or late at night, during extreme cold or extreme heat. To minimize safety risks during these types of environmental conditions, do not use headphones that could prevent you from hearing well and remaining alert, do not exercise alone, prepare for adequate hydration in the heat, and use warm clothing in extreme cold to avoid frostbite. Extreme conditions require extra vigilance on your part.

A second key principle, whether outdoor or indoor, is to simply use common sense. While this caveat seems obvious, it gets ignored far too often. Always remember the purpose of your exercise is for enjoyment and improved health. If these objectives could be compromised by going for a run at noon in 95-degree heat, or lifting large amounts of weight without a spotter, you should reconsider your plan. Before exercising in what could be risky conditions, ask yourself, “Is there a safer option available?”

Lastly, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy nature, but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions are additional variables to avoid in order to complete your exercise session without an accident.

Environmental Conditions

When exercising outdoors, you must consider the elements and other factors that could place you at increased risk of injury or illness.

Heat-Related Illness

Heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, contributed to 7,233 deaths in the United States between 1999 and 2009. A 2013 report released by the Center for Disease Control stated that about 658 deaths from heat-related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.

The number one risk factor associated with heat-related illness is hydration, the starting point of all heat-related illness. Unfortunately, sweat loss can occur at a faster rate than a person can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring hydration levels can assist in preventing illness. One simple method, while not fool proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2–3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout. This is a great way to see firsthand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre- and post-body weight by drinking fluids during and after the workout to restore what was lost. This method, when combined with urine-monitoring, can provide a fairly accurate assessment of hydration levels.

The best preventative measure for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48–64 oz. per day, per person. In an effort to individualize hydration, experts now recommend basing fluid intake on individual size, gender, activity levels, and

climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.[9] For a 150-pound individual, this would mean 75–150 ounces of water per day (½ gallon to one gallon)! While there is still considerable debate over the exact amounts, no one disputes the importance of continually monitoring your hydration using one of the techniques described previously. Insufficient hydration leads to poor performance, poor health, and potentially serious illness.

It should be noted that electrolyte “sport” drinks, such as Gatorade and PowerAde, are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost through sweating during physical activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can create conditions equally as dangerous if you fail to take proper precautions. To minimize the risk of cold-related illness, you must prevent the loss of too much body heat. The three major concerns related to cold-related illnesses are hypothermia, frost-nip, and frost bite.

As with heat-related illness, the objective of preventing cold-related illness is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear, indicating the need to take action. Some of those symptoms include:

- shivering
- numbness and stiffness of joints and appendages
- loss of dexterity and/or poor coordination
- peeling or blistering of skin, especially to exposed areas
- discoloration of the skin in the extremities

When walking or jogging in the cold, it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- **Hydration is key.** Cold air is usually drier air, which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.
- **Stay dry.** Heat loss occurs 25x faster in water than on dry land. As such, keeping shoes and socks dry and clothing from accumulating too much sweat will allow for more effective body temperature regulation.
- **Dress appropriately.** Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture-wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin, and any additional layers of clothing, without it becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can breathe.
- **Cover the extremities.** Those parts of the body farthest away from the heart (toes, fingers, and ears) tend to get coldest first. Take the appropriate steps to cover those areas by using gloves, moisture-wicking socks, and a winter cap to cover your head.

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2.1.2.12: Test Your Knowledge

1. The term exercise refers to physical activity that is:

    a. Discontinuous and unplanned but designed to improve fitness

    b. Planned, structured, and repetitive designed to improve fitness

    c. Not a contributor to physical fitness

    d. Random and unstructured

2. Which of the following is NOT considered a skill-related fitness component?

    a. Coordination

    b. Flexibility

    c. Balance

    d. Agility

3. During the initial phase of an exercise program, a beginner should:

    a. Begin slowly, exercising at a low intensity and gradually increasing volume

    b. Keep intensity high, exercise at the high end of the target heart rate range

    c. Perform short but intense bouts of activity

    d. Exercise 5-7 days per week

4. The body's ability to adapt to gradual increases in the amount of exercise is the principle of:

    a. Overload

    b. Specificity

    c. Reversibility

    d. Assessment

5. The amount of overload needed to maintain or improve one's fitness level is NOT determined by:

    a. Time (duration)

    b. Intensity

    c. Frequency

    d. Specificity

6. Another term used for organizing your training into phases or cycles is:

    a. Specificity

    b. Skill training

c. Periodization

d. Overload

Answers: 1. B, 2. B, 3. A, 4. A, 5. D, 6. C

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2.1.3: CARDIORESPIRATORY FITNESS

2.1.3.1: What are the cardiovascular and respiratory systems?

2.1.3.2: The CR System and Energy Production

2.1.3.3: Changes in the CR System

2.1.3.4: Measuring Heart Rate

2.1.3.5: Measuring Intensity

2.1.3.6: Cardiorespiratory Fitness Assessment

2.1.3.7: Test Your Knowledge

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2.1.3.1: What are the cardiovascular and respiratory systems?

Imagine for a moment climbing to the top of Mt. Everest, a challenging feat very few have accomplished. In the process, you gradually ascend from base camp, which sits at about 17,500 feet above sea level, to the peak at over 29,000 feet. At this elevation, the pressure of oxygen is so low, you struggle to take in a satisfying breath. Although you strive to breathe deeply, you are unable to get enough air. Your heart rate increases and you might even develop nausea and a headache. Unless your body has a chance to acclimate itself to higher elevations or you gain access to supplemental oxygen, your symptoms will persist or worsen.

These are the sensations many people with cardiovascular or respiratory illnesses, such as asthma, chronic bronchitis, or mild cardiovascular disease, experience on a daily basis. Climbing up a flight of steps may leave them gasping for air, as would walking briskly or even breathing in cold air. Regardless of the cause, being unable to take in sufficient air can create a sense of panic and cause serious physical discomfort.

From this simple example, hopefully, you feel an appreciation for the simple act of breathing and ensuing satisfaction that comes with each life-sustaining breath. For most people, unless they engage in strenuous physical activity sufficient to get them breathing hard, their **cardiovascular and respiratory system** (heart, blood vessels, and lungs) operates efficiently enough to go relatively unnoticed. However, does that mean their cardiorespiratory (CR) system is functioning at optimal capacity? Or, could it be operating at a minimum level and experiencing problems that go undetected? This chapter defines cardiorespiratory fitness, examines the benefits of a healthy CR system, and explores how to effectively assess and improve the CR system.

The Benefits of Good Cardiorespiratory Health

image

How the CR System Works

The cardiorespiratory system operates to obtain and circulate vital compounds throughout the body—specifically, oxygen and nutrients, such as food energy, vitamins, and minerals. Both oxygen and nutrients, which are imperative for cellular energy production, must be taken in from the lungs and digestive system. Because the heart and lungs are so interlocked in this process, the two systems are often labeled together as the cardiorespiratory system. Without a healthy respiratory system, the body would struggle to bring in enough oxygen, release carbon dioxide (the chemical waste product of cellular metabolism) and eliminate unwanted particles that enter the respiratory tract when inhaling. Without a healthy heart, transporting oxygen from the lungs and nutrients from the digestive system to the body's cells would be impossible. If the health of the CR system were compromised enough, survival would be impossible. Additionally, both must be healthy or the function of one or the other will be compromised.

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2.1.3.2: The CR System and Energy Production

Clearly the cardiovascular and respiratory systems function as one, but why is the CR system so important? What makes the distribution of oxygen throughout the body so vital to existence? The answer is simple: ENERGY. While oxygen in and of itself does not contain any energy (**calories**), it does combine with fuel extracted from food once it has been introduced into the cell to help produce **adenosine triphosphate** (ATP). ATP is the basic form of cellular energy found in the body. Because the body stores very little ATP, it must constantly be regenerated. For this reason, people must continue eating and breathing to live.

Within the context of fitness, the purpose of the cardiorespiratory system is not only to produce energy but to also adapt in a way so that energy production can be optimized. For example, a high school cross country runner wants to be fit enough to compete in the state cross country meet. Unfortunately, this athlete's current mile time is 6 minutes per mile. In other words, that is the maximum work rate possible for this athlete. However, the goal is to improve to 5 minutes per mile, or improve the maximum work rate. To do so, more energy must be produced. According to the principles of adaptation, it is possible for this athlete to become more efficient at producing energy, enabling him to run a mile in less time. An example of this adaptation comes from the world record mile time of 3 minutes and 43 seconds. The world record marathon time (26.2 miles) is 2 hours, 1 minutes, and 39 seconds. That equates to 4 minutes and 38 seconds per mile over the 26-mile course. That is some serious ATP production!

Oxidative Energy System (Aerobic)

As oxygen and nutrients are delivered to the cells, they are utilized to produce ATP. The workhorses of the cell for oxidative metabolism are the **mitochondria**. This form of energy production is contingent on the ability of the CR system to deliver oxygen and nutrients and the cell's ability to process that oxygen. Because of the importance of oxygen in this particular energy-producing pathway, it is called the oxidative energy system, or **aerobic system**.

Oxidative energy production is the primary means of ATP production during rest and for activities that last for 2 minutes or longer. Although other forms of energy production assist in ATP production at any given time, long duration exercise sessions rely on this aerobic pathway. Also, in contrast to other forms of ATP production, the oxidative energy system uses both carbohydrates and fats for fuel sources.

To consider: What activities would emphasize development of this energy pathway?

Immediate/Explosive Energy System

While the oxidative system is the primary source of ATP production, it does require a few minutes for the system to begin operating at full capacity during exercise. How then could the body immediately produce enough energy to perform a strenuous activity, such as sprinting 50 meters? Clearly, another energy system must drive ATP production. The immediate or explosive energy system utilizes the storage of **creatine phosphate** (CP) and the storage of **adenosine diphosphate**, which is stored in very small amounts, to generate ATP. When needed, this energy system provides enough ATP to sustain a short-duration, explosive activity, approximately 10–20 seconds or less. Once CP is depleted, other energy systems must assist in the ATP generating process.

Non-Oxidative or Anaerobic Energy System

As the name implies, the **non-oxidative energy system** does not require oxygen to generate ATP. Instead, the cells where the ATP is produced require **glucose** (carbohydrates that have been broken down) as the fuel source. Like the immediate energy system, this system is associated with high intensity and short duration movements. While it is possible for some elite athletes to maintain exercise at "anaerobic" levels for several minutes, even they will eventually fatigue as a result of the non-oxidative system's ability to sustain ATP production for events lasting longer than approximately 2 minutes.

As glucose is processed to produce ATP, the natural byproduct of this process, lactic acid, also begins to accumulate. The result of excessive lactic acid accumulation contributes to muscle fatigue, making it impossible to continue exercise at a high intensity.

Energy Systems Combine

It is important to understand that energy systems do not operate in a compartmental fashion, but rather operate simultaneously, each carrying some of the burden of ATP production. For example, a professional soccer player would spend most of the match “cruising” at a light/moderate intensity level, thus primarily utilizing the oxidative energy system. However, during the match, he or she may sprint for several hundred meters, utilizing the explosive and non-oxidative system, or he or she may jump, requiring use of the explosive system. Thus, both energy systems are utilized simultaneously throughout the match. To improve performance, this player would need to develop the energy system which is utilized the most during the match.

Here’s a video that goes over all 3 systems, but with a slightly different nomenclature for the Immediate Energy System (ATP-PCR Sytem) and the Non-Oxidative System (Glycolitic System): Energy Systems

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2.1.3.3: Changes in the CR System

An improvement in CR functioning, or fitness level, requires adaptation of the system. Remember, the point is to more effectively generate ATP so more work can be accomplished. In order to process more oxygen and deliver more oxygenated blood to the cells, the overall system must undergo changes to make this possible. Here is a list of adaptations that occur to the CR system as a result of consistent aerobic exercise:

- Resting heart rate may decrease. The average resting heart rate hovers around 70–75 beats per minute. Elite athletes may have resting heart rates in the high 30s. Generally, resting heart rate may decrease by approximately 10 beats per minute with chronic exercise.
- Pulmonary adaptations, such as increased **tidal volume** (the amount of oxygen entering the lungs with each breath) and increased **diffusion capacity** (the amount of oxygen that enters the blood stream from the lungs). This allows for more oxygen to enter the pulmonary circulation en route to the left side of the heart.
- The heart muscles, specifically the left side of the heart, increase in size making it possible to contract more forcefully. As a result, more blood can be pumped with each beat meaning more oxygen can be routed to the systemic circulation.
- More oxygen is delivered and transported into the cells where ATP production can occur. This is called the **arterial-vein difference** (a-VO_{2diff})

These changes in the system are not permanent due to the **principle of reversibility**. Following a period of inactivity, the benefits from chronic aerobic exercise will be reversed.

Assessing CR Fitness

To adequately prepare for starting a personal fitness program, it is important to first assess your current level of fitness. There are multiple methods for assessing a person's level of fitness. Each of the walking/jogging assessments discussed here attempts to estimate a key physiological marker of the heart's and lungs' functioning capacity and maximal oxygen consumption. **Maximal oxygen consumption**, or $VO_{2\ max}$, measures the body's maximum ability to take in and utilize oxygen, which directly correlates to overall health and fitness. A good estimate of $VO_{2\ max}$ provides a one-time glance at a person's health and fitness level and a baseline measurement for reassessment at future dates to gauge improvements.

Some of the most common walking/jogging assessments used to estimate $VO_{2\ max}$ include the 12-Minute Walk, 1.5-Mile Run/Walk Test, 3-Minute Step Test, and 1-Mile Walk Test. Unfortunately, these field assessments, although practical and inexpensive, only provide estimations. More accurate assessments require a lab-based $VO_{2\ max}$ test using equipment that measures the volume of oxygen and carbon dioxide being moved in and out of the air passages during exercise. Although this test is more accurate, the expense and availability make it impractical for most. Unlike the lab test, the field assessments are relatively cost free, user-friendly and require very little expertise to conduct or perform. In addition, the key point of the assessment is measuring differences rather than absolute values, and the field tests accurately meet that objective.

Information on how to safely perform these assessments will be provided at the end of this chapter.

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2.1.3.4: Measuring Heart Rate

Those starting the $VO_{2\ max}$ assessments must first measure their heart rate, an important component used in the calculations.

To check your pulse, you can follow these steps

1. Find your pulse. You can find your pulse on your wrist, neck, or foot.
2. Place your index and middle fingers on your skin above the pulse.
3. Press lightly until you feel the blood pulsing beneath your fingers.
4. Count the beats you feel for 10-15 seconds.
5. Multiply this number by four or six to get your heart rate (or pulse) per minute.

Creating a Plan to Develop CR Fitness

Once the assessments have been completed, the next step is to develop a plan for maintaining or improving your current level of fitness. This fitness plan should include activities that are safe and adapted to meet your personal goals. Once these fitness goals have been identified, the principles of adaptation to change can be utilized to achieve those goals. These principles include **specificity**, targeting specific areas in a workout, and **overload**, the practice of increasing exertion as the body adapts to ensure continued gains in fitness levels. Specifically, you need to apply the FITT principle (**F**requency, **I**ntensity, **T**ime, and **T**ype) described in detail in the previous chapter, “Fitness Principles”:

- **Frequency**: 3–5 days per week for healthy adults.
- **Intensity**: moderate to vigorous intensity, which equals 40–85% of heart rate reserve, or 55–90% of percentage of max heart rate. (More information about intensity will be provided later.)
- **Time/duration**: 20–60 minutes per session or accumulation of 150 minutes per week. Sessions must be continuous for 10 minutes or more.
- **Type/mode**: Use large muscle groups and exercises specific to cardiorespiratory exercise.

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2.1.3.5: Measuring Intensity

Intensity may be the most important aspect of the FITT principle. Engaging in a “cardio” program that does not stress the CR system to the recommended levels will be ineffective. Engaging in a program that overstresses the system can lead to injury and pose unnecessary risks. So how do you know if you are in the right range?

Heart rate is one of the best ways to measure effort level. Walking and jogging increase a person’s heart rate. Based on the function of the heart, this is no surprise. The heart rate directly correlates with the amount of oxygen being taken in by the lungs. As activity increases in intensity, oxygen demands increase and so does heart rate.

Because of this relationship, heart rate can be used in the design of an effective walking and jogging program by creating target heart rate zones. Heart rate zones represent an intensity range—a low end heart rate and a high end rate—within which a person’s heart rate would fall during a walking or jogging session.

The first step in determining your **target heart rate (THR)**, is to determine your **maximum heart rate (MHR)**, both measured in beats per minute (bpm). Generally, MHR is estimated to be your age subtracted from 220 beats per minute. In other words, your heart rate should theoretically stop increasing once it reaches the calculated maximum. While helpful, it is not uncommon to see variances in the laboratory tested maximum heart rate versus the calculated method.

The next step in calculating THR is to calculate a specific percentage of your MHR. This is done using two different methods. Keep in mind, finding the THR is the objective in both methods, even though slightly different numbers are used.

The first method, called Max Heart Rate Method, is more commonly used.

Max Heart Rate Method

1. Calculate MHR;
   MHR = 220 – age.
2. Calculate high and low THR by plugging in a percentage range. In this example, 60 and 80% are being used.
   MHR x .60 = THR_{Low}
   MHR x .80 =THR_{High}
3. The resulting low and high THR numbers represent the range, or target intensity.

The target intensity signifies an optimal training zone for that particular walking or jogging session. By keeping the heart rate within that range, you will drive adaptation specific to that intensity. By using real, but random numbers, and plugging them into the above equation this becomes apparent.

Female, aged 20:

1. MHR = 220 -20
   MHR = 200 bpm;
2. THR_{low} = 200 x .60
   THR_{low} = 120 bpm
   THR_{high} =200 x .80
   THR_{high} = 160 bpm
3. THR = 120 – 160 bpm

To achieve her self-established goals, the female in the example above will need to stay within the range of 120 and 160 bpm. If her efforts are intense enough that she begins to exceed 160 bpm during her session, or easy enough that her heart rate falls below 120 bpm, she would need to change her intensity mid-session to get the optimal results.

The Karvonen Formula or Heart Rate Reserve Method

1. Calculate MHR; MHR = 220 – age.

2. Determine your **resting heart rate (RHR)**.
3. Find the **heart rate reserve (HRR)**; HRR = MHR – RHR
4. Calculate high and low THR by plugging in a percentage range and then adding in the RHR. In this example, 60 and 80% are being used.
   THR_{low} = HRR x .60 + RHR
   THR_{high} = HRR x .80 + RHR
5. The resulting low and high THR numbers represent the range, or target intensity.

Clearly, the Karvonen formula requires a few more steps, specifically, the incorporation of the resting heart rate. Using the same female in the example above, along with a randomly selected RHR, the THR looks like this:

1. MHR = 220 – 20
   MHR = 200
2. RHR = 72 bpm (randomly selected)
3. HRR = MHR – RHR
   HRR = 200 – 72
   HRR = 128
4. THR_{low} = HRR x .60 + RHR
   THR_{low} = 128 x .60 + 72
   THR_{low} = 149 bpm
   THR_{high} = HRR x .80 + RHR
   THR_{high} = 128 x .80 + 72
   THR_{high} = 174 bpm
5. THR = 149 – 174 bpm

A comparison of the two methods, reveals that the low and high end of the Karvonen formula is much higher than the Max Heart Rate method, even though the exact same percentages have been used. If the female in this example used the Karvonen Formula, she would find herself at a much higher intensity, especially at the low end of the range (120 vs. 149 bpm). How can this be? Aren't these formulas supposed to have the same objective?

While it is true that both equations are used to estimate a target heart rate range, only the Karvonen Formula takes into account the RHR, the lowest possible heart rate that can be measured for that individual. The Max Heart Rate method assumes the lowest heart rate possible is "0," a number to be avoided if at all possible! Because of the difference between 0 and the maximum heart rate, the calculated percentages result in a much lower number. In terms of accuracy, the Karvonen method is superior. It simply is a better representation of true target ranges.

Other Ways to Determine Intensity

Since not everyone owns a heart rate monitor, or wishes to pause during training to take pulse, other methods of determining exercise intensity have been developed. One particular method, called the **rating of perceived exertion (RPE)**, uses subjective measurement to determine intensity. The method is as simple as asking the question, Overall, how hard do I feel I am working? The answer is given based on a scale of 6 to 20 with 6 being almost no effort and 20 being maximum effort. Studies have indicated that when subjects are asked to exercise at a moderate or heavy intensity level, subjects can accurately do so, even without seeing their heart rate. As a result, using the RPE scale can be an effective way of managing intensity.

- The original RPE scale or **Borg Scale**, designed by Dr. Gunnar Borg, was developed to mimic generalized heart rate patterns. The starting and ending point of the scale are less intuitive than a typical scale of 1-10. By design, the 6 represents a resting heart rate of 60 bpm and the 20 an exercise heart rate of 200 bpm, a beat count someone might experience at maximum effort. Over time, a modified Borg Scale was developed using a simple 1–10 scale, with 1 being resting effort and 10 being maximum effort. Even though the modified scale is more intuitive, the traditional scale is still used more frequently. Follow this link to see both the original and modified scales.
- Walking and jogging not only benefit physical health, but many enjoy the social benefits realized by exercising with friends. When walking or jogging with friends, intensity can easily be measured by monitoring your ability to carry on a conversation. With the **Talk Test**, if you are only able to say short phrases or give one word responses when attempting to converse during an exercise session, this would suggest you are working at a high enough intensity that your breathing rate makes conversation difficult. Certainly, if you can speak in full sentences without getting winded, the intensity would be very light. Just like RPE, the Talk Test is yet another way to subjectively measure intensity, which can then be correlated with heart rates.

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2.1.3.6: Cardiorespiratory Fitness Assessment

2. **Timed Two Mile Walk or Run Time to Complete 2 miles _____**

Locate a 2 mile course where you can safely walk or run. You may use a standard track at a school and complete 8 laps around, or use a self-identified course that you verify for length using your phone's GPS or your car's odometer.

**Once you complete your 2 mile walk/run, check your heart rate, and then time yourself to see how long it takes your heart rate to return to your previously recorded resting heart rate. *Once you have achieved resting heart rate, wait at least 5 minutes before doing the next activity.*

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2.1.3.7: Test Your Knowledge

Test Your Knowledge

1. Which of the following is one of the primary functions of the cardiorespiratory system?

    a. To transport oxygen

    b. To pick up waste products

    c. To transport nutrients

    d. All of the above are functions of the cardiorespiratory system.

2. Cardiorespiratory endurance is developed best by activities that:

    a. Involve continuous rhythmic movements of large muscle groups.

    b. Alternate between brief periods of maximal exertion and rest.

    c. Gently extend joints beyond their normal range of motion.

    d. Involve working with weights or resistance.

3. Maximal oxygen consumption (VO_{2max}) is:

    a. The body's maximum ability to take in and utilize oxygen

    b. The velocity of oxygen flowing through the blood

    c. Solely determined by genetics

    d. Very difficult to predict

4. The non-oxidative energy system could provide energy for up to:

    a. Maximum of 10 second or less

    b. Up to 2 minutes

    c. As long as needed

    d. Up to 5 minutes

5. Adenosine triphosphate (ATP) is defined as:

    a. The building block of proteins

    b. The stored form of sugar

    c. The simplest form of carbohydrate in the blood

    d. The basic form of energy used by the cells.

Answer key: 1. D, 2. A, 3. A, 4.B, 5. D

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2.1.4: MUSCULAR STRENGTH AND ENDURANCE

2.1.4.1: Muscular Physiology

2.1.4.2: Muscle Fiber Types

2.1.4.3: Resistance Exercise Programming

2.1.4.4: Supplements

2.1.4.5: Test Your Knowledge

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2.1.4.1: Muscular Physiology

Muscles are used for movement in the body. The largest portion of energy expenditure in the body happens in muscles while helping us perform daily activities with ease and improving our wellness. **Muscular strength** is the amount of force that a muscle can produce one time at a maximal effort, and **muscular endurance** is the ability to repeat a movement over an extended period of time. Resistance training is the method of developing muscular strength and muscular endurance, which in turns improves wellness. This chapter explores many ways to resistance train. However, achieving the best muscular performance requires the assistance of a trained professional.

Muscles are highly specialized to contract forcefully. Muscles are powered by muscle cells, which contract individually within a muscle to generate force. This force is needed to create movement.

There are over 600 muscles in the human body; they are responsible for every movement we make, from pumping blood through the heart and moving food through the digestive system, to blinking and chewing. Without muscle cells, we would be unable to stand, walk, talk, or perform everyday tasks.

Types of Muscle

There are three types of muscle:

1. **Skeletal Muscle:** Responsible for body movement.
2. **Cardiac Muscle:** Responsible for the contraction of the heart.
3. **Smooth Muscle:** Responsible for many tasks, including movement of food along intestines, enlargement and contraction of blood vessels, size of pupils, and many other contractions.

Skeletal Muscle Structure and Function

Skeletal muscles are attached to the skeleton and are responsible for the movement of our limbs, torso, and head. They are under conscious control, which means that we can consciously choose to contract a muscle and can regulate how strong the contraction actually is. Skeletal muscles are made up of a number of **muscle fibers**. Each muscle fiber is an individual muscle cell and may be anywhere from 1 mm to 4 cm in length. When we choose to contract a muscle fiber—for instance we contract our bicep to bend our arm upwards—a signal is sent from our brain via the spinal cord to the muscle. This signals the muscle fibers to contract. Each nerve will control a certain number of muscle fibers. The nerve and the fibers it controls are called a **motor unit**. Only a small number of muscle fibers will contract to bend one of our limbs, but if we wish to lift a heavy weight then many more muscles fibers will be recruited to perform the action. This is called muscle fiber recruitment.

Each muscle fiber is surrounded by connective tissue called an **external lamina**. A group of muscle fibers are encased within more connective tissue called the **endomysium**. The group of muscle fibers and the endomysium are surrounded by more connective tissue called the **perimysium**. A group of muscle fibers surrounded by the perimysium is called a **muscle fascicule**. A muscle is made up of many muscle fasciculi, which are surrounded by a thick collagenous layer of connective tissue called the epimysium. The epimysium covers the whole surface of the muscle.

Muscle fibers also contain many mitochondria, which are energy powerhouses that are responsible for the aerobic production of energy molecules, or ATP molecules. Muscle fibers also contain glycogen granules as a stored energy source, and **myofibrils**, which are threadlike structures running the length of the muscle fiber. Myofibrils are made up of two types of protein:

1. **Actin myofilaments**
2. **Myosin myofilaments**

The Actin and Myosin filaments form the contractile part of the muscle, which is called the sarcomere. Myosin filaments are thick and dark when compared with actin filaments, which are much thinner and lighter in appearance. The actin and myosin filaments lie on top of one another; it is this arrangement of the filaments that gives muscle its striated or striped appearance. When groups of actin and myosin filaments are bound together by connective tissue they make the myofibrils. When groups of myofibrils are bound together by connective tissue, they make up muscle fibers.

The ends of the muscle connect to bone through a **tendon**. The muscle is connected to two bones in order to allow movement to occur through a **joint**. When a muscle contracts, only one of these bones will move. The point where the muscle is attached to a bone that moves is called the **insertion**. The point where the muscle is attached to a bone that remains in a fixed position is called the **origin**.

How Muscles Contract

Muscles are believed to contract through a process called the **Sliding Filament Theory**. In this theory, the muscles contract when actin filaments slide over myosin filaments resulting in a shortening of the length of the sarcomeres, and hence, a shortening of the muscle fibers. During this process the actin and myosin filaments do not change length when muscles contract, but instead they slide past each other. As a result, the muscle fiber becomes shorter and fatter in appearance. As a number of muscle fibers shorten at the same time, the whole muscle contracts and causes the tendon to pull on the bone it attaches to. This creates movement that occurs at the point of insertion.

For the muscle to return to normal (i.e., to lengthen), a force must be applied to the muscle to cause the muscle fibers to lengthen. This force can be due to gravity or due to the contraction of an opposing muscle group.

Skeletal muscles contract in response to an electric signal called an **action potential**. Action potentials are conducted along nerve cells before reaching the muscle fibers. The nerve cells regulate the function of skeletal muscles by controlling the number of action potentials that are produced. The action potentials trigger a series of chemical reactions that result in the contraction of a muscle.

When a nerve impulse stimulates a motor unit within a muscle, all of the muscle fibers controlled by that motor unit will contract. When stimulated, these muscle fibers contract on an all-or-nothing basis. The all-or-nothing principle means that muscle fibers either contract maximally along their length or not at all. Therefore, when stimulated, muscle fibers contract to their maximum level and when not stimulated there is no contraction. In this way, the force generated by a muscle is not regulated by the level of contraction by individual fibers, but rather it is due to the number of muscle fibers that are recruited to contract. This is called **muscle fiber recruitment**. When lifting a light object, such as a book, only a small number of muscle fibers will be recruited. However, those that are recruited will contract to their maximum level. When lifting a heavier weight, many more muscle fibers will be recruited to contract maximally.

When one muscle contracts, another opposing muscle will relax. In this way, muscles are arranged in pairs. An example is when you bend your arm at the elbow: you contract your bicep muscle and relax your tricep muscle. This is the same for every movement in the body. There will always be one contracting muscle and one relaxing muscle. If you take a moment to think about these simple movements, it will soon become obvious that unless the opposing muscle is relaxed, it will have a negative effect on the force generated by the contracting muscle.

A muscle that contracts, and is the main muscle group responsible for the movement, is called the **agonist** or prime mover. The muscle that relaxes is called the **antagonis**t. One of the effects that regular strength training has is an improvement in the level of relaxation that occurs in the opposing muscle group. Although the agonist/antagonist relationship changes, depending on which muscle is responsible for the movement, every muscle group has an opposing muscle group.

Smaller muscles may also assist the agonist during a particular movement. The smaller muscle is called the **synergist**. An example of a synergist would be the deltoid (shoulder) muscle during a press-up. The front of the deltoid provides additional force during the push-up; however, most of the force is applied by the pectoralis major (chest). Other muscle groups may also assist the movement by helping to maintain a fixed posture and prevent unwanted movement. These muscle groups are called fixators. An example of a **fixator** is the shoulder muscle during a bicep curl or tricep extension.

Types of Muscular Contraction

Isometric: This is a static contraction where the length of the muscle, or the joint angle, does not change. An example is pushing against a stationary object such as a wall. This type of contraction is known to lead to rapid rises in blood pressure.

Isotonic: This is a moving contraction, also known as **dynamic contraction**. During this contraction the muscle fattens, and there is movement at the joint.

Types of Isotonic Contraction

Concentric: This is when the muscle contracts and shortens against a resistance. This may be referred to as the lifting or positive phase. An example would be the lifting phase of the bicep curl.

Eccentric: This occurs when the muscle is still contracting and lengthening at the same time. This may be referred to as the lowering or negative phase.

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2.1.4.2: Muscle Fiber Types

Not all muscle fibers are the same. In fact, there are two main types of muscle fiber:

1. **Type I:** often called *slow-twitch* or *highly-oxidative* muscle fibers
2. **Type II:** often called *fast-twitch* or *low-oxidative* muscle fibers

Type I (Slow-Twitch or Highly-Oxidative Muscle Fibers)

Slow-twitch muscle fibers contain more mitochondria, the organelles that produce aerobic energy. They are also smaller, have better blood supply, contract more slowly, and are more fatigue resistant than their fast-twitch brothers. Slow-twitch muscle fibers produce energy, primarily, through aerobic metabolism of fats and carbohydrates. The accelerated rate of aerobic metabolism is enhanced by the large numbers of mitochondria and the enhanced blood supply. They also contain large amounts of myoglobin, a pigment similar to hemoglobin that also stores oxygen. The myoglobin provides an additional store of oxygen for when oxygen supply is limited. This extra oxygen, along with the slow-twitch muscle fibers' slow rate of contraction, increases their endurance capacity and enhances their fatigue resistance. Slow-twitch muscle fibers are recruited during continuous exercise at low to moderate levels.

Type II (Fast-Twitch or Low-Oxidative Muscle Fibers)

These fibers are larger in size, have a decreased blood supply, have smaller mitochondria and less of them, contract more rapidly, and are more adapted to produce energy anaerobically (without the need for oxygen) than slow-twitch muscle fibers. Their reduced rate of blood supply, together with their larger size and fewer mitochondria, makes them less able to produce energy aerobically, and are therefore, not well suited to prolonged exercise. However, their faster rate of contraction, greater levels of glycogen, and ability to produce much greater amounts of energy anaerobically make them much more suited to short bursts of energy. Because of their greater speed of contraction and reduced blood supply, they are far less fatigue resistant than slow-twitch fibers, and they tire quickly during exercise.

Additionally, Type II muscle fibers can be further split into **Type IIa** and **Type IIb**. Type IIb fibers are the truly fast twitch fibers, whereas Type IIa are in between slow and fast twitch. Surprisingly, the characteristics of Type IIa fibers can be strongly influenced by the type of training undertaken. Following a period of endurance training, they will start to strongly resemble Type I fibers, but following a period of strength training they will start to strongly resemble Type IIb fibers. In fact, following several years of endurance training they may end up being almost identical to slow-twitch muscle fibers.

Numbers of Slow and Fast-Twitch Fibers

The number of slow and fast-twitch fibers contained in the body varies greatly between individuals and is determined by a person's genetics. People who do well at endurance sports tend to have a higher number of slow-twitch fibers, whereas people who are better at sprint events tend to have higher numbers of fast-twitch muscle fibers. Both the slow twitch and fast-twitch fibers can be influenced by training. It is possible through sprint training to improve the power generated by slow twitch fibers, and through endurance training, it is possible to increase the endurance level of fast-twitch fibers. The level of improvement varies, depending on the individual, and training can never make slow-twitch fibers as powerful as fast-twitch, nor can training make fast-twitch fibers as fatigue resistant as slow-twitch fibers.

Cardiac Muscle Structure and Function

Cardiac muscle cells are only found in the heart. They are elongated and contain actin and myosin filaments, which form sarcomeres; these join end to end to form myofibrils. The actin and myosin filaments give cardiac muscle a striated appearance. The striations are less numerous than in skeletal muscle. Cardiac muscles contain high numbers of mitochondria, which produce energy through aerobic metabolism. An extensive capillary network of tiny blood vessels supply oxygen to the cardiac muscle cells. Unlike the skeletal muscle cells, the cardiac cells all work as one unit, all contracting at the same time. In short, the sinoatrial node at the top of the heart sends an impulse to the atrioventricular node, which sends a wave of polarization that travels from

one heart cell to another causing them all to contract at the same time.

Smooth Muscle Structure and Function

Smooth muscle cells are variable in function and perform numerous roles within the body. They are spindle shaped and smaller than skeletal muscle and contain fewer actin and myosin filaments. The actin and myosin filaments are not organized into sarcomeres, so smooth muscles do not have a striated appearance. Unlike other muscle types, smooth muscle can apply a constant tension. This is called smooth muscle tone. Smooth muscle cells have a similar metabolism to skeletal muscle, producing most of their energy aerobically. As such, they are not well adapted to producing energy anaerobically.[1]

Muscular Strength is the capacity of the muscle to exert force with a single maximum effort
Muscular Endurance is the capacity of the muscle to exert force repeatedly over a period of time, while resisting fatigue

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2.1.4.3: Resistance Exercise Programming

Designing a resistance exercise program can seem like a daunting task. However, the basics are very simple. The table below provides instructions for designing an effective resistance exercise program.

Resistance Exercise Program

F	Frequency of Exercise	How Often	Beginner	2–3 days per week Full-body workout of all 6 body areas 48–72 hours of rest in-between workouts	
			Intermediate to High	4–5 days per week; often perform split workouts (example: Monday and Thursday, work chest, shoulders, triceps, abdominals; Tuesday and Friday, work back, legs, biceps) 48–72 hours of rest in-between workouts	
I	Intensity of Exercise	How Hard	Beginner	60%–70% of maximum strength	
			Intermediate to High	70%–90% of maximum strength	
T	Time of Exercise	–How many reps –How many sets –How much time between sets	Beginner	1–3 Sets 8–12 repetitions	30 sec to 1 minute
			Intermediate to High	Endurance – 12–20+ Reps 2–3 Sets	30 sec to 1 minute
				Strength – 2–6 Reps 3–5 Sets	2 to 5 minutes
T	Type of Exercise	Which Exercises	Weight machines, free weights, resistance tubing, medicine ball, own body weight		

Note: Specificity Principle — you must work each muscle group to have strength gains in that particular part of the body.

Recommendations for Resistance Training Exercise

- **Perform a minimum of 8 to 10 exercises that train the major muscle groups.**
  - Workouts should not be too long. Programs longer than one hour are associated with higher dropout rates.
  - Choose more compound, or multi-joint exercises, which involve more muscles with fewer exercises.
- **Perform one set of 8 to 12 repetitions to the point of fatigue.**
  - More sets may elicit slightly greater strength gains, but additional improvement is relatively small.
- **Perform exercises at least 2 days per week.**
  - More frequent training may elicit slightly greater strength gains, but additional improvement is relatively small since progress is made during the recuperation between workouts.
- **Perform exercises using proper form.**
- **Perform exercises through a full range of motion.**
  - Elderly trainees should perform the exercises in the maximum range of motion that does not elicit pain or discomfort.
- **Perform exercises in a controlled manner.**
- **Maintain a normal breathing pattern or breathe out during the power phase of the exercise.**
- **If possible, exercise with a training partner.**
  - Partners can provide feedback, assistance, and motivation.

Position Stand on Progression Models in Resistance Training for Healthy Adults[2]

- **Utilize both concentric and eccentric muscle actions.**
- **Utilize single and multiple joint exercises.**
- **Exercise sequence:**
  - large before small muscle group exercises
  - multiple-joint exercises before single-joint exercises
  - higher intensity before lower intensity exercises
- **When training at a specific load:**
  - 2-10% increase in load if one to two repetitions over the desired number
- **Training frequency:**
  - 2-3 days per week for novice and intermediate training
  - 4-5 days per week for advanced training
- **Novice training:**
  - 8-12 repetition maximum (RM)
- **Intermediate to advanced training:**
  - 1-12 RM using periodization* (strategic implementation of specific training phases alternating between phases of stress and phases of rest)
  - eventual emphasis on heavy loading (1-6 RM)
  - at least 3-min rest periods between sets
  - moderate contraction velocity
  - 1-2 s concentric, 1-2 s eccentric
- **Power training (two general loading strategies):**
  - **Strength t raining**
    - use of light loads
    - 30-60% of 1 RM
    - fast contraction velocity
    - 2-3 min of rest between sets for multiple sets per exercise
    - emphasize multiple-joint exercises especially those involving the total body
  - **Local muscular endurance training**
    - light to moderate loads
    - 40-60% of 1 RM
    - high repetitions (> 15)
    - short rest periods (< 90 seconds)

Recommendations should be viewed within the context of an individual's target goals, physical capacity, and training status.

Six Types of Resistance Training

Each type of resistance training benefits muscles in a different way. While these types of resistance training are not new, they could be unique sources of resistance that you have not considered in your quest to add muscle to your frame. Using these forms of resistance alone, in combination with one another, or in combination with the more traditional resistance apparatus, can enable you to diversify your efforts to produce valuable and improved results.

In each type of training, you may use an apparatus to create an environment for resistance. The uniqueness of these sources is found in the way they are implemented. You might use a dumbbell for a particular exercise in some of these alternative resistance methods, but the way you use the resistance through a range of motion may be altogether different.

1. Dynamic Constant Training

As the name suggests, the most distinctive feature of dynamic constant training (DCT) is that the resistance is constant. A good example of DCT occurs when you use free weights or machines that do not alter resistance, but redirect it instead. The emphasis shifts to different planes along the muscle group being worked. When you work on a shoulder-press machine, for example, the resistance remains constant over the entire range of motion. It is identical from the bottom of the movement to the top and back down again. Only the direction of the resistance varies. The resistance redirects itself through the arc and then redirects itself again when the shoulders let the weight come back down to the starting position.

2. Dynamic Progressive Training

In dynamic progressive training (DPT), resistance increases progressively as you continue to exercise. DPT is often used as a rehabilitative measure and offers the sort of resistance that builds gradually while remaining completely within the control of the person using it. Equipment includes rubber bands and tubing, springs, and an apparatus controlled by spring-loaded parts. They are low-cost items that are easily accessible and can be used anywhere. Though commonly employed for rehabilitation of torn ligaments, joints, muscles, and broken bones, it is also convenient for travelers on either vacation or business trips. When combined with traditional forms of resistance, this training creates a better-balanced program and provides the muscles with a welcome alternative from time to time.

3. Dynamic Variable Training

This form of resistance exercise takes up where dynamic constant training leaves off. Whereas DCT employs constant resistance, never varying to accommodate the body's mechanics, DVT can be adapted to the varying degrees of strength of a muscle group throughout a range of motion. Some specialized machines use the DVT principle most effectively by allowing user to increase resistance at the beginning, middle or end of the range of motion. If your joints are stronger at the end of a movement (the top) or the beginning (the bottom), you can set the resistance accordingly.

4. Isokinetic Training

In isokinetic training (IKT), the muscle is contracted at a constant tempo. Speed determines the nature of this resistance training, not the resistance itself; however, the training is based on movement carried out during a condition of resistance. IKT can be performed with the body's own weight.

In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

5. Isometric Training

Familiar to most people, isometric training (IMT) is an excellent way to build strength with little adverse effect on joints and tendons commonly associated with strength training and lifting heavy weights. Though it appears simple in comparison to traditional resistance training, IMT should not be underrated in its effectiveness. IMT is a method in which the force of contraction is equal to the force of resistance. The muscle neither lengthens nor shortens. You may be wondering how any training occurs without lengthening and shortening the muscles. In IMT, the muscles act against each other or against an immovable object.

Isometric training is used when performing planks or wall sits. Another common IMT exercise is pressing the hands together to strengthen the pectorals and biceps. Isometric training has been proven very effective for gaining strength, but this method usually strengthens only the muscles at the point of the isometric contraction. If the greatest resistance and force are acting upon the mid-portion of the biceps, that is where most of the benefit will occur.

6. Isotonic Training

This method demands constant tension, typically with free weights. Though this approach may sound a lot like dynamic constant

training, it differs because it does not necessarily redirect the resistance through a range of motion, but rather, keeps tension constant as in the negative portion of an exercise. Complete immobility of the muscle being worked is required. For example, in the preacher curl, the biceps are fixed against the bench. They lift (positive), then release the weight slowly downward (negative), keeping the same tension on the muscles in both directions. This is one reason that free-weight exercise is considered the best form of isotonic training. Merely lifting a dumbbell or barbell, however, is not necessarily enough to qualify as isotonic. The true essence of isotonic training is keeping resistance constant in both the positive and negative portions of each repetition.

Exercise Order for Resistance Training

The general guidelines for exercise order when training all major muscle groups in a workout is as follows:

- Large muscle group exercises (i.e., squat) should be performed before smaller muscle group exercises (i.e., shoulder press).
- Multiple-joint exercises should be performed before single-joint exercises.
- For power training, total body exercises (from most to least complex) should be performed before basic strength exercises. For example, the most complex exercises are the snatch (because the bar must be moved the greatest distance) and related lifts, followed by cleans and presses. These take precedence over exercises such as the bench press and squat.
- Alternating between upper and lower body exercises or opposing (agonist–antagonist relationship) exercises can allow some muscles to rest while the opposite muscle groups are trained. This sequencing strategy is beneficial for maintaining high training intensities and targeting repetition numbers.
- Some exercises that target different muscle groups can be staggered between sets of other exercises to increase workout efficiency. For example, a trunk exercise can be performed between sets of the bench press. Because different muscle groups are stressed, no additional fatigue would be induced prior to performing the bench press. This is especially effective when long rest intervals are used.[3]

Resistance Training Conclusion

The most effective type of resistance-training routine employs a variety of techniques to create a workout program that is complete and runs the gamut, from basic to specialized. Learning different methods of training, different types of resistance, and the recommended order can help you acquire a balanced, complete physique. That does not mean that these training methods will help everybody to win competitions, but they will help you learn how to tune in to your body and understand its functions through resistance and movement. This knowledge and understanding develops a valuable skill, allowing you to become more adept at finding what works best for you on any given day.

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2.1.4.4: Supplements

Many active people use nutritional supplements and drugs in the quest for improved performance and appearance. Most of these substances are ineffective and expensive, and many are dangerous. A balanced diet should be your primary nutritional strategy.

Below are links that provide additional information about the use of supplements during exercise:

Benefits and Side Effects of Steroid Use
Protein Powders
Creatine Supplements

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2.1.4.5: Test Your Knowledge

1. What is the best way to assess muscular endurance?

    a. Repetition maximum test

    b. 1-repetition maximum test

    c. 12 minute swim

    d. sit and reach

2. Static muscular strength exercises are ones where no movement occurs?

    a. True

    b. False

3. Concentric movement refers to

    a. Muscles lengthening

    b. Muscles staying the same length

    c. Muscles shortening

    d. Muscles going thru a full range of motion

4. Proper technique in resistance exercise helps all the following except

    a. Better muscular improvements

    b. Less risk for injury

    c. Makes exercising safer

    d. Makes you look better

5. Which of the following is not needed in order to be safe while doing resistance exercises?

    a. Working out in a mirror

    b. Using proper technique

    c. Using spotters

    d. Not working out when injured

Answers: 1.A, 2.A, 3.C, 4.D, 5.A

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2.1.5: FLEXIBILITY

2.1.5.1: What is Flexibility?

2.1.5.2: Benefits of Flexibility and Stretching

2.1.5.3: Improving Range of Motion

2.1.5.4: Improving Flexibility

2.1.5.5: Creating an Effective Stretching Program

2.1.5.6: Assessing Your Flexibility

2.1.5.7: Test Your Knowledge

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2.1.5.1: What is Flexibility?

One of the five health-related components of fitness is flexibility. Flexibility relates to the ability to move a joint through its full range of motion (ROM). Developing a complete fitness program requires taking time to emphasize this component by stretching. Unfortunately, as the American Council on Exercise points out, “Most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention.”[1]

Perhaps the reason it is so easy for people to overlook flexibility is because its benefits, while significant, are felt more than seen. However, failing to address this component of fitness can have serious consequences, especially as a person ages. Without flexibility, everyday tasks, such as sweeping the floor or even getting out of bed, become difficult. Reduced mobility of joints increases the risk of injury during an exercise routine, as well as the risk of occasional and chronic back pain. This chapter will provide a greater understanding of this vitally important component of a complete fitness program and demonstrate why flexibility shouldn’t be overlooked.

Types of Flexibility

Flexibility is classified into two types: static and dynamic.

1. Static flexibility

This type of flexibility is a measure of the limits of a joint’s overall range of motion. It is measured by stretching and holding a joint in the position of its maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, **passive forces**, the force generated from an external source, are required.

2. Dynamic flexibility

This type of flexibility is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production, or your own muscles contracting. Because quantifying “stiffness,” is difficult, dynamic flexibility is measured more subjectively. Assessment is based on how easy or difficult it is to perform certain tasks, such as swinging a tennis racket, climbing steps, or getting in and out of a car.

The aim of any good stretching program is to improve both static and dynamic flexibility so that normal ROM can be achieved. The definition of *normal* in this context is one developed from population studies that measured various areas of the body and established an average degree of movement for a particular joint.

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2.1.5.2: Benefits of Flexibility and Stretching

Regular stretching provides many benefits, the most important of which is simple: flexibility provides freedom of movement and the ability to complete activities with greater ease.

Healthy Joints and Pain Management

As many as 26 percent of all adults report pain and stiffness in joints. That number increases dramatically with age, and women are more likely to develop joint symptoms.[2] For adults, arthritis is one of the most common conditions, with 54% of people 75 years and older having been diagnosed with arthritis.[3] Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching increases joint mobility and function, and decreases joint stiffness and pain.

Imbalances in the muscles can cause discomfort and pain. For example, if the front of a person's thighs and hips gets too tight from a lack of flexibility, the tension will pull on the hips, where the muscles are attached. The result is the pelvis may be pulled forward and cause greater sway in your lower back. This affects posture and can eventually lead to pain and stiffness in the neck, shoulders, and lower back. Stretching all major muscle groups and joint areas regularly promotes good alignment and balance.

Muscle Relaxation and Stress Relief

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots, also called trigger points. Regular stretching decreases anxiety, blood pressure, and breathing rate, which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea, which is painful menstruation. It also relieves muscle cramps that can occur during exercise or participation in sports.

Other Benefits

In addition to the benefits listed above, research has documented additional benefits that provide good reasons for maintaining a routine of stretching:

- **Increased blood flow:** Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched, which helps them recover from exercise faster.[4]
- **Reduced risk of developing future lower back pain:** Although research is still inconclusive, most experts agree that muscle fitness and stretching exercises reduce the risk of developing lower back pain by counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging.

Flexibility and Aging

For many college students, maintaining long- term flexibility is not a concern. For young adults, bending over to tie their shoes is painless. Walking around campus with a backpack requires minimal effort. However, ROM declines with age. Simple activities like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can become painful. Therefore, flexibility is critical in maintaining a high quality of life throughout the aging process.

The Inactivity-Mobility Cycle

Anyone who has suffered an injury and had to wear a splint, cast, or brace to immobilize a joint knows how important mobility is to overall health. Unfortunately, when the joints' ROM becomes restricted by arthritis or other injuries, activity declines. As activity declines, the ROM continues to diminish as a result of inactivity, and a vicious cycle ensues. A simple stretching program can help alleviate this problem and break the cycle.

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2.1.5.3: Improving Range of Motion

Joint ROM results from a combination of factors, which are classified as either internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include gender, age, excess fat mass, muscle mass, environmental temperature, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions, such as muscular contractions and stretching, are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

Joint Structure

A joint is defined as a location on the skeletal system where two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits its ROM. For example, the shoulder joint, which is structurally a ball-in-socket joint, can rotate in multiple directions, giving it a wide range of motion. However, the knee joint is a modified hinge joint, which is limited to essentially a forward-backward direction of movement.

Additionally, ROM may be limited by excessive fat mass or even large muscle mass surrounding a particular joint. Although the amount of muscle mass and fat mass surrounding a joint can be altered by diet and activity levels, joint structure is permanent. As a result, little can be done to improve flexibility in this area.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. Stretching the hamstring will not improve flexibility in the shoulders. Likewise, flexibility in the shoulders may be excellent while fingers or ankles remain “stiff.” As such, a complete and effective stretching program includes multiple stretches for various joints.

Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. The head of the humerus fits into a small cavity to create the shoulder joint. However, those bones cannot remain in that position without the muscles, tendons, and ligaments that keep the joint tight and hold it in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through its normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed is not well understood, they do appear to be related to the elastic and plastic properties of the connective tissue. **Elasticity** is defined as the ability to return to resting length after **passive stretching** (i.e., elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. **Plasticity** is the tendency to assume a greater length after passive stretching (i.e., plastic deformation). Stretching that spring composed of soft tissues will change its resting position to a new longer length. The goal of a flexibility program is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Experts suggest that a slow, sustained stretch for 30–90 seconds is necessary to produce chronic plastic deformation.

Neuromuscular System

Modern cars come equipped with a central computer and sensors to troubleshoot problems with the vehicle. Sensors in the engine monitor temperature. Sensors on the wheels gauge tire pressure while sensors in the gas tank alert the driver when fuel is low. Much like a car, our bodies are equipped with sensors, called **proprioceptors**, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These proprioceptors are called muscle spindles and Golgi tendon organs (GTOs).

Muscle spindles lie parallel to the regular muscle and help determine the length of muscles when they are being stretched.

When a muscle is stretched, it sends signals to the central nervous system causing the stretched muscle to contract. This resistance to the stretch, called the **myotatic** or **stretch reflex** is generated by the nervous system's reflexive stimulus sent to the stretching muscle. That same signal also causes the antagonist, or opposing muscle to relax, called **reciprocal inhibition**. As such, when the upper thigh muscles (quadriceps) are stretched, the hamstrings (antagonist to the quadriceps) relax.

The GTOs are located near the **musculotendonjunction**, the end points of the muscle, and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, these signals will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called **autogenic inhibition** or the **inverse myotatic reflex**. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, to effectively stretch, movements must be sustained for long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will not be overridden and lengthening cannot occur. Whether signaling the muscles to contract or relax, the neuromuscular system manipulates the stretched muscle, presumably as a protective mechanism to prevent injury.

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2.1.5.4: Improving Flexibility

Research has identified multiple stretching techniques that aid in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using either active or passive mode. **Active stretching**, also called unassisted stretching, is done individually without an external stimulus. **Passive stretching**, or assisted stretching, is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques described below.

Static Stretching

The technique most commonly prescribed and used to improve flexibility is the static stretch. A static stretch involves slow, gradual, and controlled movements. The muscle group is stretched toward the end of the joint's ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a "static" position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be performing Yoga routines or stretching after a workout or an athletic event. Some of the major advantages of static stretching are as follows:

1. It is generally considered safe (see "Stretches to Avoid" on the next page).
2. It is simple to perform.
3. It is effective at increasing ROM.

The only major disadvantage comes from doing it too much, which can reduce strength and may make joints unstable. Of course, this potential risk applies to all of the techniques.

Ballistic Stretching

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint's ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch and the forceful nature of ballistic movements, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many coaches regard ballistic stretching as unsafe. Also, many researchers contend that it is less effective at improving ROM. Nonetheless, the American College of Sports Medicine (ACSM) still recommends ballistic stretching as one method to effectively increase flexibility.

Dynamic Stretching

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that do not involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is its ability to target and improve dynamic flexibility, which in turn may improve performance. A disadvantage comes from the movements involved, which often require good balance and coordination. Since mastering the correct form requires time and a certain level of athleticism, dynamic stretching may not be suitable for certain populations.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching

This type of exercise usually involves a partner. The partner will passively stretch the person's muscle. This movement is immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contraction, also describing the sequence of movements involved but

adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two responses: the stretch reflex and the reciprocal inhibition (the relaxing of the antagonist muscle). After 5 seconds, the GTOs then override the muscle spindle's signals causing autogenic inhibition. Because the muscle is relaxed, it can be stretched more easily. To reiterate, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself relaxes as a result of the contraction of the antagonist muscle.

While many experts assert that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF are that it generally requires a knowledgeable partner, it is somewhat complicated, and it can cause soreness as a result of the contractions.

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2.1.5.5: Creating an Effective Stretching Program

First evaluate your current flexibility status by assessing various joints' ROM. Specifically, performing the sit-and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

Setting Goals

Once you determine which of your joints are the most and least flexible, you can set some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, "I want to increase my flexibility," identify the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal is, "I will improve my sit-and-reach score by 4 cm by the end of the semester." Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of achieving it.

Applying the FITT Principle

When designing a flexibility program use the FITT Principle (**F**requency, **I**ntensity, **T**ime and **T**ype). Your flexibility program should include multiple stretching exercises that target all major joints, including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles.

After selecting your exercises, follow the recommendations below when performing your routine:

- **Frequency:** Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.
- **Intensity:** Stretch to the point of tightness or mild discomfort.
- **Time (duration of each stretch):** Stretch for a minimum of 10 seconds for very tight muscles with an emphasis on progressing to 30-90 seconds. Complete two to four repetitions of each stretch.
- **Type (mode):** Select the technique that best suits your circumstances: static, dynamic, ballistic, or proprioceptive neuromuscular facilitation.

When to Stretch

Although stretching can be done any time, the ACSM traditionally recommends that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies suggests that stretching before an exercise session will compromise the force-producing capabilities of muscles and should be avoided. Therefore, it is recommended that stretching be restricted to *after* the warm-up or workout, when the temperature of the body and muscles has increased. Additional evidence pertaining to this concept shows that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. These findings confirm that temperature also plays a significant role in muscle ROM.

Stretching Safely

In addition to warming up your muscles before performing stretching exercises, additional precautions can be taken to ensure the safety of your routine. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned previously, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

Stretches to Avoid

Research indicates that some stretches are **contraindicated**, which means they are not recommended because they provide little to no benefit and may cause injury. A list of stretches to avoid, as well as safer, alternate stretches, can be found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. To avoid injury, it is important to

consider personal limitations before performing a stretch exercise.

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2.1.5.6: Assessing Your Flexibility

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2.1.5.7: Test Your Knowledge

1. Experts, such as the American College of Sports Medicine, recommend performing flexibility exercises:

    a. A minimum of 2-3 days p/week

    b. At least 1-2 days p/week

    c. Ideally, 5-7 days p/week

    d. Both a and c

2. The best time to perform stretching exercises is:

    a. After a warm-up or after a workout session

    b. Immediately before all high-performance activities.

    c. To the point of pain

    d. While holding one's breath.

3. The technique of stretching that emphasizes contracting followed by relaxing a muscle is called:

    a. Ballistic

    b. Dynamic

    c. PNF

    d. Passive

4. The key objective of performing flexibility exercises is to:

    a. Increase elasticity and plasticity of the muscles

    b. Improve body composition

    c. Release toxins that accumulate in the blood

    d. Improve lung capacity

6. The stretching technique most often recommended by experts for general fitness is:

    a. Dynamic

    b. Ballistic

    c. PNF

    d. Static

Answers: 1.D, 2.A, 3.C, 4.A, 5.D

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2.1.6: BODY COMPOSITION

2.1.6.1: Body Weight versus Body Composition

2.1.6.2: Diseases Associated with Excessive Body Fat

2.1.6.3: Body Fat Distribution

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2.1.6.1: Body Weight versus Body Composition

According to surveys, the top reason American females exercise is for weight control. For males, the top reason is to improve muscle tone while weight control ranks as the fourth most important reason.[1] Levels of attractiveness based on weight and visible musculature are significant points of emphasis in American culture. As such, individuals with well-toned muscles and low body weight are marketed as *superior* within the context of attractiveness, financial success, and multiple other traits. Unfortunately, this emphasis, as seen in mainstream media, can result in unrealistic ideals and potentially harmful behaviors, such as eating disorders.

Unlike the mainstream outlets, which focus on the association between fat levels and physical attractiveness, this chapter focuses on the health-related consequences related to good and bad body composition. **Body composition** is defined as the body's relative amount of fat-free mass (FFM) and fat mass (FM) and is generally expressed as a percentage of total body weight. FFM includes bones, muscles, ligaments, body fluids and other organs, while FM is limited to fat tissue.

The Importance of Measuring Body Composition Rather Than Just Tracking Body Weight

Tracking weight can be helpful, but body composition measurements help separate a person's actual weight from the weight that could be unhealthy.

For example, an individual who weighs 200 pounds and has 8% body fat, such as an athlete, only carries around 16 pounds of FM. However, a 200-pound person who has a sedentary lifestyle and a body composition of 20%, carries 40 pounds of FM. Weight alone, in this case, does not distinguish between FFM and FM and would suggest both individuals have similar health. As body fat percentage increases, the potential for various diseases also increases significantly.

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2.1.6.2: Diseases Associated with Excessive Body Fat

According to the National Institute of Health (NIH), a wide array of diseases can be linked to excessive body fat.[2] Some of them are:

- Type II Diabetes Mellitus
- Hypertension
- Cancer
- Cerebrovascular Disease (Stroke)
- Cardiovascular Disease
- Metabolic Syndrome
- Lung Disorders
- Sleep Apnea
- Asthma
- Musculoskeletal Diseases
- Osteoarthritis
- Gout
- Gallbladder Disease
- Pancreatitis
- Non-Alcohol Fatty Liver Disease
- Dementia
- Psychological Problems and Quality of Life
- Kidney Disease
- Pregnancy Problems

How Much Fat is Needed?

Fat is a necessary component of daily nutrition. It is needed for healthy cellular function, energy, cushioning for vital organs, insulation, and for food flavor.

Fat storage in the body consists of two types of fat: essential and nonessential fat. **Essential fat** is the minimal amount of fat necessary for normal physiological function. For males and females, essential fat values are typically considered to be 3% and 12%, respectively. Fat above the minimal amount is referred to as **nonessential fat**. It is generally accepted that an overall range of 10-22 percent for men and 20-32 percent for women is considered satisfactory for good health. A body composition within the recommended range suggests a person has less risk of developing obesity-related diseases, such as diabetes, high blood pressure, and even some cancers.

A woman's essential fat range is naturally greater than a man's because of fat deposits in breasts, uterus and sex-specific sites. In both males and females, non-essential fat reserves can be healthy, especially in providing substantial amounts of energy.

Excessive body fat is categorized by the terms overweight and obesity. These terms do not implicate social status or physical attractiveness, but rather indicate health risks. **Overweight** is defined as the accumulation of non-essential body fat to the point that it adversely affects health. According to the American College of Sports Medicine (ACSM), the threshold for being characterized as overweight is having a body composition of FM greater than 32% and 19% for females and males, aged 20-39, respectively.[3]

Obesity is characterized by excessive accumulation of body fat and can be defined as a more serious degree of being overweight. Classifications of obesity begin at body composition of FM greater than 39% and 25% in females and males ages 20-39, respectively. [4]

Other Health Risks

Diseases are not the only concern with an unhealthy body fat percentage. Several others are listed below.

Performance of physical activity

An important component of a healthy lifestyle and weight management is regular physical activity and exercise. To the contrary, those who live a sedentary lifestyle will find it more difficult to maintain a healthy body weight or develop adequate musculature, endurance, and flexibility. Unfortunately, additional body weight makes it more difficult to be active because it requires more energy and places a higher demand on weak muscles and the cardiovascular system. The result is a self-perpetuating cycle of inactivity leading to more body weight, which leads to more inactivity.

Emotional wellness

Studies indicate obesity is associated with a 25% increase in anxiety and mood disorders, regardless of age or gender. Other studies suggest increases in BMI significantly increase the incidence of personality disorders and anxiety and mood disorders. Additional studies have been able to associate a higher incidence of psychological disorders and suicidal tendencies in obese females compared with obese males.[5]

Pre-mature death

The association between obesity and diseases, such as cancer, CVD, and diabetes, suggests that people with more body fat generally have shorter lifespans. The Center for Disease Control (CDC) estimates up to 365,000 deaths each year can be linked with obesity, representing nearly 15% of all deaths. Other studies have tied the Years of Life Lost to body mass index measurements, estimating anywhere from 2 to 20 years can be lost, depending on ethnicity, age at time of obese classification, and gender.[6]

Economic impact

The physical harm caused by obesity and overweight is mirrored by its economic impact on the health care system. The CDC has estimated the medical costs to be about $147 billion in 2008, which includes preventative, diagnostic, and treatments. Overweight and obesity also contribute to loss of productivity at work through absenteeism and *presenteeism*, defined as being less productive while working. The annual nationwide productive costs fall within the range of from $3.38 to $6.38 billion.[7]

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2.1.6.3: Body Fat Distribution

Body composition measurements can help determine health risks and assist in creating an exercise and nutrition plan to maintain a healthy weight. However, the presence of unwanted body fat is not the only concern associated with an unhealthy weight. Where the fat is stored, or fat distribution, also affects overall health risks.

Non-essential fat is primarily stored in **adipose tissue**, or fat cells, located on the surface of the body and surrounding the body's organs. Surface fat, located just below the skin, is called **subcutaneous fat**. Fat that lies deeper in the body surrounding the body's organs is called **visceral fat**. Unlike subcutaneous fat, visceral fat is more often associated with abdominal fat. Researchers have found that excessive belly fat decreases insulin sensitivity, making it easier to develop type II diabetes. It may also negatively impact blood lipid metabolism, contributing to more cases of cardiovascular disease and stroke in patients with excessive belly fat.[8]

Body fat distribution can easily be determined by simply looking in the mirror. The outline of the body, or body shape, would indicate the location of where body fat is stored. Abdominal fat storage patterns are generally compared to the shape of an apple, called the **android shape**. This shape is more commonly found in males and post-menopausal females. In terms of disease risk, this implies males and post-menopausal females are at greater risk of developing health issues associated with excessive visceral fat. Individuals who experience chronic stress tend to store fat in the abdominal region.

A pear-shaped body fat distribution pattern, or **gynoidshape**, is more commonly found in pre-menopausal females. Gynoid shape is characterized by fat storage in the lower body such as the hips and buttocks. This shape may be connected to females' child-bearing abilities as enzymes associated with fat-storage and mobilization are activated during certain times of pregnancy and post-partum.

Besides looking in the mirror to determine body shape, people can use an inexpensive tape measure to measure the diameter of their hips and waist. Many leading organizations and experts currently believe a waist circumference of 40″ or greater for males and 35″ or greater for females significantly increases risk of disease.[9]

In addition to measuring waist circumference, measuring the waist and the hips and using a waist-to-hip ratio (waist circumference divided by the hip circumference) is equally effective at predicting body fat-related health outcomes. According to the National Heart, Lung, and Blood Institute, a ratio of greater than 0.82 for females and 0.94 for males is associated with a higher risk of developing heart disease, diabetes, and hypertension. [10]

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In addition to body composition and waist/hip circumferences, measuring body mass has also been used as an effective method to assess health risks. **Body mass index(BMI)** is a measurement of height (m^2) and weight (kg) suggesting that a person's weight should be proportional to his or her height. For example, based on the BMI scale, a female with a height of 5'6" should not weigh more than 155 lbs. If her weight exceeded 155 lbs., she would be categorized as "overweight."

BMI = Weight (kg) / Height (m^2)

Among several criticisms, the BMI method has been faulted for not distinguishing between FM and FFM, since only the overall weight is taken into account. For athletes, who may be more massive as a result of larger muscles, this criticism holds true. For example, a professional football player who weighs 215 pounds and stands at 6'3" would have the exact same BMI as a relatively sedentary arm-chair quarterback who also weighs 215 pounds with the same height. This discrepancy also exists when applying BMI to the senior population. As age increases, muscle mass declines. Seniors who have experienced years of muscle mass decline but increased body fat may maintain a constant weight despite having a very different body composition.

Other criticisms of using BMI as a health risk assessment tool include its failure to take age or gender into account. As discussed previously, females naturally have more body fat yet are classified in the same context as males. Because this measurement is so widely used by physicians, patients continue to express concerns about the validity of BMI as an indication of fatness.

Regardless of the criticisms, BMI as used for the general population, has been shown to be a reasonable predictor of health outcomes. At its core, it is not intended to be an estimate of body composition, i.e., measure Fat Mass and Fat-Free Mass. Instead, it is intended to be used as an estimate of healthy/unhealthy levels of body fat. When used as a means of tracking weight changes over time it can be a valuable tool in predicting health and for recommending lifestyle modifications.[11]

Waist-to-Hip Ratio

An alternative measurement which some studies have found to be more accurate than BMI is waist-to-hip ratio.

Unlike body mass index (BMI), which calculates the ratio of your weight to your height, waist-to-hip ratio takes into account the differences in body structure. So the very fit football lineman who might have a BMI rating of obese, may have a much healthier WHR rating. WHR measures the ratio of your waist circumference to your hip circumference. It determines how much fat is stored on your waist, hips, and buttocks.

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2.1.6.5: How to Measure Body Composition

Multiple methods exist to estimate body composition. Remember, body composition is the ratio of Fat Mass and Fat-Free Mass used to help determine health risks. Of the other methods already mentioned (waist, waist-to-hip ratio, and BMI), none provide estimates of body composition but do provide measurements of other weight-related health markers, such as abdominal fat. Experts have designed several methods to estimate body composition. While they are not flawless, they do provide a fairly accurate representation of body composition. The most common are:

Hydrostatic Weighing (Underwater Weighing)

At one time, hydrostatic weighing (also and maybe more accurately called **hydrodensitometry**) was considered the criterion for measuring body composition. Many other methods are founded on this model, in one form or another.

This method attempts to measure the density of the body by applying Archimedes' principle: density = mass/volume.

The mass and volume components are measured by using dry weight and then weight while being submerged in a water tank. Since fat is less dense than muscle tissue, a person with more body fat will weigh less in the water than a similar person with more lean mass. Using the measurements, the density can be determined and converted into body fat percentage. With a small margin of error (around 1-2%) this method is very accurate. Unfortunately, the expense and practicality of building and maintaining a water tank limits access for most. Also, for those with a fear of water, this would obviously not be the preferred method.

Dual Energy X-Ray Absorptiometry (DEXA)

Replacing underwater weighing as the new "gold standard," is DEXA. While underwater weighing accurately compartmentalizes FM and FFM, DEXA adds a third compartment by using low-radiation X-rays to distinguish bone mineral. This addition slightly increases the accuracy of DEXA by eliminating some of the guess work associated with individual differences, such as total body water and bone mineral density.Originally, DEXA scanners were designed to determine and help diagnose bone density diseases. As a result, they can be found in many physicians' offices. However, a full body scan, which takes only a few minutes, is all that is needed to also determine body fat percentage. Major disadvantages to this method are its high cost and the need for a well-trained professional to operate the equipment and analyze the results.

Air Displacement (Plethysmography)

A good alternative to more expensive methods, air displacement determines body density using the same principle as underwater weighing, by measuring mass and volume. Clearly, the main difference is that mass and volume are being determined by air displacement rather than water displacement. Using a commercial device (the Bod Pod is most commonly referenced), a person sits in a chamber that varies the air pressure allowing for body volume to be assessed. Air displacement provides a viable alternative for those with a fear of water. Like many other methods, the expense, availability, and training of personnel Air Displacement requires limit accessibility. Additionally, its accuracy is slightly less than underwater weighing.

Bio-electrical Impedance Analysis (BIA)

BIA takes a slightly different approach to measuring FFM. The premise behind BIA is that FFM will be proportional to the electrical conductivity of the body. Fat-tissue contains little water, making it a poor conductor of electricity; whereas, lean tissue contains mostly water and electrolytes, making it an excellent conductor. BIA devices emit a low-level electrical current through the body and measure the amount of resistance the current encounters. Based on the level of impedance, a pre-programed equation is used to estimate body fat percentage. The most accurate BIA devices use electrodes on the feet and hands to administer the point-to-point electrical current. The margin of error for these devices falls in the range of 3–5%. Portable or handheld BIA devices that only measure lower or upper body conductivity have a higher margin of error (4–8%). Because BIA devices primarily measure hydration, circumstances that may influence hydration status at the time of measurement must be taken into account. Recent exercise, bladder content, hydration habits, and meal timing can cause wide measurement variations and influence accuracy. However, this method is generally inexpensive, often portable, and requires limited training to use, making

it a very practical option.

Skinfold Analysis

Skinfold analysis is a widely used method of assessing body composition because of its simplicity, portability, and affordability. It is also fairly accurate when administered properly. Margins of error are about 4–7%, depending on the quality of the skinfold calipers and skill of the administrator/technician. The assumption of skinfold measurement is that the amount of subcutaneous fat is proportionate to overall body fat. As such, a technician pinches the skin at various sites and uses calipers to measure and record the diameter of the skin folds. These numbers can then be plugged into an equation to generate an estimate of body fat percentage. The proportionality of subcutaneous fat and overall body fat depends on age, gender, ethnicity, and activity rates. As such, technicians should use the skinfold technique specific to the equation that accounts for those variables to improve accuracy.

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2.1.6.6: Weighing in on the U.S.

Despite the well-known health concerns implicated in overweight and obesity and the availability of multiple methods for assessment and tools to improve body composition, current trends in the United States and around the world are moving in the wrong direction. The unprecedented number of obese Americans has led experts to label it an epidemic, much like they would a disease in a developing country. According to the CDC, the number of American adults (>20 years) that fall into the overweight classification based on BMI are 70.7%. Of those, 37.9% fall within the obese classification. In 1962, the overweight and obesity rates for adults in the U.S. were 32% and 13%, respectively. In other words, overweight trends have more than doubled and obesity rates have almost tripled over the past 50+ years.[12]

Of more concern are the increasing number of obese children ages 6-11 and adolescents ages 12-19, amounting to 17.4% and 20.6%, respectively.[13] While those numbers have stabilized over the past decade, this has led to a dramatic increase in insulin resistance, a form of diabetes formerly known as adult onset diabetes.

With such a diverse population in the U.S. and with an understanding of how BMI is calculated, it is only natural to question the high number of overweight and obese citizens based on BMI alone. However, it is generally believed this is an accurate portrayal of weight status. In a study attempting to compare BMI measurements to actual body fat percentage, it was determined that the total number of obese citizens may be underestimated, and its current prevalence may be worse than is currently being reported.

What Can Be Done?

With the available tools to identify health risks associated with body fat, anyone concerned about their health should gather as much data about body composition and body fat distribution as possible. Compiling multiple measurements and analyzing them provides a better idea of a person's current health status and will help determine the next course of action. For example, BMI alone can be beneficial. But when combined with waist circumference, a greater understanding of risk can be achieved. Likewise, when combining BMI and waist circumference with body fat percentage, an ideal conclusion of health status can be made.

In a lab activity that your instructor may assign for this chapter, you will be guided through the process of assessing your BMI, waist circumference, waist-to-hip ratio, and body fat percentage.

The next course of action is to set goals and formulate a plan to get to a healthy range of weight and body fat percentage. Where weight loss is needed, the plan should include a balance of calorie restriction and physical activity/exercise. This might also include tracking your current eating and activity habits. More specific information on weight management strategies will be discussed in a later chapter.

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2.1.6.7: Low Body Composition

Because more people experience excess body fat, the focus up to this point has been on health concerns related to overweight and obesity. However, fat is an essential component to a healthy body, and in rare cases, individuals have insufficient fat reserves, which can also be a health concern. The range of essential body fat for males is 3-5% and 8-12% for females. Attempting to, or intentionally staying in those ranges, through excessive exercise or calorie restriction is not recommended. Unfortunately, low body fat is often associated with individuals struggling with eating disorders, the majority of whom are females.

The main concern of low body fat relates to the number and quality of calories being consumed. Foods not only provide energy but also provide the necessary nutrients to facilitate vital body functions. For example, low amounts of iron from a poor diet can result in anemia. Potassium deficiencies can cause hypokalemia leading to cardiovascular irregularities. If adequate calcium is not being obtained from foods, bone deficiencies will result. Clearly, having low body fat, depending on the cause, can be equally as detrimental to health as having too much.

The health concerns most often linked to low body fat are:

- Reproductive disorders
- Infrequent or missing menstrual cycles
- Respiratory disorders
- Immune System disorders
- Circulatory disorders
- Premature death

In some cases, despite attempts to gain weight, individuals are unable to gain the pounds needed to maintain a healthy weight. In these cases, as in the case of excess fat, a holistic approach should be taken to determine if the low levels of body fat are adversely affecting health. These individuals should monitor their eating habits to assure they are getting adequate nutrition for their daily activity needs. Additionally, other lifestyle habits should be monitored or avoided, such as smoking, which may suppress hunger.

Additional reading on low body fat and its impact can be found on the Livestrong.com website, on this page: At what body fat percent do you start losing your period?.

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2.1.6.8: Test Your Knowledge

1. The key to healthy body composition is to:

    a. Emphasize short-term weight loss

    b. Focus on lifestyle changes

    c. Emphasize diet only

    d. Set unrealistic goals

2. The people who tend to gain weight in the hip area have a higher incidence of coronary heart disease than those people who gain weight in the abdominal area.

    a. True

    b. False

3. The “Bod Pod” estimates percent body fat by using:

    a. Low energy x rays

    b. Water displacement

    c. Air displacement

    d. Electrical current

4. Essential body fat is best described as:

    a. Fat essential to look good

    b. Fat essential for body functioning

    c. Fat used as energy storage

    d. Fat used to cushion organs

5. Which of the following methods for measuring body composition would be considered most accurate?

    a. DEXA

    b. Skin folds

    c. BIA

    d. Plethysmography

Answers: 1.B, 2.B, 3.C, 4.B, 5.A

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2.1.7: WEIGHT MANAGEMENT

2.1.7.1: Weight Management Through Diet

2.1.7.2: The Importance of Physical Activity in Maintaining a Healthy Weight

2.1.7.3: Keeping the Weight Off

2.1.7.4: Health Risks of Being Underweight

2.1.7.5: Test Your Knowledge

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2.1.7.1: Weight Management Through Diet

The majority of Americans are unhappy with their current weight. Almost everyone would like to lose at least 5 pounds. A growing percentage of Americans are carrying enough excess weight to put them at risk for many diseases and even death. Few people, however, know enough about their own bodies to successfully manage their weight. Anyone planning to start a weight loss program should begin by carefully considering the following factors:

- How many calories are being consumed daily? Myplate or HappyForks
- How many calories are being expended? BMR calculator
- How much fluids are being consumed?
- How well are electrolytes being managed?

Achieving one's ideal weight can be a challenge. But like most endeavors in life, knowledge is power. The more people know about their diet, the better equipped they will be to manage their weight. Most people focus on the number of calories consumed. However, it is also important for them to know how many macronutrients are in the foods they eat. The most effective way to do this is performing a 10-day nutritional intake analysis. These analyses are best done on consecutive days to account for the habitual ebb and flow of one's daily food intake.

Remaining healthy during any weight loss program is paramount. Fad diets that promise quick results do not consider the effects of rapid weight loss on the body. Restricting weight loss to 1 to 2 pounds a week is a far healthier approach. Slow weight loss also prevents the body from burning lean muscle since the body can only burn a certain amount of fat in a week. Dieters who experience steady declines in weight are more likely to keep the weight off. The term "diet" is often synonymous with strict routines that require drastic changes in one's eating habits. In reality, the term "diet" simply describes the intake of food.

To lose weight, dieters need a clear understanding of how weight loss occurs. One pound of fat loss is going to require a reduction in caloric intake of 3,500 calories. When viewed in terms of daily food intake, to lose a pound a week, a dieter needs to reduce their daily food intake by 500 calories a day: 3,500 calories/7 days= 500 calories per day. To successfully lose 2 pounds per week, that reduction would have to be doubled to 1,000 calories per day. Attempting to lose 2 pounds or more per week would require a calorie reduction too drastic to be maintained and too restrictive to be healthy. Thus the recommendation of combining diet and exercise is the most effective method for experiencing weight loss. Subtracting 500 calories of food intake and exerting 500 calories in exercise will provide that same 1000 calorie reduction, but in a manner that is far easier to maintain, and certainly more enjoyable.

No matter what your weight loss goal is, even a modest weight loss, such as 5 to 10 percent of your total body weight, is likely to produce health benefits, such as improvements in blood pressure, blood cholesterol, and blood sugars.[1]

Getting Started with Weight Loss

On its website, the CDC explains the importance of including physical activity as part of any weight loss program. You can find information about the benefits of physical activity, recommended levels of physical activity, and the number of calories burned during common activities in this step-by-step guide to healthy weight loss. That same information is reprinted below for your convenience:

Step 1: Make a commitment.

Making the decision to lose weight, change your lifestyle, and become healthier is a big step to take. Start simply by making a commitment to yourself. Many people find it helpful to sign a written contract committing to the process. This contract may include things like the amount of weight you want to lose, the date you would like to lose the weight by, the dietary changes you will make to establish healthy eating habits, and a plan for getting regular physical activity.

Writing down the reasons why you want to lose weight can also help. It might be because you have a family history of heart disease, or because you want to see your kids get married, or simply because you want to feel better in your clothes. Post these reasons where they serve as a daily reminder of why you want to make this change.

Step 2: Take stock of where you are.

Consider talking to your health care provider. He or she can evaluate your height, weight, and explore other weight-related risk factors you may have. Ask for a follow-up appointment to monitor changes in your weight or any related health conditions.

Keep a “food diary” for a few days, in which you write down everything you eat. By doing this, you become more aware of what you are eating and when you are eating. This awareness can help you avoid mindless eating.

Next, examine your current lifestyle. Identify things that might pose challenges to your weight loss efforts. For example, does your work or travel schedule make it difficult to get enough physical activity? Do you find yourself eating sugary foods because that is what you buy for your kids? Do your coworkers frequently bring high-calorie items, such as doughnuts, to the workplace to share with everyone? Think through things you can do to help overcome these challenges.

Finally, think about aspects of your lifestyle that can help you lose weight. For example, is there an area near your workplace where you and some coworkers can take a walk at lunchtime? Is there a place in your community, such as a YMCA, with exercise facilities for you and child care for your kids?

Step 3: Set realistic goals.

Set some short-term goals and reward your efforts along the way. If your long-term goal is to lose 40 pounds and to control your high blood pressure, some short-term eating and physical activity goals might be to start eating breakfast, taking a 15-minute walk in the evenings, or having a salad or vegetable with supper.

Focus on two or three goals at a time. Great, effective goals are:

- Specific
- Realistic
- Forgiving (less than perfect)

For example, “Exercise more” is not a specific goal. But if you say, “I will walk 15 minutes, 3 days a week for the first week,” you are setting a specific and realistic goal for the first week.

Remember, small changes every day can lead to big results in the long run. Also, remember that realistic goals are achievable goals. By achieving your short-term goals day by day, you will feel good about your progress and be motivated to continue. Setting unrealistic goals, such as losing 20 pounds in 2 weeks, can leave you feeling defeated and frustrated.

Being realistic also means expecting occasional setbacks. Setbacks happen when you get away from your plan for whatever reason—maybe the holidays, longer work hours, or another life change. When setbacks happen, get back on track as quickly as possible. Also, take some time to think about what you would do differently if a similar situation happens, to prevent setbacks.

Keep in mind everyone is different—what works for someone else might not be right for you. Just because your neighbor lost weight by taking up running, doesn’t mean running is the best option for you. Try a variety of activities: walking, swimming, tennis, or group exercise classes, to see what you enjoy most and can fit into your life. These activities will be easier to stick with over the long term.

Step 4: Identify resources for information and support.

Find family members or friends who will support your weight loss efforts. Making lifestyle changes can feel easier when you have others you can talk to and rely on for support. You might have coworkers or neighbors with similar goals, and together you can share healthful recipes and plan group exercise. Joining a weight loss group or visiting a health care professional, such as a registered dietitian, can help.

Step 5: Continually “check in” with yourself to monitor your progress.

Revisit the goals you set for yourself in Step 3 and evaluate your progress regularly. If you set a goal to walk each morning but are having trouble fitting it in before work, see if you can shift your work hours or if you can get your walk in at lunchtime or after work. Evaluate which parts of your plan are working well and which ones need tweaking. Then rewrite your goals and plan accordingly.

If you are consistently achieving a particular goal, add a new goal to help you continue on your pathway to success.

Reward yourself for your successes! Recognize when you are meeting your goals and be proud of your progress. Use non-food rewards, such as a new workout top or bottom or a new pair of running shoes, a sports outing with friends, or a relaxing bath. Rewards help keep you motivated on the path to better health.[2]

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2.1.7.2: The Importance of Physical Activity in Maintaining a Healthy Weight

Why is physical activity important?

Regular physical activity is important for good health, and it is especially important if you are trying to lose weight or to maintain a healthy weight.

When losing weight, more physical activity increases the number of calories your body uses for energy or “burns off.” The burning of calories through physical activity, combined with reducing the number of calories you eat, creates a “calorie deficit” that results in weight loss.

Most weight loss occurs because of decreased caloric intake. However, evidence shows the only way to maintain weight loss is to be engaged in regular physical activity.

Most importantly, physical activity reduces risks of cardiovascular disease and diabetes beyond that produced by weight reduction alone.

Physical activity also helps to:

- Maintain weight.
- Reduce high blood pressure.
- Reduce risk for type 2 diabetes, heart attack, stroke, and several forms of cancer.
- Reduce arthritis pain and associated disability.
- Reduce risk for osteoporosis and falls.
- Reduce symptoms of depression and anxiety.

How much physical activity do I need?

When it comes to weight management, people vary greatly in how much physical activity they need. Here are some guidelines to follow:

To maintain your weight. Work your way up to 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent mix of the two each week. Strong scientific evidence shows that physical activity can help you maintain your weight over time. However, the exact amount of physical activity needed to do this is not clear since it varies greatly from person to person. It is possible that you may need to do more than the equivalent of 150 minutes of moderate-intensity activity a week to maintain your weight.

To lose weight and keep it off. You will need a high amount of physical activity unless you also adjust your diet and reduce the amount of calories you are eating and drinking. Getting to and staying at a healthy weight requires both regular physical activity and a healthy eating plan.

What do moderate- and vigorous-intensity mean?

Moderate: While performing physical activity, if your breathing and heart rate are noticeably faster but you can still carry on a conversation, it is probably moderately intense. Examples include:

- Walking briskly (a 15-minute mile).
- Light yard work (raking/bagging leaves or using a lawn mower).
- Light snow shoveling.
- Actively playing with children.
- Biking at a casual pace.

Vigorous: If your heart rate is increased substantially, and you are breathing too hard and fast to have a conversation, it is probably vigorously intense. Examples include:

- Jogging/running.
- Swimming laps.
- Rollerblading/inline skating at a brisk pace.
- Cross-country skiing.
- Most competitive sports (football, basketball, or soccer).
- Jumping rope.

This table provides a list of common physical activities and the average calories expended during those activities.

[table id=5 /]

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh less.

Source: Adapted from Dietary Guidelines for Americans 2005, page 16, Table 4.

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2.1.7.3: Keeping the Weight Off

On its website the CDC admonishes that permanent weight loss is a result of making changes to eating habits that become a long-term part of a healthier lifestyle. You may access that section on their website in the references at the end of this text. It is also reprinted below for your convenience.

Reflect, Replace, Reinforce: A process for improving your eating habits

Create a list of your eating habits.

Keeping a food diary for a few days, in which you write down everything you eat and the time of day you ate it, will help you uncover your habits. For example, you might discover that you always seek a sweet snack to get you through the mid-afternoon energy slump. Use this diary to help. It's good to note how you were feeling when you decided to eat, especially if you were eating when not hungry. Were you tired? Stressed out?

Highlight the habits on your list that may be leading you to overeat. Common eating habits that can lead to weight gain are:

- Eating too fast
- Always cleaning your plate
- Eating when not hungry
- Eating while standing up (may lead to eating mindlessly or too quickly)
- Always eating dessert
- Skipping meals (or maybe just breakfast)

Look at the unhealthy eating habits you have highlighted. Be sure you have identified all the triggers that cause you to engage in those habits. Identify a few you would like to work on improving first. Don't forget to pat yourself on the back for the things you are doing right. Maybe you almost always eat fruit for dessert, or you drink low-fat or fat-free milk. These are good habits! Recognizing your successes will help encourage you to make more changes.

Create a list of "cues."

Review your food diary to become more aware of when and where you are "triggered" to eat for reasons other than hunger. Note how you are typically feeling at those times. Often an environmental "cue," or a particular emotional state, is what encourages eating for non-hunger reasons.

Common triggers for eating when not hungry are:

- Opening up the cabinet and seeing your favorite snack food.
- Sitting at home watching television.
- Before or after a stressful meeting or situation at work.
- Coming home after work and having no idea what's for dinner.
- Having someone offer you a dish they made "just for you!"
- Walking past a candy dish on the counter.
- Sitting in the break room beside the vending machine.
- Seeing a plate of doughnuts at the morning staff meeting.
- Swinging through your favorite drive-through every morning.
- Feeling bored or tired and thinking food might offer a pick-me-up.

Circle the "cues" on your list that you face on a daily or weekly basis. Going home for the Thanksgiving holiday may be a trigger for you to overeat, and eventually, you want to have a plan for as many eating cues as you can. But for now, focus on the ones you face more often.

Ask yourself these questions for each “cue” you have circled:

- Is there anything I can do to avoid the cue or situation? This option works best for cues that don’t involve others. For example, could you choose a different route to work to avoid stopping at a fast food restaurant on the way? Is there another place in the break room where you can sit so you are not next to the vending machine?
- For things I cannot avoid, can I do something differently that would be healthier? Obviously, you cannot avoid all situations that trigger your unhealthy eating habits, like staff meetings at work. In these situations, evaluate your options. Could you suggest or bring healthier snacks or beverages? Could you offer to take notes to distract your attention? Could you sit farther away from the food so it won’t be as easy to grab something? Could you plan ahead and eat a healthy snack before the meeting?
- Replace unhealthy habits with new, healthy ones. For example, in reflecting upon your eating habits, you may realize that you eat too fast when you eat alone. So, make a commitment to share a lunch each week with a colleague, or have a neighbor over for dinner one night a week. Other strategies might include putting your fork down between bites or minimizing other distractions (i.e., watching the news during dinner) that might keep you from paying attention to how quickly—and how much—you are eating.

Here are more ideas to help you replace unhealthy habits:

- Eat more slowly. If you eat too quickly, you may “clean your plate” instead of paying attention to whether your hunger is satisfied.
- Eat only when you are truly hungry instead of when you are tired, anxious, or feeling an emotion besides hunger. If you find yourself eating when you are experiencing an emotion besides hunger, such as boredom or anxiety, try to find a non-eating activity to do instead. You may find a quick walk or phone call with a friend helps you feel better.
- Plan meals ahead of time to ensure that you eat a healthy well-balanced meal.
- Reinforce your new, healthy habits and be patient with yourself. Habits take time to develop. It doesn’t happen overnight. When you do find yourself engaging in an unhealthy habit, stop as quickly as possible and ask yourself: Why do I do this? When did I start doing this? What changes do I need to make?
- Be careful not to berate yourself or think that one mistake “blows” a whole day’s worth of healthy habits. You can do it! It just takes one day at a time![4]

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2.1.7.4: Health Risks of Being Underweight

The 2003–2006 National Health and Nutrition Examination Survey (NHANES) estimated that 1.8 percent of adults and 3.3 percent of children and adolescents in the United States are underweight. Centers for Disease Control and Prevention. “NCHS Health E-Stat. Prevalence of Underweight among Children and Adolescents: United States, 2003–2006.” Accessed October 8, 2011. http://www.cdc.gov/nchs/data/hestat/underweight/underweight_children.htm.

Being underweight is linked to nutritional deficiencies, especially iron-deficiency anemia, and to other problems such as delayed wound healing, hormonal abnormalities, increased susceptibility to infection, and increased risk of some chronic diseases such as osteoporosis. In children, being underweight can stunt growth.

The most common underlying cause of being underweight in America is inadequate nutrition. Other causes are wasting diseases, such as cancer, multiple sclerosis, tuberculosis, and eating disorders. People with wasting diseases are encouraged to seek nutritional counseling, as a healthy diet greatly affects survival and improves responses to disease treatments. Eating disorders that result in underweight affect about eight million Americans (seven million women and one million men).

Anorexia Nervosa

Anorexia nervosa, more often referred to as “anorexia,” is a psychiatric illness in which a person obsesses about their weight and about food that they eat. Anorexia results in extreme nutrient inadequacy and eventually to organ malfunction. The National Institute of Mental Health (NIMH) reports that 0.9 percent of females and 0.3 percent of males will develop anorexia according to The National Institute of Mental Health. Eating Disorders. But it is an extreme example of how an unbalanced diet can affect health. Anorexia frequently manifests during adolescence and it has the highest rate of mortality of all mental illnesses. People with anorexia consume, on average, fewer than 1,000 kilocalories per day and exercise excessively. They are in a tremendous caloric imbalance. Moreover, some may participate in binge eating, self-induced vomiting, and purging with laxatives or enemas. The very first time a person starves him- or herself may trigger the onset of anorexia. The exact causes of anorexia are not completely known, but many things contribute to its development including economic status, as it is most prevalent in high-income families. It is a genetic disease and is often passed from one generation to the next. Pregnancy complications and abnormalities in the brain, endocrine system, and immune system may all contribute to the development of this illness.

The primary signs of anorexia are fear of being overweight, extreme dieting, an unusual perception of body image, and depression. The secondary signs and symptoms of anorexia are all related to the caloric and nutrient deficiencies of the unbalanced diet and include excessive weight loss, a multitude of skin abnormalities, diarrhea, cavities and tooth loss, osteoporosis, and liver, kidney, and heart failure. There is no physical test that can be used to diagnose anorexia and distinguish it from other mental illnesses. Therefore, a correct diagnosis involves eliminating other mental illnesses, hormonal imbalances, and nervous system abnormalities. Eliminating these other possibilities involves numerous blood tests, urine tests, and x-rays. Coexisting organ malfunction is also examined. Treatment of any mental illness involves not only the individual, but also family, friends, and a psychiatric counselor. Treating anorexia also involves a dietitian, who helps to provide dietary solutions that often have to be adjusted over time. The goals of treatment for anorexia are to restore a healthy body weight and significantly reduce the behaviors associated with causing the eating disorder. Relapse to an unbalanced diet is high.

Bulimia

Bulimia, like anorexia, is a psychiatric illness that can have severe health consequences. The NIMH reports that 0.5 percent of females and 0.1 percent of males will have bulimia at some point in their lifetime. Bulimia is characterized by episodes of eating large amounts of food followed by purging, which is accomplished by vomiting and with the use of laxatives and diuretics. Unlike people with anorexia, those with bulimia often have a normal weight, making the disorder more difficult to detect and diagnose. The disorder is characterized by signs similar to anorexia such as fear of being overweight, extreme dieting, and bouts of excessive exercise. Secondary signs and symptoms include gastric reflux, severe erosion of tooth enamel, dehydration, electrolyte imbalances, lacerations in the mouth from vomiting, and peptic ulcers. Repeated damage to the esophagus puts people with bulimia at an increased risk for esophageal cancer. The disorder is also highly genetic, linked to depression and anxiety disorders, and most commonly occurs in adolescent girls and young women. Treatment often involves antidepressant medications and, like anorexia, has better results when both the family and the individual with the disorder participate in nutritional and psychiatric counseling.

Binge-Eating Disorder

Similar to those who experience anorexia and bulimia, people who have a binge-eating disorder have lost control over their eating. Binge-eating disorder is not currently diagnosed as a distinct psychiatric illness, although there is a proposal from the American Psychiatric Association to categorize it more specifically. People with binge-eating disorder will periodically overeat to the extreme, but their loss of control over eating is not followed by fasting, purging, or compulsive exercise. As a result, people with this disorder are often overweight or obese, and their chronic disease risks are those linked to having an abnormally high body weight such as hypertension, cardiovascular disease, and Type 2 diabetes. Additionally, they often experience guilt, shame, and depression. Binge-eating disorder is commonly associated with depression and anxiety disorders. According to the NIMH, binge-eating disorder is more prevalent than anorexia and bulimia, and affects 3.5 percent of females and 2.0 percent of males at some point during their lifetime. Treatment often involves antidepressant medication as well as nutritional and psychiatric counseling.

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2.1.7.5: Test Your Knowledge

1. To lose one pound of fat, how many calories must be burned?

    a. 1500

    b. 2000

    c. 3000

    d. 3500

2. This is the type of eating disorder where someone eats too few calories for a long period.

    a. Binge-Eating Disorder

    b. Anorexia

    c. Bulimia

    d. Muscle Dysmorphic Disorder

3. The Eating disorder that happens at night, often alone:

    a. Binge-Eating Disorder

    b. Anorexia

    c. Bulimia

    d. Muscle Dysmorphic Disorder

4. The eating disorder that has a binge-purge cycle.:

    a. Binge-Eating Disorder

    b. Anorexia

    c. Bulimia

    d. Muscle Dysmorphic Disorder

5. The % of Americans currently Overweight:

    a. 33

    b. 45

    c. 66

    d. 90

Answers: 1.D, 2.B, 3.A, 4.C, 5.C

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2.2.1: INTRODUCTION TO HEALTH

In this section, readers will learn about the nature of health, health education, health promotion and related concepts. This will help to understand the social, psychological and physical components of health.

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2.2.1.2: Behavior Change and Goal Setting

2.2.1.3: SMART Goal Setting

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2.2.1.8: Life Expectancy at Birth

2.2.1.9: Leading Causes of Death

2.2.1.10: About Determinants of Health

2.2.1.11: Health Disparities

2.2.1.12: Risk Factors and Levels of Disease Prevention

Thuimbnail: Health is a critical aspect of human life. (CC BY-SA 2.0 Generic;Tulane Public Relations).

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2.2.1.1: Levels of Disease Prevention

Prevention includes a wide range of activities — known as “interventions” — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviors that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- Legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)
- Education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- Immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent re-injury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems.

Examples include:

- Regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- Daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- Suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- Cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- Support groups that allow members to share strategies for living well
- Vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

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2.2.1.2: Behavior Change and Goal Setting

Transtheoretical Model (Stages of Change)

The transtheoretical model of behavior change, developed by Prochaska and DiClemente, assesses an individual's readiness to implement a healthier behavior and provides insight into the decision making process that leads to action. For many people, changing or modifying a behavior that is unhealthy or potentially harmful can be quite challenging. Here are the stages that lead to behavior change:

- Precontemplation (Not Ready) – You are not intending to take action in the foreseeable future, and can be unaware that your behavior is problematic
- Contemplation (Getting Ready) – You are beginning to recognize that your behavior is problematic, and start to look at the pros and cons of your continued actions
- Preparation (Ready) – You are intending to take action in the immediate future, and may begin taking small steps toward behavior change
- Action – You are making actual changes to your problem behavior by incorporating healthy choices/behaviors into your life
- Maintenance – You have been able to sustain action for at least six months and are working to prevent relapse into previous unhealthy behaviors

Stage 1: Precontemplation (not ready)

People at this stage do not intend to start the healthy behavior in the near future (within 6 months), and may be unaware of the need to change. People here learn more about healthy behavior: they are encouraged to think about the pros of changing their behavior and to feel emotions about the effects of their negative behavior on others.

Precontemplators typically underestimate the pros of changing, overestimate the cons, and often are not aware of making such mistakes.

One of the most effective steps that others can help with at this stage is to encourage them to become more mindful of their decision-making and more conscious of the multiple benefits of changing an unhealthy behavior.

Stage 2: Contemplation (getting ready)

At this stage, participants are intending to start the healthy behavior within the next 6 months. While they are usually now more aware of the pros of changing, their cons are about equal to their Pros. This ambivalence about changing can cause them to keep putting off taking action. People here learn about the kind of person they could be if they changed their behavior and learn more from people who behave in healthy ways.

Others can influence and help effectively at this stage by encouraging them to work at reducing the cons of changing their behavior.

Stage 3: Preparation (ready)

People at this stage are ready to start taking action within the next 30 days. They take small steps that they believe can help them make the healthy behavior a part of their lives. For example, they tell their friends and family that they want to change their behavior.

People in this stage should be encouraged to seek support from friends they trust, tell people about their plan to change the way they act, and think about how they would feel if they behaved in a healthier way. Their number one concern is: when they act, will they fail? They learn that the better prepared they are, the more likely they are to keep progressing.

Stage 4: Action (current action)

People at this stage have changed their behavior within the last 6 months and need to work hard to keep moving ahead. These participants need to learn how to strengthen their commitments to change and to fight urges to slip back. People in this stage progress by being taught techniques for keeping up their commitments such as substituting activities related to the unhealthy behavior with positive ones, rewarding themselves for taking steps toward changing, and avoiding people and situations that

tempt them to behave in unhealthy ways.

Stage 5: Maintenance (monitoring)

People at this stage changed their behavior more than 6 months ago. It is important for people in this stage to be aware of situations that may tempt them to slip back into doing the unhealthy behavior—particularly stressful situations. It is recommended that people in this stage seek support from and talk with people whom they trust, spend time with people who behave in healthy ways, and remember to engage in healthy activities to cope with stress instead of relying on unhealthy behavior.

Relapse (recycling):

Relapse in the TTM specifically applies to individuals who successfully quit smoking or using drugs or alcohol, only to resume these unhealthy behaviors. Individuals who attempt to quit highly addictive behaviors such as drug, alcohol, and tobacco use are at particularly high risk of a relapse. Achieving a long-term behavior change often requires ongoing support from family members, a health coach, a physician, or another motivational source. Supportive literature and other resources can also be helpful to avoid a relapse from happening.

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2.2.1.3: SMART Goal Setting



Figure 2.2.1.3.1 SMART Acronym

Have you ever said to yourself that you need to "eat healthier" or "exercise more" to improve your overall health? How well did that work for you? In most cases, probably not very well. That's because these statements are too vague and do not give us any direction for what truly needs to be done to achieve such goals. To have a better chance at being successful, try using the SMART acronym for setting your goals (S= Specific, M= Measurable, A=Attainable, R= Realistic, T= Time-oriented):

Specific – Create a goal that has a focused and clear path for what you actually need to do.

Examples:

- I will drink 8 ounces of water 3 times per day
- I will walk briskly for 30 minutes, 5 times per week
- I will reduce my soda intake to no more than 2 cans of soda per week

Do you see how that is more helpful than just saying you will eat healthier or exercise more? It gives you direction.

Measurable – This enables you to track your progress, and ties in with the "specific" component. The above examples all have actual numbers associated with the behavior change that let you know whether or not it has been met.

Attainable – Make sure that your goal is within your capabilities and not too far out of reach. For example, if you have not been physically active for a number of years, it would be highly unlikely that you would be able to achieve a goal of running a marathon within the next month.

Realistic – Try to ensure that your goal is something you will be able to continue doing and incorporate as part of your regular routine/lifestyle. For example, if you made a goal to kayak 2 times each week, but don't have the financial resources to purchase or rent the equipment, no way to transport it, or are not close enough to a body of water in which to partake in kayaking, then this is not going to be feasible.

Time-oriented – Give yourself a target date or deadline in which the goal needs to be met. This will keep you on track and motivated to reach the goal, while also evaluating your progress.

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2.2.1.4: Definition and Concepts of Health

In the Oxford English Dictionary health is defined as: "the state of being free from sickness, injury, disease, bodily conditions; something indicating good bodily condition." Clearly, health is not quite as simple as the definition implies. The concept of health is wide and the way we define health also depends on individual perception, religious beliefs, cultural values, norms, and social class. Generally, there are two different perspectives concerning people's own definitions of health: a narrow perspective and a broader perspective.

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2.2.1.5: Narrow Perspectives of Health

People with a narrow perspective consider health as the absence of disease or disability or biological dysfunction. According to this view (or model), to call someone unhealthy or sick means there should be evidence of a particular illness. Social, emotional and psychological factors are not believed to cause unhealthy conditions. This model is narrow and limits the definition of health to the physical and physiological capabilities that are necessary to perform routine tasks.

According to this definition, the individual is healthy if all the body parts, cells, tissues and organ systems are functioning well and there is no apparent dysfunction of the body. Using this model people view the human body in the same terms as a computer, or mechanical device, when something is wrong you take it to experts who maintain it. Physicians, unlike behavioral experts, often focus on treatment and clinical interventions with medication rather than educational interventions to bring about behavior change.

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2.2.1.6: Broader Perspectives of Health

The most widely used of the broader definitions of health is that within the constitution of the World Health Organization (WHO), which defines health as: A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. This classic definition is important, as it identifies the vital components of health.

Well-being includes the presence of positive emotions and moods (e.g., contentment, happiness), the absence of negative emotions (e.g., depression, anxiety), satisfaction with life, fulfillment and positive functioning. In simple terms, well-being can be described as judging life positively and feeling good. Well-being is associated with numerous health-, job-, family-, and economically related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities.

Many practitioners have expanded their focus to include wellness at the positive end of the health continuum. Wellness is being in good physical and mental health. Because mental health and physical health are linked, problems in one area can impact the other. At the same time, improving your physical health can also benefit your mental health, and vice versa. It is important to make healthy choices for both your physical and mental well-being. Remember that wellness is not just the absence of illness or stress. One can still strive for wellness even if he/she is experiencing these challenges in life.

To more fully understand the meaning of health, it is important to understand each of its individual components.

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2.2.1.7: The Six Dimensions of Health

1. **Physical**

Body size and functioning; recognizing the need for physical activity, healthy foods, and adequate sleep; avoiding unhealthy habits

2. **Social**

Developing a sense of connection, belonging, and sustained support system; having positive relationships

3. **Intellectual**

Recognizing creative abilities and finding ways to expand knowledge and skills; being open-minded

4. **Emotional**

Coping effectively with life and expressing emotions in an appropriate manner

5. **Spiritual**

Having a sense of purpose and meaning in life; establishing peace, harmony, and balance in our lives

6. **Environmental**

Occupying pleasant, healthy, and safe environments that support wellbeing; positively impacting the quality of our surroundings (including protecting and preserving nature)

Learning about the Six Dimensions of Health can help a person choose how to make wellness a part of everyday life. Wellness strategies are practical ways to start developing healthy habits that can have a positive impact on physical and mental health.

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2.2.1.8: Life Expectancy at Birth

Life expectancy is a measure often used to gauge the overall health of a population. Life expectancy at birth represents the average number of years that a group of infants would live if the group were to experience the age-specific death rates present in the year of birth. Differences in life expectancy among various demographic subpopulations, including racial and ethnic groups, may reflect differences in a range of factors such as socioeconomic status, access to medical care, and the prevalence of specific risk factors in a particular subpopulation.

During 1975–2015, life expectancy at birth in the United States increased from 68.8 to 76.3 years for males and from 76.6 to 81.2 years for females. During this period, life expectancy at birth for males and females was longer for white persons than for black persons. Racial disparities in life expectancy at birth persisted for both males and females in 2015, but continued to narrow.

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2.2.1.9: Leading Causes of Death

In 1975, the five leading causes of death were heart disease, cancer, stroke, unintentional injuries, and influenza and pneumonia. In 2015, the five leading causes of death were heart disease, cancer, chronic lower respiratory diseases, unintentional injuries, and stroke. Throughout 1975–2015, heart disease and cancer remained the top two leading causes of death.

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2.2.1.10: About Determinants of Health

The range of personal, social, economic, and environmental factors that influence health status are known as determinants of health.

What makes some people healthy and others unhealthy?

How can we create a society in which everyone has a chance to live a long, healthy life?

Determinants of health are factors that contribute to a person's current state of health. These factors may be biological, socioeconomic, psychosocial, behavioral, or social in nature. Scientists generally recognize five determinants of health of a population:

Healthy People 2020 is exploring these questions by:

- Developing objectives that address the relationship between health status and biology, individual behavior, health services, social factors, and policies.
- Emphasizing an ecological approach to disease prevention and health promotion. An ecological approach focuses on both individual-level and population-level determinants of health and interventions.
- Genes and biology: for example, sex and age
- Health behaviors: for example, alcohol use, injection drug use (needles), unprotected sex, and smoking
- Social environment or social characteristics: for example, discrimination, income, and gender
- Physical environment or total ecology: for example, where a person lives and crowding conditions
- Health services or medical care: for example, access to quality health care and having or not having insurance
- Other factors that could be included are culture, social status, and healthy child development.

Determinants of health fall under several broad categories:

Policymaking

Policies at the local, state, and federal level affect individual and population health. Increasing taxes on tobacco sales, for example, can improve population health by reducing the number of people using tobacco products. Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. For example, the 1966 Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the Federal Government to set and regulate standards for motor vehicles and highways. This led to an increase in safety standards for cars, including seat belts, which in turn reduced rates of injuries and deaths from motor vehicle accidents.

Social Factors:

Social determinants of health reflect the social factors and physical conditions of the environment in which people are born, live, learn, play, work, and age. Also known as social and physical determinants of health, they impact a wide range of health, functioning, and quality-of-life outcomes. Examples of social determinants include:

- Availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods
- Social norms and attitudes, such as discrimination
- Exposure to crime, violence, and social disorder, such as the presence of trash
- Social support and social interactions
- Exposure to mass media and emerging technologies, such as the Internet or cell phones
- Socioeconomic conditions, such as concentrated poverty
- Quality schools
- Transportation options
- Public safety
- Residential segregation

Examples of physical determinants include:

- Natural environment, such as plants, weather, or climate change

- Built environment, such as buildings or transportation
- Worksites, schools, and recreational settings
- Housing, homes, and neighborhoods
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities
- Aesthetic elements, such as good lighting, trees, or benches

Poor health outcomes are often made worse by the interaction between individuals and their social and physical environment. For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with state and national averages. Poor air quality can worsen asthma symptoms, especially in children.

Both access to health services and the quality of health services can impact health. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas.

Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment.

Barriers to accessing health services include:

- Lack of availability
- High cost
- Lack of insurance coverage
- Limited language access

These barriers to accessing health services lead to:

- Unmet health needs
- Delays in receiving appropriate care
- Inability to get preventive services
- Hospitalizations that could have been prevented

Individual Behavior

Individual behavior also plays a role in health outcomes. For example, if an individual quits smoking, his or her risk of developing heart disease is greatly reduced.

Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country.

Examples of individual behavior determinants of health include:

- Diet
- Physical activity
- Alcohol, cigarette, and other drug use
- Hand washing

Some biological and genetic factors affect specific populations more than others. For example, older adults are biologically prone to being in poorer health then adolescents due to the physical and cognitive effects of aging.

Sickle cell disease is a common example of a genetic determinant of health. Sickle cell is a condition that people inherit when both parents carry the gene for sickle cell. The gene is most common in people with ancestors from West African countries, Mediterranean countries, South or Central American countries, Caribbean islands, India, and Saudi Arabia.

Examples of biological and genetic social determinants of health include:

- Age
- Sex
- HIV status
- Inherited conditions, such as sickle-cell anemia, hemophilia, and cystic fibrosis

- Carrying the BRCA1 or BRCA2 gene, which increases risk for breast and ovarian cancer
- Family history of heart disease

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2.2.1.11: Health Disparities

Although the term disparities is often interpreted to mean racial or ethnic disparities, many dimensions of disparity exist in the United States, particularly in health. If a health outcome is seen to a greater or lesser extent between populations, there is disparity. Race or ethnicity, sex, sexual identity, age, disability, socioeconomic status, and geographic location all contribute to an individual's ability to achieve good health. It is important to recognize the impact that social determinants have on health outcomes of specific populations. Healthy People strives to improve the health of all groups.

To better understand the context of disparities, it is important to understand more about the U.S. population. In 2008, the U.S. population was estimated at 304 million people.

- In 2008, approximately 33%, or more than 100 million people, identified themselves as belonging to a racial or ethnic minority population.
- In 2008, 51%, or 154 million people, were women.
- In 2008, approximately 12%, or 36 million people not living in nursing homes or other residential care facilities, had a disability.
- In 2008, an estimated 70.5 million people lived in rural areas (23% of the population), while roughly 233.5 million people lived in urban areas (77%).
- In 2002, an estimated 4% of the U.S. population ages 18 to 44 identified themselves as lesbian, gay, bisexual, or transgender.

During the past 2 decades, one of Healthy People's overarching goals has focused on disparities. In Healthy People 2000, it was to reduce health disparities among Americans. In Healthy People 2010, it was to eliminate, not just reduce, health disparities. In Healthy People 2020, that goal expanded even further: to achieve health equity, eliminate disparities, and improve the health of all groups.

Healthy People 2020 defines health equity as the "attainment of the highest level of health for all people. Achieving health equity requires valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices, and the elimination of health and health care disparities."

Healthy People 2020 defines a health disparity as "a particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage. Health disparities adversely affect groups of people who have systematically experienced greater obstacles to health based on their racial or ethnic group; religion; socioeconomic status; gender; age; mental health; cognitive, sensory, or physical disability; sexual orientation or gender identity; geographic location; or other characteristics historically linked to discrimination or exclusion."

Over the years, efforts to eliminate disparities and achieve health equity have focused primarily on diseases or illnesses and on health care services. However, the absence of disease does not automatically equate to good health. Powerful, complex relationships exist between health and biology, genetics, and individual behavior, and between health and health services, socioeconomic status, the physical environment, discrimination, racism, literacy levels, and legislative policies. These factors, which influence an individual or population's health, are known as determinants of health.

For all Americans, other influences on health include the availability of and access to:

- High-quality education
- Nutritious food
- Decent and safe housing
- Affordable, reliable public transportation
- Culturally sensitive health care providers
- Health insurance
- Clean water and non-polluted air

Throughout the next decade, Healthy People 2020 will assess health disparities in the U.S. population by tracking rates of illness, death, chronic conditions, behaviors, and other types of outcomes in relation to demographic factors including:

- Race and ethnicity

- Gender
- Sexual identity and orientation
- Disability status or special health care needs
- Geographic location (rural and urban)

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2.2.1.12: Risk Factors and Levels of Disease Prevention

What is a Risk Factor?

Part of learning how to take charge of one's health requires understanding risk factors for different diseases. Risk factors are things in life that increase your chances of getting a certain disease. Some risk factors are beyond your control. A person may be born with them or have exposure with no fault assigned.

Some risk factors that you have little or no control over include:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some controllable risk factors include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs

In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

A person can have one risk factor for a disease or he/she can have many. The more risk factors a person has, the more likely he/she will get the disease. For example, if people eat healthy, exercise on a regular basis, and control blood pressure, their chances of getting heart disease are less than those of diabetics, smokers, and sedentary people. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

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2.2.2: PSYCHOLOGICAL HEALTH

Psychological health is a level of psychological well-being or an absence of Psychological illness - the state of someone who is "functioning at a satisfactory level of emotional and behavioral adjustment". From the perspectives of positive psychology or of holism, Psychological health may include an individual's ability to enjoy life, and to create a balance between life activities and efforts to achieve psychological resilience. Psychological health includes "subjective well-being, perceived self-efficacy, autonomy, competence, inter-generational dependence, and self-actualization of one's intellectual and emotional potential, among others."

2.2.2.1: Intro to Psychological Health

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2.2.2.1: Intro to Psychological Health

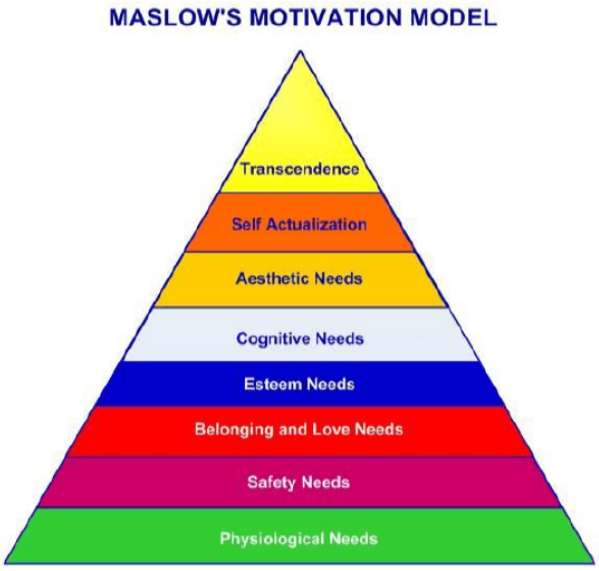


Figure 2.2.2.1.1 Maslow's Motivation Model

Maslow's hierarchy of needs is a theory in psychology proposed by Abraham Maslow in his 1943 paper "A Theory of Human Motivation" in Psychological Review. Maslow used the terms "physiological", "safety", "belonging" and "love", "esteem", "self-actualization", and "self-transcendence" to describe the pattern that human motivations generally move through. The goal of Maslow's Theory is to attain the sixth level of stage: self-transcendent needs.

Maslow's hierarchy of needs is often portrayed in the shape of a pyramid with the largest, most fundamental needs at the bottom and the need for self-actualization and self-transcendence at the top.

The most fundamental and basic four layers of the pyramid contain what Maslow called "deficiency needs" or "d-needs": esteem, friendship and love, security, and physical needs. If these "deficiency needs" are not met – with the exception of the most fundamental (physiological) need – there may not be a physical indication, but the individual will feel anxious and tense. Maslow's theory suggests that the most basic level of needs must be met before the individual will strongly desire (or focus motivation upon) the secondary or higher level needs.

The human brain is a complex system and has parallel processes running at the same time, thus many different motivations from various levels of Maslow's hierarchy can occur at the same time. Maslow spoke clearly about these levels and their satisfaction in terms such as "relative", "general", and "primarily". Instead of stating that the individual focuses on a certain need at any given time, Maslow stated that a certain need "dominates" the human organism. Thus Maslow acknowledged the likelihood that the different levels of motivation could occur at any time in the human mind, but he focused on identifying the basic types of motivation and the order in which they should be met.

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2.2.2.2: Social Health

The capacity for an individual to develop and flourish is deeply influenced by immediate social surroundings – including their opportunity to engage positively with family members, friends or colleagues, and earn a living for themselves and their families – and also by the socioeconomic circumstances in which said individual find himself/herself. Restricted or lost opportunities to gain an education and income are especially pertinent socio-economic factors.

Psychoneuroimmunology is defined as the examination of the interactions among psychological, behavioral, and social factors with immunological and neuroendocrine outcomes. It is now well established that psychological factors, especially chronic stress, can lead to impairments in immune system function in both the young and older adults. In several studies of older adults, those who are providing care for a relative with dementia report high levels of stress and exhibit significant impairments in immune system functioning when compared with non-caregivers. Stress-induced changes in the immune system may affect a number of outcomes, including slowing the wound healing process and increasing susceptibility to infections.

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2.2.2.3: Developing and Protecting Individual Attributes

At its core, mental health and well-being rests on the capacity of individuals to manage their thoughts, feelings and behavior, as well as their interactions with others. It is essential that these core attributes of self-control, resilience and confidence be allowed to develop and solidify in the formative stages of life, so that individuals are equipped to deal with the complex choices and potential adversities they will face as they grow older.

Alcohol, tobacco and drug use pose risks to mental and physical health, particularly among pregnant women and adolescents. Raising awareness about the health risks of substance use can be accompanied by implementation of a number of proven strategies for reducing their use, including fiscal measures (namely, increased excise taxes) and regulatory instruments (such as comprehensive restrictions on advertising, minimum age of use and restrictions on smoking in public places).

Maintaining a healthy diet and regular physical exercise are also protective factors for mental health and can be considered as part of a holistic approach to health promotion and protection in the population.

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2.2.2.4: Supporting Families and Communities

Individual-level mental health and well-being is strongly mediated by the immediate social context in which people live, work and carry out their day-to-day activities. The focus of family- and community-level attention is therefore to foster living and working conditions that enable psychosocial development (particularly among vulnerable persons) and promote positive interactions within and between families and social groups. Certain mental health promotion and protection strategies are targeted at specific groups, including: home-based interventions for socioeconomically disadvantaged families and for children with a mentally ill parent; prevention of intimate partner violence; school-based interventions for children and adolescents exhibiting emotional or behavioral problems; work-based interventions for adults looking for employment or struggling to cope at work; community-based interventions aimed at enhanced social participation of older adults; and psychosocial support for persons affected by conflict or disaster.

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2.2.2.5: Supporting Vulnerable Groups in Society

At the level of social and environmental determinants, key predictors of – and also consequences of – mental ill-health include lack of access to basic amenities and services, social exclusion, discrimination and exposure to violence, conflict or disasters. State-wide policy instruments that can address these failings and contribute towards social equality, inclusion and security include: anti-discrimination laws and campaigns; social protection for the poor; and elaboration of peaceful relations within and across national or ethnic boundaries.

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2.2.2.6: Mental Illness

We have all had some exposure to mental illness, but do we really understand it or know what it is? Many of our preconceptions are incorrect. A mental illness can be defined as a health condition that changes a person's thinking, feelings, or behavior (or all three) and that causes the person distress and difficulty in functioning. As with many diseases, mental illness is severe in some cases and mild in others. Individuals who have a mental illness don't necessarily look like they are sick, especially if their illness is mild. Other individuals may show more explicit symptoms such as confusion, agitation, or withdrawal.

Even if you or a family member has not experienced mental illness directly, it is very likely that you have known someone who has. Estimates are that at least one in four people is affected by mental illness either directly or indirectly.

Consider the following statistics to get an idea of just how widespread the effects of mental illness are in society:

- According to recent estimates, approximately 20 percent of Americans, or about one in five people over the age of 18, suffer from a diagnosable mental disorder in a given year.
- Four of the 10 leading causes of disability—major depression, bipolar disorder, schizophrenia, and obsessive-compulsive disorder—are mental illnesses.
- About 3 percent of the population have more than one mental illness at a time.
- About 5 percent of adults are affected so seriously by mental illness that it interferes with their ability to function in society. These severe and persistent mental illnesses include schizophrenia, bipolar disorder, other severe forms of depression, panic disorder, and obsessive-compulsive disorder.
- Approximately 20 percent of doctors' appointments are related to anxiety disorders such as panic attacks. Eight million people have depression each year.
- Two million Americans have schizophrenia disorders, and 300,000 new cases are diagnosed each year.

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2.2.2.7: Mood Disorders

Major mood disorders are depression, bipolar disorder, and dysthymic disorder. Like anxiety, depression might seem like something that everyone experiences at some point, and it is true that most people feel sad or “blue” at times in their lives. A true depressive episode, however, is more than just feeling sad for a short period. It is a long-term, debilitating illness that usually needs treatment to cure. And bipolar disorder is characterized by dramatic shifts in energy and mood, often affecting the individual’s ability to carry out day-to-day tasks. Bipolar disorder used to be called manic depression because of the way that people would swing between manic and depressive episodes.

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2.2.2.8: Depression

Depression, or depressive disorders, is a leading cause of disability in the United States as well as worldwide. It affects an estimated 9.5 percent of American adults in a given year. Nearly twice as many women as men have depression. Depression is more than just being in a bad mood or feeling sad. Everyone experiences these feelings on occasion, but that does not constitute depression. Depression is actually not a single disease; there are three main types of depressive disorders. They are major depressive disorder, dysthymia, and bipolar disorder (manic-depression).

While some of the symptoms of depression are common during a passing “blue mood,” major depressive disorder is diagnosed when a person has five or more of the symptoms nearly every day during a two-week period. Symptoms of depression include a sad mood, a loss of interest in activities that one used to enjoy, a change in appetite or weight, oversleeping or difficulty sleeping, physical slowing or agitation, energy loss, feelings of worthlessness or inappropriate guilt, difficulty concentrating, and recurrent thoughts of death or suicide.

When people have depression, their lives are affected severely: they have trouble performing at work or school, and they aren’t interested in normal family and social activities. In adults, an untreated major depressive episode lasts an average of nine months. At least half of the people who experience an episode of major depression will have another episode of depression at some point.

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2.2.2.9: Dysthymic Disorder

Dysthymia is less severe than major depressive disorder, but it is more chronic. In dysthymia, a depressed mood along with at least two other symptoms of depression persist for at least two years in adults, or one year in children or adolescents. These symptoms may not be as disabling, but they do keep affected people from functioning well or feeling good. Dysthymia often begins in childhood, adolescence, or early adulthood. On average, untreated dysthymia lasts four years in children and adolescents.

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2.2.2.10: Bipolar Disorder

A third type of depressive disorder is bipolar disorder, also called manic-depression. A person who has bipolar disorder alternates between episodes of major depression and mania (periods of abnormally and persistently elevated mood or irritability). During manic periods, the person will also have three or more of the following symptoms: overly inflated self-esteem, decreased need for sleep, increased talkativeness, racing thoughts, distractibility, increased goal-directed activity or physical agitation, and excessive involvement in pleasurable activities that have a high potential for painful consequences.

While in a manic phase, adolescents may engage in risky or reckless behaviors such as fast driving and unsafe sex. Bipolar disorder frequently begins during adolescence or young adulthood. Adults with bipolar disorder often have clearly defined episodes of mania and depression, with periods of mania every two to four years.

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2.2.2.11: Factors That Influence Psychological Well-Being

Infancy and Early Childhood

There is a strong body of evidence to show the importance of attachment by neonates to their mothers or other primary caregivers for subsequent social and emotional development. Separation from the primary caregiver - due for example to parental absence or rejection - leads to anxiety, stress and insecurity. Post-natal depression among new mothers can likewise contribute to sub-optimal attachment and development. Parents who have difficulties in bonding, have limited skills or exhibit negative attitudes place their children at increased risk of exposure to stress and behavioral problems. Other important risks to physical and cognitive development in infancy and early childhood include maltreatment and neglect (by parents and other caregivers), malnutrition and infectious or parasitic diseases.

Individual attributes and behaviors

These relate to a person's innate and learned ability to deal with thoughts and feelings and to manage him/herself in daily life ('emotional intelligence'). It is also the capacity to deal with the social world around by partaking in social activities, taking responsibilities or respecting the views of others ('social intelligence'). An individual's mental health state can also be influenced by genetic and biological factors; that is, determinants that persons are born or endowed with, including chromosomal abnormalities (e.g. Down's syndrome) and intellectual disability caused by prenatal exposure to alcohol or oxygen deprivation at birth.

Social and economic circumstances

The capacity for people to develop and flourish is deeply influenced by their immediate social surroundings – including their opportunity to engage positively with family members, friends or colleagues, and earn a living for themselves and their families – and also by the socioeconomic circumstances in which they find themselves. Restricted or lost opportunities to gain an education and income are especially pertinent socio-economic factors.

Environmental factors

The wider sociocultural and geopolitical environment in which people live can also affect an individual's, household's or community's mental health status, including levels of access to basic commodities and services (water, essential health services, the rule of law), exposure to predominating cultural beliefs, attitudes or practices, as well as by social and economic policies formed at the national level; for example, the on-going global financial crisis is expected to have significant mental health consequences, including increased rates of suicide and harmful alcohol use. Discrimination, social or gender inequality and conflict are examples of adverse structural determinants of mental well-being.

Personality

Personality measures turn out to be good predictors of your health, your sexual promiscuity, your likelihood of divorce, how happy you typically are—even your taste in paintings. Personality is a much better predictor of these things than social class or age. The origin of these differences is in part innate. That is to say, when people are adopted at birth and brought up by new families, their personalities are more similar to their blood relatives than to the ones they grew up with. The differences begin to emerge early in life and are surprisingly stable across the decades. This is not to say that people cannot change, but major change is the exception rather than the rule. Personality differences tend to manifest themselves through the quick, gut-feeling, intuitive, and emotional systems of thehuman mind. The slower, rational, deliberate systems show less variation in output from person to person. Deliberate rational strategies can be used to over-ride intuitive patterns of response, and this is how people wishing to change their personalities or feelings have to go about it.

So what are the major ways personalities can differ? The dominant approach is to think of the space of possible personalities as being defined by a number of dimensions. Each person can be given a location in the space by their scores on all the different

dimensions. Virtually all theories agree on two of the main dimensions, though they differ on how many additional ones they recognize.

Five factors

- Openness to experience: (inventive/curious vs. consistent/cautious). Appreciation for art, emotion, adventure, unusual ideas, curiosity, and variety of experience. Openness reflects the degree of intellectual curiosity, creativity and a preference for novelty and variety a person has. It is also described as the extent to which a person is imaginative or independent and depicts a personal preference for a variety of activities over a strict routine. High openness can be perceived as unpredictability or lack of focus. Moreover, individuals with high openness are said to pursue selfactualization specifically by seeking out in tense, euphoric experiences. Conversely, those with low openness seek to gain fulfillment through perseverance and are characterized as pragmatic and data-driven—sometimes even perceived to be dogmatic and closed-minded. Some disagreement remains about how to interpret and contextualize the openness factor.
- Conscientiousness: (efficient/organized vs. easy-going/careless). A tendency to be organized and dependable, show self-discipline, act dutifully, aim for achievement, and prefer planned rather than spontaneous behavior. High conscientiousness is often perceived as stubbornness and obsession. Low conscientiousness is associated with flexibility and spontaneity, but can also appear as sloppiness and lack of reliability.
- Extraversion: (outgoing/energetic vs. solitary/reserved). Energy, positive emotions, surgency, assertiveness, sociability and the tendency to seek stimulation in the company of others, and talkativeness. High extraversion is often perceived as attention-seeking, and domineering. Low extraversion causes a reserved, reflective personality, which can be perceived as aloof or self-absorbed.
- Agreeableness: (friendly/compassionate vs. challenging/detached). A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others. It is also a measure of one's trusting and helpful nature, and whether a person is generally well-tempered or not. High agreeableness is often seen as naive or submissive. Low agreeableness personalities are often competitive or challenging people, which can be seen as argumentativeness or untrustworthiness.
- Neuroticism: (sensitive/nervous vs. secure/confident). The tendency to experience unpleasant emotions easily, such as anger, anxiety, depression, and vulnerability. Neuroticism also refers to the degree of emotional stability and impulse control and is sometimes referred to by its low pole, "emotional stability". A high need for stability manifests itself as a stable and calm personality, but can be seen as uninspiring and unconcerned. A low need for stability causes a reactive and excitable personality, often very dynamic individuals, but they can be perceived as unstable or insecure.

Assess yourself! This is an interactive version of the IPIP Big-Five Factor Markers, a measure of the big five personality traits: Big 5 Personality Test

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2.2.2.12: Physiological Needs

Physiological needs are the physical requirements for human survival. If these requirements are not met, the human body cannot function properly and will ultimately fail. Physiological needs are thought to be the most important; they should be met first.

Air, water, and food are metabolic requirements for survival in all animals, including humans. Clothing and shelter provide necessary protection from the elements. While maintaining an adequate birth rate shapes the intensity of the human sexual instinct, sexual competition may also shape said instinct.

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2.2.2.13: The Causes of Depression (depressive disorders)

Depression, like other mental illnesses, is probably caused by a combination of biological, environmental, and social factors, but the exact causes are not yet known. For years, scientists thought that low levels of certain neurotransmitters (such as serotonin, dopamine, or norepinephrine) in the brain caused depression. However, scientists now believe that the interplay of factors leading to depression is much more complex. Genetic causes have been suggested from family studies that have shown that between 20 and 50 percent of children and adolescents with depression have a family history of depression and that children of depressed parents are more than three times as likely as children with nondepressed parents to experience a depressive disorder. Abnormal endocrine function, specifically of the hypothalamus or pituitary, may play a role in causing depression. Other risk factors for depressive disorders in youths include stress, cigarette smoking, loss of a parent, the breakup of a romantic relationship, attention disorders, learning disorders, abuse, neglect, and other trauma including experiencing a natural disaster.

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2.2.2.14: Treating Depression

A variety of antidepressant medications and psychotherapies are used to treat depression. The most effective treatment for most people is a combination of medication and psychotherapy. Many of us are aware that medications are available to treat depressive disorders—we see the ads on television and in magazines. Up to 70 percent of people with depression can be treated effectively with medication.

Medications used to treat depressive disorders usually act on the neurotransmission pathway. For example, some medications affect the activity of certain neurotransmitters, such as serotonin or norepinephrine. Different depressive disorders require different medication therapies. For example, individuals who have bipolar disorder are often treated with a mood-stabilizing drug, such as lithium, during their manic phase and a combination of mood-stabilizer and antidepressant medications during their depressive phase.

Medications usually lead to relief from the symptoms of depression within six to eight weeks. If one drug doesn't relieve symptoms, doctors can prescribe a different antidepressant drug. As with drugs to treat other mental illnesses, patients are monitored closely by their doctor for symptoms of depression and for side effects. Patients who continue to take their medication for at least six months after recovery from major depression are 70 percent less likely to experience a relapse. Psychotherapy helps patients learn more effective ways to deal with the problems in their lives. These therapies usually involve 6 to 20 weekly meetings. These treatment plans should be revised if there is no improvement of symptoms within three or four months.

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2.2.2.15: Coping with Depression

People who have depression (or another depressive disorder) feel exhausted, worthless, helpless, and hopeless. These negative thoughts and feelings that are part of depression make some people feel like giving up. As treatment takes effect, these thoughts begin to go away.

Some strategies that can help a person waiting for treatment to take effect include setting realistic goals in light of the depression and assuming a reasonable amount of responsibility; breaking large tasks into small ones, setting some priorities, and doing what one can as one can; trying to be with other people and to confide in someone—it is usually better than being alone and secretive; participating in activities that may make one feel better; getting some mild exercise, going to a movie or a ball game, or participating in religious, social, or other activities; expecting one's mood to improve gradually, not immediately (feeling better takes time); postponing important decisions until the depression has lifted and discussing big decisions with family or friends who have a more objective view of the situation; remembering that positive thinking will replace the negative thinking that is part of the depression as one's depression responds to treatment; and letting one's family and friends help.

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2.2.2.16: 2.23 Anxiety Disorders

Anxiety Disorders affect about 40 million American adults age 18 years and older (about 18%) in a given year, causing them to be filled with fearfulness and uncertainty. Unlike the relatively mild, brief anxiety caused by a stressful event (such as speaking in public or a first date), anxiety disorders last at least 6 months and can get worse if they are not treated.

Anxiety disorders commonly occur along with other mental or physical illnesses, including alcohol or substance abuse, which may mask anxiety symptoms or make them worse. In some cases, these other illnesses need to be treated before a person will respond to treatment for the anxiety disorder.

Panic Disorders

> "For me, a panic attack is almost a violent experience. I feel disconnected from reality. I feel like I'm losing control in a very extreme way. My heart pounds really hard, I feel like I can't get my breath, and there's an overwhelming feeling that things are crashing in on me."
>
> "It started 10 years ago, when I had just graduated from college and started a new job. I was sitting in a business seminar in a hotel and this thing came out of the blue. I felt like I was dying."
>
> "In between attacks there is this dread and anxiety that it's going to happen again. I'm afraid to go back to places where I've had an attack. Unless I get help, there soon won't be anyplace where I can go and feel safe from panic."

Panic disorder is a real illness that can be successfully treated. It is characterized by sudden attacks of terror, usually accompanied by a pounding heart, sweatiness, weakness, faintness, or dizziness. During these attacks, people with panic disorder may flush or feel chilled; their hands may tingle or feel numb; and they may experience nausea, chest pain, or smothering sensations. Panic attacks usually produce a sense of unreality, a fear of impending doom, or a fear of losing control.

A fear of one's own unexplained physical symptoms is also a symptom of panic disorder. People having panic attacks sometimes believe they are having heart attacks, losing their minds, or on the verge of death. They can't predict when or where an attack will occur, and between episodes many worry intensely and dread the next attack.

Panic attacks can occur at any time, even during sleep. An attack usually peaks within 10 minutes, but some symptoms may last much longer. Panic disorder affects about 6 million American adults and is twice as common in women as men. Panic attacks often begin in late adolescence or early adulthood, but not everyone who experiences panic attacks will develop panic disorder. Many people have just one attack and never have another. The tendency to develop panic attacks appears to be inherited.

Obsessive-Compulsive Disorder

> "I couldn't do anything without rituals. They invaded every aspect of my life. Counting really bogged me down. I would wash my hair three times as opposed to once because three was a good luck number and one wasn't. It took me longer to read because I'd count the lines in a paragraph. When I set my alarm at night, I had to set it to a number that wouldn't add up to a 'bad' number."
>
> "I knew the rituals didn't make sense, and I was deeply ashamed of them, but I couldn't seem to overcome them until I had therapy."
>
> "Getting dressed in the morning was tough, because I had a routine, and if I didn't follow the routine, I'd get anxious and would have to get dressed again. I always worried that if I didn't do something, my parents were going to die. I'd have these terrible thoughts of harming my parents. That was completely irrational, but the thoughts triggered more anxiety and more senseless behavior. Because of the time I spent on rituals, I was unable to do a lot of things that were important to me."

People with obsessive-compulsive disorder (OCD) have persistent, upsetting thoughts (obsessions) and use rituals (compulsions) to control the anxiety these thoughts produce. Most of the time, the rituals end up controlling them.

For example, if people are obsessed with germs or dirt, they may develop a compulsion to wash their hands over and over again. If they develop an obsession with intruders, they may lock and relock their doors many times before going to bed. Being afraid of social embarrassment may prompt people with OCD to comb their hair compulsively in front of a mirror-sometimes they get "caught" in the mirror and can't move away from it. Performing such rituals is not pleasurable. At best, it produces temporary relief from the anxiety created by obsessive thoughts.

Healthy people also have rituals, such as checking to see if the stove is off several times before leaving the house. The difference is that people with OCD perform their rituals even though doing so interferes with daily life and they find the repetition distressing. Although most adults with OCD recognize that what they are doing is senseless, some adults and most children may not realize that their behavior is out of the ordinary.

OCD affects about 2.2 million American adults, and the problem can be accompanied by eating disorders, other anxiety disorders, or depression. It strikes men and women in roughly equal numbers and usually appears in childhood, adolescence, or early adulthood. One-third of adults with OCD develop symptoms as children, and research indicates that OCD might run in families.

Post-Traumatic Stress Disorder

> "I was raped when I was 25 years old. For a long time, I spoke about the rape as though it was something that happened to someone else. I was very aware that it had happened to me, but there was just no feeling."
>
> "Then I started having flashbacks. They kind of came over me like a splash of water. I would be terrified. Suddenly I was reliving the rape. Every instant was startling. I wasn't aware of anything around me, I was in a bubble, just kind of floating. And it was scary. Having a flashback can wring you out."
>
> "The rape happened the week before Thanksgiving, and I can't believe the anxiety and fear I feel every year around the anniversary date. It's as though I've seen a werewolf. I can't relax, can't sleep, don't want to be with anyone. I wonder whether I'll ever be free of this terrible problem."

Post-traumatic stress disorder (PTSD) develops after a terrifying ordeal that involved physical harm or the threat of physical harm. The person who develops PTSD may have been the one who was harmed, the harm may have happened to a loved one, or the person may have witnessed a harmful event that happened to loved ones or strangers. PTSD was first brought to public attention in relation to war veterans, but it can result from a variety of traumatic incidents, such as mugging, rape, torture, being kidnapped or held captive, child abuse, car accidents, train wrecks, plane crashes, bombings, or natural disasters such as floods or earthquakes.

People with PTSD may startle easily, become emotionally numb (especially in relation to people with whom they used to be close), lose interest in things they used to enjoy, have trouble feeling affectionate, be irritable, become more aggressive, or even become violent. They avoid situations that remind them of the original incident, and anniversaries of the incident are often very difficult. PTSD symptoms seem to be worse if the event that triggered them was deliberately initiated by another person, as in a mugging or a kidnapping.

Most people with PTSD repeatedly relive the trauma in their thoughts during the day and in nightmares when they sleep. These are called flashbacks. Flashbacks may consist of images, sounds, smells, or feelings, and are often triggered by ordinary occurrences, such as a door slamming or a car backfiring on the street. A person having a flashback may lose touch with reality and believe that the traumatic incident is happening all over again.

Not every traumatized person develops full-blown or even minor PTSD. Symptoms usually begin within 3 months of the incident but occasionally emerge years afterward. They must last more than a month to be considered PTSD. The course of the illness varies. Some people recover within 6 months, while others have symptoms that last much longer. In some people, the condition becomes chronic.

PTSD affects about 7.7 million American adults, but it can occur at any age, including childhood. Women are more likely to develop PTSD than men, and there is some evidence that susceptibility to the disorder may run in families. PTSD is often accompanied by depression, substance abuse, or one or more of the other anxiety disorders.

Social Phobia (Social Anxiety Disorder)

> "In any social situation, I felt fear. I would be anxious before I even left the house, and it would escalate as I got closer

> to a college class, a party, or whatever. I would feel sick in my stomach-it almost felt like I had the flu. My heart would pound, my palms would get sweaty, and I would get this feeling of being removed from myself and from everybody else."
>
> "When I would walk into a room full of people, I'd turn red and it would feel like everybody's eyes were on me. I was embarrassed to stand off in a corner by myself, but I couldn't think of anything to say to anybody. It was humiliating. I felt so clumsy, I couldn't wait to get out."

Social phobia, also called social anxiety disorder, is diagnosed when people become overwhelmingly anxious and excessively self-conscious in everyday social situations. People with social phobia have an intense, persistent, and chronic fear of being watched and judged by others and of doing things that will embarrass them. They can worry for days or weeks before a dreaded situation. This fear may become so severe that it interferes with work, school, and other ordinary activities, and can make it hard to make and keep friends.

While many people with social phobia realize that their fears about being with people are excessive or unreasonable, they are unable to overcome them. Even if they manage to confront their fears and be around others, they are usually very anxious beforehand, are intensely uncomfortable throughout the encounter, and worry about how they were judged for hours afterward.

Social phobia can be limited to one situation (such as talking to people, eating or drinking, or writing on a blackboard in front of others) or may be so broad (such as in generalized social phobia) that the person experiences anxiety around almost anyone other than the family.

Physical symptoms that often accompany social phobia include blushing, profuse sweating, trembling, nausea, and difficulty talking. When these symptoms occur, people with social phobia feel as though all eyes are focused on them.

Social phobia affects about 15 million American adults. Women and men are equally likely to develop the disorder, which usually begins in childhood or early adolescence. There is some evidence that genetic factors are involved. Social phobia is often accompanied by other anxiety disorders or depression, and substance abuse may develop if people try to self-medicate their anxiety.

A specific phobia is an intense, irrational fear of something that poses little or no actual danger. Some of the more common specific phobias are centered around closed-in places, heights, escalators, tunnels, highway driving, water, flying, dogs, and injuries involving blood. Such phobias aren't just extreme fear; they are irrational fear of a particular thing. You may be able to ski the world's tallest mountains with ease but be unable to go above the 5th floor of an office building. While adults with phobias realize that these fears are irrational, they often find that facing, or even thinking about facing, the feared object or situation brings on a panic attack or severe anxiety.

Specific phobias affect an estimated 19.2 million adult Americans and are twice as common in women as men. They usually appear in childhood or adolescence and tend to persist into adulthood. The causes of specific phobias are not well understood, but there is some evidence that the tendency to develop them may run in families.

Generalized Anxiety Disorder (GAD)

> "I always thought I was just a worrier. I'd feel keyed up and unable to relax. At times it would come and go, and at times it would be constant. It could go on for days. I'd worry about what I was going to fix for a dinner party, or what would be a great present for somebody. I just couldn't let something go."
>
> "When my problems were at their worst, I'd miss work and feel just terrible about it. Then I worried that I'd lose my job. My life was miserable until I got treatment."
>
> "I'd have terrible sleeping problems. There were times I'd wake up wired in the middle of the night. I had trouble concentrating, even reading the newspaper or a novel. Sometimes I'd feel a little lightheaded. My heart would race or pound. And that would make me worry more. I was always imagining things were worse than they really were. When I got a stomachache, I'd think it was an ulcer."

People with generalized anxiety disorder (GAD) go through the day filled with exaggerated worry and tension, even though there is little or nothing to provoke it. They anticipate disaster and are overly concerned about health issues, money, family problems, or difficulties at work. Sometimes just the thought of getting through the day produces anxiety.

GAD is diagnosed when a person worries excessively about a variety of everyday problems for at least 6 months. People with GAD can't seem to get rid of their concerns, even though they usually realize that their anxiety is more intense than the situation warrants. They can't relax, startle easily, and have difficulty concentrating. Often they have trouble falling asleep or staying asleep. Physical symptoms that often accompany the anxiety include fatigue, headaches, muscle tension, muscle aches, difficulty swallowing, trembling, twitching, irritability, sweating, nausea, lightheadedness, having to go to the bathroom frequently, feeling out of breath, and hot flashes.

When their anxiety level is mild, people with GAD can function socially and hold down a job. Although they don't avoid certain situations as a result of their disorder, people with GAD can have difficulty carrying out the simplest daily activities if their anxiety is severe. GAD affects about 6.8 million American adults, including twice as many women as men. The disorder develops gradually and can begin at any point in the life cycle, although the years of highest risk are between childhood and middle age. There is evidence that genes play a modest role in GAD.

Other anxiety disorders, depression, or substance abuse often accompany GAD, which rarely occurs alone. GAD is commonly treated with medication or cognitive-behavioral therapy, but co-occurring conditions must also be treated using the appropriate therapies.

Treatment of Anxiety Disorders

In general, anxiety disorders are treated with medication, specific types of psychotherapy, or both. Treatment choices depend on the problem and the person's preference. Before treatment begins, a doctor must conduct a careful diagnostic evaluation to determine whether a person's symptoms are caused by an anxiety disorder or a physical problem. If an anxiety disorder is diagnosed, the type of disorder or the combination of disorders that are present must be identified, as well as any coexisting conditions, such as depression or substance abuse. Sometimes alcoholism, depression, or other coexisting conditions have such a strong effect on the individual that treating the anxiety disorder must wait until the coexisting conditions are brought under control.

People with anxiety disorders who have already received treatment should tell their current doctor about that treatment in detail. If they received medication, they should tell their doctor what medication was used, what the dosage was at the beginning of treatment, whether the dosage was increased or decreased while they were under treatment, what side effects occurred, and whether the treatment helped them become less anxious. If they received psychotherapy, they should describe the type of therapy, how often they attended sessions, and whether the therapy was useful.

Often people believe that they have "failed" at treatment or that the treatment didn't work for them when, in fact, it was not given for an adequate length of time or was administered incorrectly. Sometimes people must try several different treatments or combinations of treatment before they find the one that works for them.

Personality Disorders

Personality disorders are long-term patterns of thoughts and behaviors that cause serious problems with relationships and work. People with personality disorders have difficulty dealing with everyday stresses and problems. They often have stormy relationships with other people. The exact cause of personality disorders is unknown. However, genes and childhood experiences may play a role. Symptoms vary widely depending on the specific type of personality disorder. Treatment usually includes talk therapy and sometimes medicine.

Borderline Personality Disorder

Borderline personality disorder is a serious mental illness marked by unstable moods, behavior, and relationships. In 1980, the Diagnostic and Statistical Manual for Mental Disorders, Third Edition (DSM-III) listed borderline personality disorder as a diagnosable illness for the first time. Most psychiatrists and other mental health professionals use the DSM to diagnose mental illnesses. Because some people with severe borderline personality disorder have brief psychotic episodes, experts originally thought of this illness as atypical, or borderline, versions of other mental disorders. While mental health experts now generally agree that the name "borderline personality disorder" is misleading, a more accurate term does not exist yet. Most people who have borderline personality disorder suffer from:

- Problems with regulating emotions and thoughts

- Impulsive and reckless behavior
- Unstable relationships with other people

People with this disorder also have high rates of co-occurring disorders, such as depression, anxiety disorders, substance abuse, and eating disorders, along with self-harm, suicidal behaviors, and completed suicides. According to data from a subsample of participants in a national survey on mental disorders, about 1.6 percent of adults in the United States have borderline personality disorder in a given year. Borderline personality disorder is often viewed as difficult to treat. However, recent research shows that borderline personality disorder can be treated effectively, and that many people with this illness improve over time.

According to the DSM, Fourth Edition, Text Revision (DSM-IV-TR), to be diagnosed with borderline personality disorder, a person must show an enduring pattern of behavior that includes at least five of the following symptoms:

- Extreme reactions—including panic, depression, rage, or frantic actions—to abandonment, whether real or perceived
- A pattern of intense and stormy relationships with family, friends, and loved ones, often veering from extreme closeness and love (idealization) to extreme dislike or anger (devaluation)
- Distorted and unstable self-image or sense of self, which can result in sudden changes in feelings, opinions, values, or plans and goals for the future (such as school or career choices)
- Impulsive and often dangerous behaviors, such as spending sprees, unsafe sex, substance abuse, reckless driving, and binge eating.
- Recurring suicidal behaviors or threats or self-harming behavior, such as cutting Intense and highly changeable moods, with each episode lasting from a few hours to a few days
- Chronic feelings of emptiness and/or boredom. Inappropriate, intense anger or problems controlling anger
- Having stress-related paranoid thoughts or severe dissociative symptoms, such as feeling cut off from oneself, observing oneself from outside the body, or losing touch with reality.

Seemingly mundane events may trigger symptoms. For example, people with borderline personality disorder may feel angry and distressed over minor separations — such as vacations, business trips, or sudden changes of plans —from people to whom they feel close. Studies show that people with this disorder may see anger in an emotionally neutral face and have a stronger reaction to words with negative meanings than people who do not have the disorder.

Schizophrenia

Schizophrenia affects approximately 1 percent of the population, or 2.2 million U.S. adults. Men and women are equally affected. The illness usually emerges in young people in their teens or twenties. Although children over the age of five can develop schizophrenia, it is rare before adolescence. In children, the disease usually develops gradually and is often preceded by developmental delays in motor or speech development. Childhood-onset schizophrenia tends to be harder to treat and has a less favorable prognosis than does the adult-onset form.

The Symptoms of schizophrenia:

There are many myths and misconceptions about schizophrenia. Schizophrenia is not a multiple or split personality, nor are individuals who have this illness constantly incoherent or psychotic. Although the media often portray individuals with schizophrenia as violent, in reality, very few affected people are dangerous to others. In fact, individuals with schizophrenia are more likely to be victims of violence than violent themselves. Schizophrenia has severe symptoms. A diagnosis of schizophrenia requires that at least two of the symptoms below be present during a significant portion of a one-month period: delusions (false beliefs such as conspiracies, mind control, or persecution); hallucinations (usually voices criticizing or commenting on the person's behavior); disorganized speech (incomprehensible or difficult to understand); grossly disorganized or catatonic behavior; and negative symptoms such as flat emotions, lack of facial expressions, and inattention to basic self-care needs such as bathing and eating.

However, the presence of either one of the first two symptoms is sufficient to diagnose schizophrenia if the delusions are especially bizarre or if the hallucinations consist of one or more voices that keep a running commentary on the person's behavior or thoughts. The DSM-IV specifies additional criteria for a diagnosis of schizophrenia: occupational dysfunction, persistence of the disturbance for at least six months, exclusion of a mood disorder, exclusion of a substance-abuse or medical condition that causes similar symptoms, and consideration of a possible pervasive developmental disorder. The course of schizophrenia varies considerably from one individual to the next. Most people who have schizophrenia experience at least one, and usually more, relapses after their first psychotic episode. Relapses are periods of more intense symptoms of illness (hallucinations and delusions). During remissions, the negative symptoms related to emotion or personal care are usually still present. About 10

percent of patients remain severely ill for long periods of time and do not return to their previous state of mental functioning. Several long-term studies found that as many as one-third to one-half of people with schizophrenia improve significantly or even recover completely from their illness.

The Causes of Schizophrenia

Like the other mental illnesses discussed here, scientists are still working to determine what causes schizophrenia. Also like the other mental illnesses, genetic and environmental factors most likely interact to cause the disease. Several studies suggest that an imbalance of chemical neurotransmitter systems of the brain, including the dopamine, GABA, glutamate, and norepinephrine neurotransmitter systems, are involved in the development of schizophrenia. Family, twin, and adoption studies support the idea that genetics plays an important role in the illness. For example, children of people with schizophrenia are 13 times more likely, and identical twins are 48 times more likely, to develop the illness than are people in the general population. Scientists continue to look at genes that may play a role in causing schizophrenia. One gene of interest to scientists who study schizophrenia codes for an enzyme that breaks down dopamine in the synapse.

Treating Schizophrenia

There is no cure for schizophrenia; however, effective treatments that make the illness manageable for most affected people are available. The optimal treatment includes antipsychotic medication combined with a variety of psychotherapeutic interventions. Since the 1950s, doctors have used antipsychotic drugs, such as chlorpromazine and haloperidol, to relieve the hallucinations and delusions typical of schizophrenia. Recently, newer (also called atypical) antipsychotic drugs such as risperidone and clozapine have proven to be more effective. Early and sustained treatment that includes antipsychotic medication is important for long-term improvement of the course of the disease. Patients who discontinue medication are likely to experience a relapse of their illness. People who manage schizophrenia best combine medication with psychosocial rehabilitation (life-skills training). Therapies that combine family and community support, education, and behavioral and cognitive skills to address specific challenges help schizophrenic patients improve their functioning and the quality of their lives.

Suicide and Self-harm

Suicide is among the most common causes of death in the United States. People may consider suicide when they are hopeless and can't see any other solution to their problems. Often it's related to serious depression, alcohol or substance abuse, or a major stressful event.

People who have the highest risk of suicide are white men. But women and teens report more suicide attempts. If someone talks about suicide, you should take it seriously. Urge them to get help from their doctor or the emergency room, or call the **National Suicide Prevention Lifeline at 1-800-273-TALK (8255).**

Therapy and medicines can help most people who have suicidal thoughts. Treating mental illnesses and substance abuse can reduce the risk of suicide.

Suicidal behavior is complex. Some risk factors vary with age, gender, or ethnic group and may occur in combination or change over time. Suicide is a major, preventable public health problem. In 2007, it was the tenth leading cause of death in the U.S., accounting for 34,598 deaths. The overall rate was 11.3 suicide deaths per 100,000 people. An estimated 11 attempted suicides occur per every suicide death.

In 2007, suicide was the third leading cause of death for young people ages 15 to 24. As in the general population, young people were much more likely to use firearms, suffocation, and poisoning than other methods of suicide, overall. However, while adolescents and young adults were more likely to use firearms than suffocation, children were dramatically more likely to use suffocation.

There were also gender differences in suicide among young people, as follows:

- Nearly five times as many males as females ages 15 to 19 died by suicide.
- Just under six times as many males as females ages 20 to 24 died by suicide.

Research shows that risk factors for suicide include:

- depression and other mental disorders, or a substance-abuse disorder (often in combination with other mental disorders). More than 90 percent of people who die by suicide have these risk factors.

- prior suicide attempt
- family history of mental disorder or substance abuse
- family history of suicide
- family violence, including physical or sexual abuse
- firearms in the home, the method used in more than half of suicides
- incarceration
- exposure to the suicidal behavior of others, such as family members, peers, or media figures.

However, suicide and suicidal behavior are not normal responses to stress; many people have these risk factors, but are not suicidal. Research also shows that the risk for suicide is associated with changes in brain chemicals called neurotransmitters, including serotonin. Decreased levels of serotonin have been found in people with depression, impulsive disorders, and a history of suicide attempts, and in the brains of suicide victims. Public health approaches to preventing suicide include establishing telephone crisis hot lines, restricting access to suicide methods (for example, firearms), counseling media to reduce “copycat” suicides, screening teens for risk factors of suicide, and training professionals to improve recognition and treatment of mood disorders. Research about the effectiveness of these methods indicates that the screening and training strategies are more helpful for preventing suicides among young people than the other methods are.

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2.2.2.17: The Stigma of Mental Illness

Words can hurt. Many derogatory words and phrases are used in relation to mental illness. However, these words maintain the stereotyped image and not the reality about mental illness. Try not to use these words, and encourage students not to use them. It is more appropriate to refer to “a person who has a mental illness” when speaking about someone. “Mentally ill people are nuts, crazy, wacko.” “Mentally ill people are morally bad.” “Mentally ill people are dangerous and should be locked in an asylum forever.” “Mentally ill people need somebody to take care of them.” How often have we heard comments like these or seen these types of portrayals in movies, television shows, or books? We may even be guilty of making comments like them ourselves. Is there any truth behind these portrayals, or is that negative view based on our ignorance and fear?

Stigmas are negative stereotypes about groups of people. Common stigmas about people who are mentally ill are

- Individuals who have a mental illness are dangerous.
- Individuals who have a mental illness are irresponsible and can’t make life decisions for themselves.
- People who have a mental illness are childlike and must be taken care of by parents or guardians.
- People who have a mental illness should just get over it.

Each of those preconceptions about people who have a mental illness is based on false information. Very few people who have a mental illness are dangerous to society. Most can hold jobs, attend school, and live independently. A person who has a mental illness cannot simply decide to get over it any more than someone who has a different chronic disease such as diabetes, asthma, or heart disease can. A mental illness, like those other diseases, is caused by a physical problem in the body.

Stigmas against individuals who have a mental illness lead to injustices, including discriminatory decisions regarding housing, employment, and education. Overcoming the stigmas commonly associated with mental illness is yet one more challenge that people who have a mental illness must face. Indeed, many people who successfully manage their mental illness report that the stigma they face is in many ways more disabling than the illness itself. The stigmatizing attitudes toward mental illness held by both the public and those who have a mental illness lead to feelings of shame and guilt, loss of self-esteem, social dependence, and a sense of isolation and hopelessness. One of the worst consequences of stigma is that people who are struggling with a mental illness may be reluctant to seek treatment that, in most cases, would significantly relieve their symptoms.

Providing accurate information is one way to reduce stigmas about mental illness. Advocacy groups protest stereotypes imposed upon those who are mentally ill. They demand that the media stop presenting inaccurate views of mental illness and that the public stops believing these negative views. A powerful way of countering stereotypes about mental illness occurs when members of the public meet people who are effectively managing a serious mental illness: holding jobs, providing for themselves, and living as good neighbors in a community. Interaction with people who have mental illnesses challenges a person’s assumptions and changes a person’s attitudes about mental illness.

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2.2.2.18: Safety Needs

Once a person's physiological needs are relatively satisfied, his/her safety needs take precedence and dominate behavior. In the absence of physical safety – due to war, natural disaster, family violence, childhood abuse, etc. – people may (re-)experience post-traumatic stress disorder or transgenerational trauma. In the absence of economic safety – due to economic crisis and lack of work opportunities – these safety needs manifest themselves in ways such as a preference for job security, grievance procedures for protecting the individual from unilateral authority, savings accounts, insurance policies, disability accommodations, etc. This level is more likely to be found in children as they generally have a greater need to feel safe.

Safety and Security needs include:

- Personal security
- Financial security
- Health and well-being
- Safety net against accidents/illness and their adverse impacts

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2.2.2.19: Social Belonging

After physiological and safety needs are fulfilled, the third level of human needs is interpersonal and involves feelings of belongingness. This need is especially strong in childhood and it can override the need for safety as witnessed in children who cling to abusive parents. Deficiencies within this level of Maslow's hierarchy – due to hospitalism, neglect, shunning, ostracism, etc. – can adversely affect the individual's ability to form and maintain emotionally significant relationships in general, such as:

- Friendships
- Intimacy
- Family

According to Maslow, humans need to feel a sense of belonging and acceptance among their social groups, regardless whether these groups are large or small. For example, some large social groups may include clubs, co-workers, religious groups, professional organizations, sports teams, and gangs. Some examples of small social connections include family members, intimate partners, mentors, colleagues, and confidants. Humans need to love and be loved – both sexually and non-sexually – by others. Many people become susceptible to loneliness, social anxiety, and clinical depression in the absence of this love or belonging element. This need for belonging may overcome the physiological and security needs, depending on the strength of the peer pressure.

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2.2.2.20: Esteem

All humans have a need to feel respected; this includes the need to have self-esteem and self-respect. Esteem presents the typical human desire to be accepted and valued by others. People often engage in a profession or hobby to gain recognition. These activities give the person a sense of contribution or value. Low self-esteem or an inferiority complex may result from imbalances during this level in the hierarchy. People with low self-esteem often need respect from others; they may feel the need to seek fame or glory. However, fame or glory will not help the person to build their self-esteem until they accept who they are internally. Psychological imbalances such as depression can hinder the person from obtaining a higher level of self-esteem or self-respect. Most people have a need for stable self-respect and self-esteem. Maslow noted two versions of esteem needs: a "lower" version and a "higher" version. The "lower" version of esteem is the need for respect from others. This may include a need for status, recognition, fame, prestige, and attention. The "higher" version manifests itself as the need for self-respect. For example, the person may have a need for strength, competence, mastery, self-confidence, independence, and freedom. This "higher" version takes precedence over the "lower" version because it relies on an inner competence established through experience. Deprivation of these needs may lead to an inferiority complex, weakness, and helplessness.

Maslow states that while he originally thought the needs of humans had strict guidelines, the "hierarchies are interrelated rather than sharply separated". This means that esteem and the subsequent levels are not strictly separated; instead, the levels are closely related.

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2.2.2.21: Self-Actualization

"What a man can be, he must be."

This quotation forms the basis of the perceived need for self-actualization. This level of need refers to what a person's full potential is and the realization of that potential. Maslow describes this level as the desire to accomplish everything that one can, to become the most that one can be. Individuals may perceive or focus on this need very specifically. For example, one individual may have the strong desire to become an ideal parent. In another, the desire may be expressed athletically. For others, it may be expressed in paintings, pictures, or inventions. As previously mentioned, Maslow believed that to understand this level of need, the person must not only achieve the previous needs, but master them.

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2.2.2.22: Self-Transcendence

In his later years, Abraham Maslow explored a further dimension of needs, while criticizing his own vision on self-actualization. The self only finds its actualization in giving itself to some higher goal outside oneself, in altruism and spirituality, which is essentially the desire to reach infinite. "Transcendence refers to the very highest and most inclusive or holistic levels of human consciousness, behaving and relating, as ends rather than means, to oneself, to significant others, to human beings in general, to other species, to nature, and to the cosmos" (Farther Reaches of Human Nature, New York 1971, p. 269).

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2.2.2.23: Mental Health

According to the World Health Organization (WHO), mental health includes "subjective wellbeing, perceived self-efficacy, autonomy, competence, inter-generational dependence, and self-actualization of one's intellectual and emotional potential, among others." The WHO further states that the well-being of an individual is encompassed in the realization of their abilities, coping with normal stresses of life, productive work and contribution to their community. Cultural differences, subjective assessments, and competing professional theories all affect how "mental health" is defined. A widely accepted definition of health by mental health specialists is psychoanalyst Sigmund Freud's definition: the capacity "to work and to love".

Mental Health Issues Are Prevalent Among College Students

Mental health issues are a leading impediment to academic success among college students. Untreated mental illness in the college student population — including depression, anxiety and eating disorders — is associated with lower GPA and higher probability of dropping out of school. Treatment is effective and available yet because of an unnecessary shame surrounding these issues, mental health is not discussed and too many students are suffering in silence

- An estimated 26 percent of Americans ages 18 and older – or about 1 in 4 adults - live with a diagnosable mental health disorder.
- Half of all serious adult psychiatric illnesses – including major depression, anxiety disorders, and substance abuse – start by 14 years of age. Three-fourths of them are present by 25 years of age.
- Compared to older adults, the 18-24 year old age group shows the lowest rate of help-seeking.

Mental Health Issues Impact Students' Ability To Succeed:

- Almost one third of all college students report having felt so depressed that they had trouble functioning.
- Mental health issues in the college student population, such as depression, anxiety, and eating disorders, are associated with lower GPA and higher probability of dropping out of college.
- More than 80 percent of college students felt overwhelmed by all they had to do in the past year and 45 percent have felt things were hopeless.

Mental health issues can be deadly:

- Suicide is the 2nd leading cause of death among college students, claiming the lives of 1,100 students each year.
- 67% of college students tell a friend they are feeling suicidal before telling anyone else.
- More than half of college students have had suicidal thoughts and 1 in 10 students seriously consider attempting suicide. Half of students who have suicidal thoughts never seek counseling or treatment.
- 80-90% of college students who die by suicide were not receiving help from their college counseling centers

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2.2.2.24: Emotional Health

Emotional well-being is a term that has been used increasingly in recent decades. The implications of decreased emotional well-being are related to mental health concerns such as stress, depression, and anxiety. These in turn can contribute to physical ill-health such as digestive disorders, sleep disturbances, and general lack of energy.[1] The profile of a person prone to emotional distress is usually someone with low self-esteem, pessimistic, very self-critical, etc. and people who need to constantly assert themselves through their behavior. They also tend to be afraid, overly worried about the future, and focused on the past.

On the positive side, enhanced emotional well-being is seen to contribute to upward spirals in increasing coping ability, self-esteem, performance and productivity at work, and even longevity. Thoughts determine feelings, and thoughts are nothing more than firings of neurons. And those feelings that thoughts generate make the body release extremely addicting substances like adrenaline and cortisol. Like with any other addiction, the need to continually feed off these addicting substances tends to make the body think and feel in a certain way. When someone decides to disengage from these emotional addictions, he/she must learn to think differently.

Emotions and feelings are part of every step a person takes. A person must learn how to manage himself/herself in order to reach the maximum potential in all aspects of life. Good emotional health leads to better physical health, prevents diseases, and makes it possible to enjoy life and be happier. In this way you can become a “medicine person” through mirror neurons, those that lead to empathy and fire to imitate the emotions of others. Mirror neurons are what make you feel good when you’re with someone who is positive, cheerful and motivational. At the other extreme are the so-called “toxic people”, who make others around them feel bad.

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2.2.2.25: Spiritual Health

The spiritual dimension is understood to imply a phenomenon that is not material in nature, but belongs to the realm of ideas, beliefs, values and ethics that have arisen in the minds and conscience of human beings, particularly ennobling ideas. Ennobling ideas have given rise to health ideals, which have led to a practical strategy for Health for All that aims at attaining a goal that has both a material and non-material component. If the material component of the strategy can be provided to people, the non-material or spiritual one is something that has to arise within people and communities in keeping with their social and cultural patterns. The spiritual dimension plays a great role in motivating people's achievement in all aspects of life.

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2.2.3: STRESS MANAGEMENT

Stress is a feeling you get when faced with a challenge. In small doses, stress can be good for you because it makes you more alert and gives you a burst of energy. For instance, if you start to cross the street and see a car about to run you over, that jolt you feel helps you to jump out of the way before you get hit. But feeling stressed for a long time can take a toll on your mental and physical health. Even though it may seem hard to find ways to de-stress with all the things you have to do, it's important to find those ways. Your health depends on it.

2.2.3.1: Chronic Stress

2.2.3.2: The Effects of Stress on the Body

2.2.3.3: Stress and the Brain

2.2.3.4: Your Bodies Response to Stress

2.2.3.5: General Adaption Syndrome

2.2.3.6: Distress may be Destructive to Health

2.2.3.7: Eustress

2.2.3.8: Burnout and Stress Relateed Illness

2.2.3.9: Common Causes of Stress

2.2.3.10: Common signs and symptoms of stress

2.2.3.11: Do women react to stress differently than men?

2.2.3.12: Can Stress Affect My Health?

2.2.3.13: The Effect of Stress on the Immune System

2.2.3.14: Does Stress Cause Ulcers?

2.2.3.15: Post-traumatic stress disorder (PTSD)

2.2.3.16: Stress is in the Eye of the Beholder

2.2.3.17: Managing Stress

2.2.3.18: Coping with Stress

2.2.3.19: Exercise and Stress

2.2.3.20: Meditation and Health

2.2.3.21: Relaxation Techniques

2.2.3.22: Resilience

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2.2.3.1: Chronic Stress

We all have stress sometimes. For some people, it happens before having to speak in public. For other people, it might be before a first date. What causes stress for you may not be stressful for someone else. Sometimes stress is helpful - it can encourage you to meet a deadline or get things done. But long-term stress can increase the risk of diseases like depression, heart disease and a variety of other problems. A stress-related illness called post-traumatic stress disorder (PTSD) develops after an event like war, physical or sexual assault, or a natural disaster.

If you have chronic stress, the best way to deal with it is to take care of the underlying problem. Counseling can help you find ways to relax and calm down. Medicines may also help.

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2.2.3.2: The Effects of Stress on the Body

Not all stress is bad. All animals have a stress response, which can be lifesaving in some situations. The nerve chemicals and hormones released during such stressful times prepares the animal to face a threat or flee to safety. When you face a dangerous situation, your pulse quickens, you breathe faster, your muscles tense, your brain uses more oxygen and increases activity—all functions aimed at survival. In the short term, it can even boost the immune system.

However, with chronic stress, those same nerve chemicals that are life-saving in short bursts can suppress functions that aren't needed for immediate survival. Your immunity is lowered and your digestive, excretory, and reproductive systems stop working normally. Once the threat has passed, other body systems act to restore normal functioning. Problems occur if the stress response goes on too long, such as when the source of stress is constant, or if the response continues after the danger has subsided.

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2.2.3.3: Stress and the Brain

Stress has many definitions, but according to Richard Lazarus, stress is a state of anxiety produced when events and responsibilities exceed one's coping abilities. In this way, stress relies not only on environmental factors, but on cognitive appraisals of these factors (Myers, 2004). The cerebral cortex perceives the stressor, the hypothalamus stimulates the pituitary gland to release epinephrine and norepinephrine. This in turn stimulates the adrenal glands to release the hormone cortisol (Myers, 2004). Stress affects many other areas of the body, such as the amygdala, which produces a fear response. It seems to hardwire the brain differently. Middle-aged rats that had undergone early life stress had abnormal brain-cell activity and memory loss (Brunson et. al., 2005).

The sources of stress are numerous: from catastrophes such as Hurricane Katrina, significant life changes, poverty and inequality, to daily hassles like traffic tie-ups and demanding jobs (Myer, 2004). Especially in urban and overcrowded environments, psychologist s see links between everyday stressors and hypertension, and unhealthy behaviors such as lack of sleep and alcoholism (Lazarus & Folkman, 1984). In fact, the leading causes of death today in America are linked to lifestyle and stress. According United Nations Security Council, about half of the world's children grow up in extremely stressful environments (poverty, violence, war, abuse), which means that these children may have impaired cognitive abilities later on in life.

According to research by Janet Rodin, the less perceived control of a situation, the greater the stress. The elderly that lived in nursing homes, were lonely, and had to be fed, dressed, and changed, felt significantly more stress and had shorter lifespans than their independent, active counterparts. Females seem to be more susceptible to stress and depression. After experiencing traumatic events, females are twice as likely as men to develop Post Traumatic Stress Disorder, where humans develop maladaptive behaviors such as avoidance, reduced responsiveness and guilt (Myers, 2004).

However, mindful exercise, such as Tai Chi, meditation, and aerobic exercise decrease stress response and promote overall well-being (Sandlund and Norlander, 2000). In a University of Wisconsin study, participants who did meditative exercises showed more electrical activity in the left side of the frontal lobe, indicating that they had a lower anxiety and a more positive emotional state (Davidson, 2003). Meditation, yoga, and other relaxation exercises also assist in autonomic reflexes. This is called conscious control. Through these practices, it is possible to gain control over the sphincter muscles in the anus and bladder. Yoga has been shown to help control heart rate, blood pressure, and other autonomic functions. These are learned behaviors - they involve the formation of new pathways in the brain.

Researchers have also found the correlation between a social support network of close friends and family and less physiological stress effects (Brown and Harris, 1978). Stress Inoculation Training and Hardiness Training are cognitive behavioral techniques that work to improve stress resistance through analyzing stressors, teaching coping techniques, and changing behavior so that the patient feels more assertive and in control (Kobasa, 1986). Drugs, such as beta-blockers, which reduce stress arousal, anxiolytic drugs, such as minor tranquilizers, and anti-depressant drugs, which treat severe anxiety, can also be used to combat stress.

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2.2.3.4: Your Bodies Response to Stress

Fight or Flight Response

When we experience excessive stress, either from internal worry or external circumstance, a bodily reaction called the "fight-or-flight" response will be triggered. Harvard physiologist Walter Cannon originally defined it. The response system represents the genetic impulse to protect ourselves from bodily harm, but also can result in negative health effects. According to Cannon's theory, during stress-response processes, the sympathetic nervous system increases the heart rate and releases chemicals to prepare our body to either fight or flee. When the fight-or-flight response system get activated, it tends to perceive everything in the environment as a potential threat to survival.

In modern life, we do not get the option of "flight" very often. We have to deal with those stressors all the time and find a solution. When you need to take an SAT test, there is no way for you to avoid it; sitting in the test room for five hours is the only choice. Lacking the "flight" option in stress-response process leads to higher stress levels in modern society.

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2.2.3.5: General Adaption Syndrome

Selye's Concept of General Adaptation Syndrome

Hans Selye (1907-1982) started the modern era of research into something called stress. In 1950, Selye addressed the American Psychological Association convention. He described a theory of stress-induced responses that become the standard model of stress, the one people usually refer to (or criticize) in academic journal articles about stress.

How did Selye discover the stress response?

Selye's discovery of the stress response was an accident. He was doing research on the effect of hormone injections in rats. Initially he thought he detected a harmful effect from the hormones, because many of the rats became sick after receiving the injections. But when Selye used a control group of rats, injected only with a neutral solution containing no hormones, he observed that they became sick, too.

As it turned out, the rats responded more profoundly to the trauma of being injected than they did to the hormones. The experience of being handled and injected led to high levels of sympathetic nervous system arousal and eventually to health problems such as ulcers. (Note that stress was not found to directly cause ulcers by Selye.) Selye coined the term "stressor" to label a stimulus that had this effect.

What is a stressor for rats? For lab assistants?

The immediate response to stress is the release of adrenaline into the blood plasma (the liquid part of the bloodstream). "Mild stressors such as opening a cage door or handling a rat produces an eightfold increase in plasma epinephrine [adrenaline] concentrations" (Axelrod and Reisine, 1984). The sentence is ambiguous; does the rat or the human experience the eightfold increase in adrenaline? In this case, it is the rat which is having its adrenaline (plasma epinephrine) measured. However, many lab assistants probably experience a burst of adrenaline, too, when handling a rat for the first time.

What were the three stages of Selye's General Adaptation Syndrome?

Selye proposed a three-stage pattern of response to stress that he called the General Adaptation Syndrome (GAS) . He proposed that when the organism first encountered stress, in the form of novelty or threat, it responded with an alarm reaction. This is followed by a recovery or resistance stage during which the organism repairs itself and stores energy. If the stress-causing events continue, exhaustion sets in. This third stage is what became known popularly as burn-out. Classic symptoms of burn-out include loss of drive, emotional flatness, and (in humans) dulling of responsiveness to the needs of others.

Hans Selye’s Study of Stress Response

In 1934, Hans Selye at McGill University discovered a new type of hormone. He gave rats daily injections of ovarian extract and found that the rats had enlarged adrenals and shrunken spleens, thymus, lymph nodes, and intestinal ulcers. “Multiple organs in the body generate this hormone, and thus he announced that it is a nonspecific response of body to noxious agents. (Evan-Martin, 2007)

In 1936, Selye defined these series of symptoms in the experiments with the rats as the General Adaptation Syndrome, which consists of three stages: the alarm stage, the resistance stage, and the exhaustion stage (Evan-Martin, 2007). The alarm stage is similar to the fight-to-flight response, and the body mobilizes resources to react to the incoming noxious agent. The resistance forces will be built up when the noxious challenge is detected as continuing. The exhaustion stage will cause death if the body is unable to overcome the threat.

For example, your mom told you that you are going to take the SAT next month. The first reaction is shock, starting complaints and feelings of stress, which represent the beginning of the first stage. In the resistance stage, you will try your best to do practice tests, reviewing vocabulary, studying any type of study aids that are available. Finally, you will feel like you are doomed to fail this test and feel desperate, feel constantly anxious, have difficulty falling asleep and waking up in the morning. The exhaustion of this stage will have deleterious effects on your health by depleting your body resources which are crucial for the maintenance of normal functions. Your immune system will be exhausted and function will be impaired. Also, the decomposition which is a functional deterioration of body may happen as the exhaustion stage extends. Selye believed that one becomes sick at that point because stored hormones secrete during the stress response are depleted (Sapolsky, 1998).

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2.2.3.6: Distress may be Destructive to Health

Hans Selye's research that led to the concept of the General Adaptation Syndrome (GAS) demonstrated that stress that is perceived as a threat (distress) may be debilitating if it is continuous. But even "flow" could go on too long and the person would need a break. But "flow" only develops in activities that are freely engaged in. Negative stress, or distress, is often part of activities that we perceive we cannot escape. Our bodies and minds seem to have evolved to cope well with sudden and brief stressors, such as escaping attack by a predator. We do not seem to be designed to handle chronic stress even if it is mild, like driving in heavy traffic. Our society has created many conditions that produce chronic stress and are associated with stress related illnesses. We have time pressures, work pressures, relationship pressures, crowding, noise, crime, to many things to do in too little time, achievement pressures, and even education-related pressures in this course. It is this detrimental effect of ongoing stress that underlies the GAS and the concepts of stressinduced health problems.

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2.2.3.7: Eustress

Hans Selye originally defined stress as the body's response to challenges. He was dismayed by the implication that all challenging events in life were unhealthy and undesirable. Stress was not always bad, he pointed out. Sometimes a challenge is a good thing. Indeed, one could argue that nothing useful in life can be accomplished without some degree of stress.

"Good stress," Selye pointed out, is "the spice of life." To combat the notion that all stress was bad, Selye developed the idea of eustress, which is a person's ideal stress level. Selye proposed that different people needed different levels of challenge or stimulation (stress) in their lives. Some people ("turtles") need low levels of stress. Others ("racehorses") thrive on challenges.

In the long run, the popular conception of stress as something bad proved to be more durable and accurate than Selye's notion of stress as a challenge to the system. In other words, the word stress continues to mean something bad (not something challenging) to most people. That seems to make the most sense, because psychologists found that only unpleasant stressors produced the harmful stress reaction identified by Selye (corticosteroid secretion). Challenges were not harmful in themselves. A person could be a busy executive or engage in strenuous exercise without experiencing negative stressrelated symptoms, as long as the person enjoyed the challenge.

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2.2.3.8: Burnout and Stress Relateed Illness

Burnout syndrome is considered an important work-related illness in welfare societies. It was through observations by German psychologist Herbert Freudenberger inside a detoxification clinic in the mid-1960s that the first scientific descriptions came to light of staff affected by this disorder. It was only in the 1980s that evaluation criteria for the syndrome became available, through the design of a standard measurement instrument, the Maslach Burnout Inventory or MBI.

Burnout is a psychosocial syndrome. It involves feelings of emotional exhaustion, depersonalization and diminished personal accomplishment at work. Emotional exhaustion is a situation where, owing to lack of energy, workers perceive they are no longer able to participate on an emotional level. Depersonalization entails the development of negative attitudes and feelings towards persons for whom work is done, to the point where they are blamed for the subject's own problems. Diminished personal accomplishment is a tendency in professionals to negatively value their own capacity to carry out tasks and to interact with persons for whom they are performed, and feeling unhappy or dissatisfied with the results obtained.

The MBI questionnaire has been adapted for application not only to human services professions but to all types of occupations in general. An updated definition of burnout, constructed using the latest version of the MBI, is that proposed by Maslach et al. In their description, it is "a prolonged response to chronic emotional and interpersonal stressors on the job, and is defined by the three dimensions of exhaustion, cynicism, and inefficiency." Exhaustion is the feeling of not being able to offer any more of oneself at an emotional level; cynicism is contemplated as a distant attitude towards work, the people being served by it and among colleagues; ineffectiveness is the feeling of not performing tasks adequately and of being incompetent at work.

Burnout is generally considered a response by a person to chronic work-related stress in an attempt to adapt or protect oneself from it. From a transactional approach, stress is defined as "the result of a relationship with the environment that the person appraises as significant for his or her well-being and in which the demands tax or exceed available coping resources." This is the case because a life event is not what produces stress; rather, it is caused by the appraisal the affected person makes of it. According to Lazarus and Folkman, coping is "cognitive and behavioral efforts to manage specific internal and/or external demands that are appraised as taxing or exceeding the resources of the person." A person will be psychologically vulnerable to a determined situation if he or she does not possess sufficient coping resources to handle it adequately, and if at the same time, he or she places considerable importance on the threat implicit in the consequences of this inadequate handling. From this perspective, burnout syndrome may be seen as a progressively-developed process resulting from the use of the relatively ineffective coping strategies with which professionals try to protect themselves from work-related stress.

Burnout has also been described as an experience where the worker is aware of considerable discrepancy between his or her efforts and the results, between the invested efforts and the rewards obtained at work. This phenomenological analysis framework is introduced into the subjective experience of those affected, and the conclusion is reached that the burnout process is triggered when the worker feels that his or her efforts are disproportionate to the gratification achieved, and consequently is no longer able to justify or cope with further investment of effort. Burnout syndrome may be seen as the continuous perception that efforts made to carry out tasks are not effective, because expected gratitude, recognition or success at work are not being achieved.

This tool can help you check yourself for burnout. It helps you look at the way you feel about your job and your experiences at work, so that you can get a feel for whether you are at risk of burnout. Resource:
MindTools http://www.mindtools.com/pages/article/newTCS_08.htm

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2.2.3.9: Common Causes of Stress

Stress happens when people feel like they don't have the tools to manage all of the demands in their lives. Stress can be short-term or long-term. Missing the bus or arguing with your spouse or partner can cause short-term stress. Money problems or trouble at work can cause long-term stress. Even happy events, like having a baby or getting married can cause stress. Some of the most common stressful life events include:

- Death of a spouse
- Death of a close family member Divorce
- Losing your job
- Major personal illness or injury
- Marital separation
- Marriage
- Pregnancy
- Retirement
- Spending time in jail

SOCIAL READJUSTMENT RATING SCALE*

LIFE EVENT	LIFE-CHANGE UNIT
Death of one's spouse	100
Divorce	73
Marital Separation	65
Jail Term	63
Death of a Close Family Member	63
Personal Injury or Illness	53
Marriage	50
Being Fired	47
Retirement	45
Pregnancy	40
Change in One's Financial State	38
More Arguments with One's Spouse	35
Change in Responsibilities at Work	29
Son or Daughter Leaving Home	29
Trouble with In-Laws	29
Beginning or Ending School	26
Change in Living Conditions	25
Trouble with One's Boss	23
Change in Work Hours or Conditions	20
Change in Eating Habits	15
Vacation	13
Christmas	12

Figure 2.2.3.9.1

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2.2.3.10: Common signs and symptoms of stress

Everyone responds to stress a little differently. Symptoms may vary person to person. Here are some of the signs to look for:

- Not eating or eating too much
- Feeling like you have no control
- Needing to have too much control
- Forgetfulness
- Headaches
- Lack of energy
- Lack of focus
- Trouble getting things done
- Poor self-esteem
- Short temper
- Upset stomach
- Back pain
- General aches and pains

These symptoms may also be signs of depression or anxiety, which can be caused by long-term stress.

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2.2.3.11: Do women react to stress differently than men?

One recent survey found that women were more likely to experience physical symptoms of stress than men. But we don't have enough proof to say that this applies to all women. We do know that women often cope with stress in different ways than men. Women "tend and befriend," taking care of those closest to them, but also drawing support from friends and family. Men are more likely to have the "fight or flight" response. They cope by "escaping" into a relaxing activity or other distraction.

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2.2.3.12: Can Stress Affect My Health?

The body responds to stress by releasing stress hormones. These hormones make blood pressure, heart rate, and blood sugar levels go up. Long-term stress can help cause a variety of health problems, including:

- Mental health disorders, like depression and anxiety
- Obesity
- Heart disease
- High blood pressure
- Abnormal heart beats
- Menstrual problems
- Acne and other skin problems

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2.2.3.13: The Effect of Stress on the Immune System

Psychoneuroimmunology (PNI) is defined as the examination of the interactions among psychological, behavioral, and social factors with immunological and neuroendocrine outcomes. It is now well established that psychological factors, especially chronic stress, can lead to impairments in immune system functioning in both the young and older adults. In several studies of older adults, those who are providing care for a relative with dementia report high levels of stress and exhibit significant impairments in immune system functioning when compared with noncaregivers. Stress-induced changes in the immune system may affect a number of outcomes, including slowing the wound healing process and increasing susceptibility to infections.

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2.2.3.14: Does Stress Cause Ulcers?

A bacterium called Helicobacter pylori (H. pylori) is a major cause of peptic ulcers. Nonsteroidal anti-inflammatory drugs (NSAIDs), such as aspirin and ibuprofen, are another common cause. Rarely, cancerous or noncancerous tumors in the stomach, duodenum, or pancreas cause ulcers.

Peptic ulcers are NOT caused by stress or eating spicy food, but both can make ulcer symptoms worse. Smoking and drinking alcohol also can worsen ulcers and prevent healing.

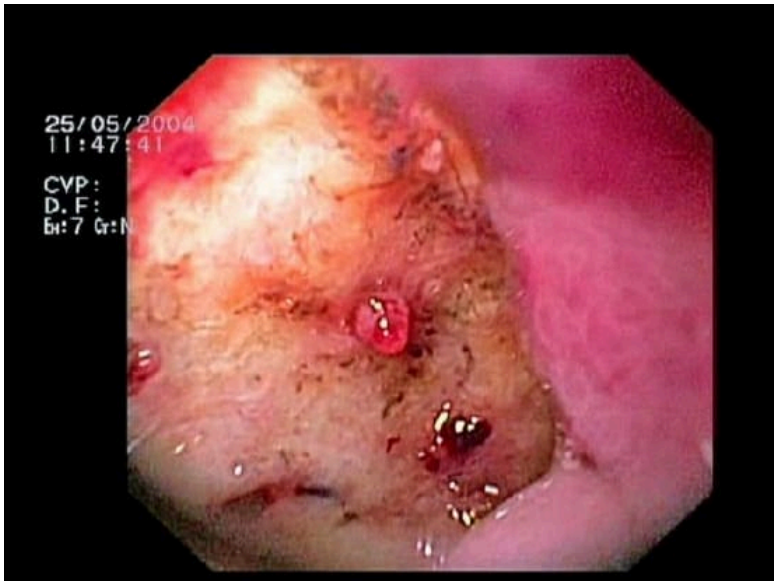


Figure 2.2.3.14.1 Ulcer

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2.2.3.15: Post-traumatic stress disorder (PTSD)

Post-traumatic stress disorder (PTSD) is a type of anxiety disorder that can occur after living through or seeing a dangerous event. It can also occur after a sudden traumatic event. This can include:

- Being a victim of or seeing violence
- Being a victim of sexual or physical abuse or assault
- The death or serious illness of a loved one
- Fighting in a war
- A severe car crash or a plane crash
- Hurricanes, tornadoes, and fires

You can start having PTSD symptoms right after the event or symptoms can develop months or even years later. Symptoms may include:

- Nightmares
- Flashbacks, or feeling like the event is happening again
- Staying away from places and things that remind you of what happened
- Being irritable, angry, or jumpy
- Feeling strong guilt, depression, or worry
- Trouble sleeping
- Feeling numb
- Having trouble remembering the event

Women are 2 to 3 times more likely to develop PTSD than men. Also, people with ongoing stress in their lives are more likely to develop PTSD after a dangerous event.

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2.2.3.16: Stress is in the Eye of the Beholder

The process by which we influence the emotion we experience in a situation by the interpretation or cognitions we select in the experience is described by Lazarus's theory of appraisal as influencing our stress experience. This theory may be beneficial to our understanding of the differences between individual's stress levels. The theory's main points are:

1. When we experience a situation or event we first determine if it is a threat, a challenge, or is neutral.
2. We then assess our inventory of resources to cope with the event. If we do not perceive we are adequate to the task, we must be able to withdraw or we will feel trapped in a situation with aversive consequences coming. That induces distress and all the physiological processes that harm our health. If we perceive that we have the resources to successfully cope with the situation, we feel challenged and optimistic. Note that challenge and optimism are related to enhanced health and sense of wellbeing.

This second stage of appraisal impacts the first stage in a loop process. If we at first perceive a threat but then realize we can handle it, it reduces the distress and may even create a perception of challenge. If at first we perceive a challenge but then realize that we don't have what it takes to be successful, we may begin to experience distress as we see the aversive outcome of failure looming ahead. Depending on the meaning of the outcome to us, the distress may be mild or severe. If the situation is always hanging over us and we always feeling inadequate to it and anxious about negative outcomes, we are always under distress. Our health and well-being take a beating in that scenario.

Next, we must select from our repertoire of coping resources. There are two types of coping resources:

- Instrumental
- palliative (emotion-focused)

Instrumental coping solves the problem and removes the stressor from our experience as in working out a conflict with someone to reduce the distress or by getting a better job to reduce financial pressures.

Palliative coping alters our physiological reactions to stress that will not go away and cannot be escaped. These include relaxation skills, reinterpretation of the meaning or effects of the stressor, acceptance of the situation, or optimism about future improvements in the situation. Palliative skills would include relaxing in the traffic jam even though you have an important appointment that is being missed. You realize you cannot do anything about it, so you may as well relax because anger and tension will not make the cars move any faster, but it will hurt you, so you choose to relax instead.

As we go to our repertoire of coping skills to select one or more, we may become more optimistic of success and reappraise the situation in the first step. It may become less threatening and hence less distressful. We could find that our coping resources will be less adequate than we initially thought and we would become more threatened now. Even a challenge might be converted into a threat as in traveling to a another country for the first time and finding your credit cards are missing and you have no money for anything and no way to get any.

This interactive appraisal and coping process is at the heart of the impact of stress on us. If we interpret a situation as stressful, it has the stress-related effects on us. If we have few coping sources, more situations will be perceived as distressing. If we have many coping resources, more situations will be perceived as challenging or at least neutral.

As I am driving down the road and have a flat tire, I could be annoyed at the trouble it causes or highly threatened by the memory of Bill Cosby's son's murder a few years ago as he changed his tire. If I don't know how to change a tire and it is night time, I may feel very threatened as I perceive helplessness and vulnerability to someone's attacking me. If I assure myself that this is unlikely, and I do know how to change a tire, I may decide that I will get this done in ten minutes and be on the road safely. But then I find that my spare tire is flat. Now I feel threatened for sure. But if I have a good spare, have a good flashlight, have a handgun and the skill to use it, and have changed many tires, I may only feel annoyed at the hassle and not feel threatened (many instrumental skills). I may have none of these things but have a cell phone and a close friend who will quickly be here to solve the problem for me (social support). My distress is much less then.

These factual situations are part of the appraisal and coping process. Perception is also critically important. If I have little confidence in myself to handle a flat tire even though I have been taught how to do it and have the tire, I may feel more threatened. If I have the cell phone but don't believe I should bother anybody to come here, or don't believe they would want to

help me, the facts do not determine my reaction as much as my perception of the facts determines it.

A second example of the role of coping skills and perception could involve getting started in this course. If you are a computer whiz and have taken several college courses including online courses before, you got started with little problem. Learning to use Etudes, to take online quizzes probably did not cause much distress. But if you were new to using the Internet, had never taken an online course, and had low self-confidence, you may have been quite distressed. Same situation, different coping resources. Some of our community colleges go to great effort to be sure new online students have the knowledge and coping skills to begin a course with little stress.

Now add pure perception. If you perceive college as a supportive environment that will find a way to assist you to get through as long as you put forth the effort, and perceive instructors as willing to be flexible when circumstances are beyond all of our control, like getting started on the three programs we use and getting books late, you may be hassled but not threatened about failing the course because of these factors. But if you see colleges and instructors as money-hungry and deliberately placing obstacles in your path to cause you to fail and drop out, you have been very distressed when you had these difficulties as you would see no support or flexibility to allow you to adapt to the new situation and have the time to catch up. You might even feel quite angry at this new ploy to get your tuition and frustrate you into quitting. The reality of the college and instructor's intent make no difference in your initial perception and resultant choices. It is your perception of reality that determines what you will do.

The appraisal and coping process underlies the statement that "stress is in the eye of the beholder." Any event of situation may be perceived differently by different individuals due to past experience with it, learned skills, personality traits like Type A and optimism, and the amount of distress being experienced already. Social support may be instrumental in helping cope with problem as in coming to help with the flat tire, or being eager to listen and be supportive with your sharing your experiences. Both reduce the distress levels.

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2.2.3.17: Managing Stress

Everyone has to deal with stress. There are steps you can take to help you handle stress in a positive way and keep it from making you sick. Try these tips to keep stress in check:

Develop a new attitude

- Become a problem solver. Make a list of the things that cause stress. From your list, figure out which problems you can solve now and which are beyond your control for the moment. From your list of problems that you can solve now, start with the little ones. Learn how to calmly look at a problem, think of possible solutions, and take action to solve the problem. Being able to solve small problems will give you confidence to tackle the big ones. And feeling confident that you can solve problems will go a long way to helping you feel less stressed.
- Be flexible. Sometimes, it's not worth the stress to argue. Give in once in a while or meet people halfway.
- Get organized. Think ahead about how you're going to spend your time. Write a to-do list. Figure out what's most important to do and do those things first.
- Set limits. When it comes to things like work and family, figure out what you can really do. There are only so many hours in the day. Set limits for yourself and others. Don't be afraid to say NO to requests for your time and energy.

Relax

- Take deep breaths. If you're feeling stressed, taking a few deep breaths makes you breathe slower and helps your muscles relax.
- Stretch. Stretching can also help relax your muscles and make you feel less tense. Massage tense muscles. Having someone massage the muscles in the back of your neck and upper back can help you feel less tense.
- Take time for yourself. We all have lots of things that we have to do. But often we don't take the time to do the things that we really want to do. It could be listening to music, reading a good book, or going to a movie. Think of this as an order from your doctor, so you won't feel guilty!

Take care of your body

- Get enough sleep. Getting enough sleep helps you recover from the stresses of the day. Also, being well-rested helps you think better so that you are prepared to handle problems as they come up. Most adults need 7 to 9 hours of sleep a night to feel rested.
- Eat right. Try to fuel up with fruits, vegetables, beans, and whole grains. Don't be fooled by the jolt you get from caffeine or high-sugar snack foods. Your energy will wear off, and you could wind up feeling more tired than you did before.
- Get moving. Getting physical activity can not only help relax your tense muscles but improve your mood. Research shows that physical activity can help relieve symptoms of depression and anxiety.
- Don't deal with stress in unhealthy ways. This includes drinking too much alcohol, using drugs, smoking, or overeating.

Connect with others

- Share your stress. Talking about your problems with friends or family members can sometimes help you feel better. They might also help you see your problems in a new way and suggest solutions that you hadn't thought of.
- Get help from a professional if you need it. If you feel that you can no longer cope, talk to your doctor. She or he may suggest counseling to help you learn better ways to deal with stress. Your doctor may also prescribe medicines, such as antidepressants or sleep aids.
- Help others. Volunteering in your community can help you make new friends and feel better about yourself.

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2.2.3.18: Coping with Stress

The effects of stress tend to build up over time. Taking practical steps to maintain your health and outlook can reduce or prevent these effects. The following are some tips that may help you to cope with stress:

- Seek help from a qualified mental health care provider if you are overwhelmed, feel you cannot cope, have suicidal thoughts, or are using drugs or alcohol to cope.
- Get proper health care for existing or new health problems.
- Stay in touch with people who can provide emotional and other support. Ask for help from friends, family, and community or religious organizations to reduce stress due to work burdens or family issues, such as caring for a loved one.
- Recognize signs of your body's response to stress, such as difficulty sleeping, increased alcohol and other substance use, being easily angered, feeling depressed, and having low energy.
- Set priorities-decide what must get done and what can wait, and learn to say no to new tasks if they are putting you into overload.
- Note what you have accomplished at the end of the day, not what you have been unable to do.
- Avoid dwelling on problems. If you can't do this on your own, seek help from a qualified mental health professional who can guide you.
- Schedule regular times for healthy and relaxing activities.
- Explore stress coping programs, which may incorporate meditation, yoga, tai chi, or other gentle exercises.
- Exercise regularly - just 30 minutes per day of gentle walking can help boost mood and reduce stress.

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2.2.3.19: Exercise and Stress

Exercise builds stronger bodies only if we push ourselves beyond our regular level of strength and endurance. Progressing in your intellectual skills occurs only by going beyond your adaptation level for the complexity and amount of knowledge you must acquire. Stress as "challenge" enhances physical and emotional well-being. Mountain climbers want risk and challenge, but they want the type that they feel they can master and mostly control. They don't want to be perfectly in control because then the challenge would not be so great. They want to be on the edge between in-control and having to use every degree of skill, concentration, and problem solving to succeed. The same is true of race car drivers, downhiill skiers, chess players, musicians, and artists.

These activities have been described by Csikszentmihalyi as inducing the experience of "flow" that totally captures the attention, makes it very easy to continue, and very hard to stop. There are many other activities and professions that produce "flow", but the essence of the experience is to be on the edge of challenge and failure with the perception that your own efforts will make the difference between good and bad outcomes. In these conditions stress builds healthier bodies and higher well-being. People who experience "flow" frequently report high degrees of satisfaction in life.

Physiological Toughness Model

There is also a psychophysiological framework for explaining how exercise cannot only reduce the immediate effects of stress but also can enhance the recovery from stressors. This framework is called the Physiological Toughness Model and it theorizes that intermittent but regular exposure to stressors, like exercise, can lead to psychological coping, emotional stability, and physiological changes. These physiological changes include increases in endorphins and reductions in stress hormones and lead to improvements in performance during challenging/threatening situations, strengthening of immune system functioning, and improvements in stress tolerance.

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2.2.3.20: Meditation and Health

Many people practice meditation for a number of health-related purposes. A 2007 national government survey found that 9.4% of respondents had used meditation in the past 12 months.

What is meditation?

The term meditation refers to a group of techniques which may be practiced for many reasons, such as to increase calmness and physical relaxation, to improve psychological balance, to cope with illness, or to enhance overall wellness. Most types of meditation have four elements in common:

- A quiet location. Meditation is usually practiced in a quiet place with as few distractions as possible. This can be particularly helpful for beginners.
- A specific, comfortable posture. Depending on the type being practiced, meditation can be done while sitting, lying down, standing, walking, or in other positions.
- A focus of attention. Focusing one's attention is usually a part of meditation. For example, the meditator may focus on a mantra (a specially chosen word or set of words), an object, or the sensations of the breath.
- Having an open attitude. During meditation this means letting distractions come and go naturally without judging them.

How can meditation affect my health?

It is not fully known what changes occur in the body during meditation; whether they influence health; and, if so, how. Research is under way to find out more about meditation's effects, how it works, and diseases and conditions for which it may be most helpful. The National Center for Complementary and Alternative Medicine (NCCAM) is the federal government's lead agency for scientific research on complementary and alternative medicine (CAM). Some recent NCCAM-supported studies have been investigating meditation for relieving stress in caregivers for elderly patients with dementia and for relieving asthma symptoms.

Is meditation right for me?

Meditation is considered to be safe for healthy people, but if you are thinking about using meditation practices to prevent asthma attacks, to control high blood pressure, to reduce arthritis pain, or for any other medical reason, be smart.

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2.2.3.21: Relaxation Techniques

Relaxation techniques include a number of practices such as progressive relaxation, guided imagery, biofeedback, self-hypnosis, and deep breathing exercises. The goal is similar in all: to consciously produce the body's natural relaxation response, characterized by slower breathing, lower blood pressure, and a feeling of calm and well-being.

Relaxation techniques (also called relaxation response techniques) may be used by some to release tension and to counteract the ill effects of stress. Relaxation techniques are also used to induce sleep, reduce pain, and calm emotions. This fact sheet provides a general overview of relaxation techniques and suggests sources for additional information.

Key Points

- Relaxation techniques are used for a variety of health-related purposes, such as counteracting the effects of stress on the body.
- Most relaxation techniques can be self-taught and self-administered.
- Relaxation techniques are generally safe, but there is limited evidence of usefulness for specific health conditions. Research is under way to find out more about relaxation and health outcomes.
- Do not use relaxation techniques as a replacement for conventional care or to postpone seeing a doctor about a medical problem.
- Tell your health care providers about any complementary and alternative practices you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

About Relaxation Techniques

Relaxation is more than a state of mind; it physically changes the way your body functions. When your body is relaxed breathing slows, blood pressure and oxygen consumption decrease, and some people report an increased sense of well-being. This is called the "relaxation response." Being able to produce the relaxation response using relaxation techniques may counteract the effects of long-term stress, which may contribute to or worsen a range of health problems including depression, digestive disorders, headaches, high blood pressure, and insomnia.

Relaxation techniques often combine breathing and focused attention on pleasing thoughts and images to calm the mind and the body. Most methods require only brief instruction from a book or experienced practitioner before they can be done without assistance. These techniques may be most effective when practiced regularly and combined with good nutrition, regular exercise, and a strong social support system.

Some relaxation response techniques include:

- **Autogenic training**: When using this method, you focus on the physical sensation of your own breathing or heartbeat and picture your body as warm, heavy, and/or relaxed.
- **Biofeedback**: Biofeedback-assisted relaxation uses electronic devices to teach you how to consciously produce the relaxation response. Biofeedback is sometimes used to relieve conditions that are caused or worsened by stress.
- **Deep breathing or breathing exercises:** To relax using this method, you consciously slow your breathing and focus on taking regular and deep breaths.
- **Guided imagery:** For this technique, you focus on pleasant images to replace negative or stressful feelings and relax. Guided imagery may be directed by you or a practitioner through storytelling or descriptions designed to suggest mental images (also called visualization).
- **Progressive relaxation:** (also called Jacobson's progressive relaxation or progressive muscle relaxation). For this relaxation method, you focus on tightening and relaxing each muscle group. Progressive relaxation is often combined with guided imagery and breathing exercises.
- **Self-Hypnosis:** In self-hypnosis you produce the relaxation response with a phrase or nonverbal cue (called a "suggestion"). Self-hypnosis may be used to relieve pain (tension headaches, labor, or minor surgery) as well as to treat anxiety and irritable bowel syndrome.

Use of Relaxation Techniques for Health in the United States

People may use relaxation techniques as part of a comprehensive plan to treat, prevent, or reduce symptoms of a variety

of conditions including stress, high blood pressure, chronic pain, insomnia, depression, labor pain, headache, cardiovascular disease, anxiety, chemotherapy side effects, and others. According to the 2007 National Health Interview Survey, which included a comprehensive survey of complementary and alternative medicine (CAM) use by Americans, 12.7 percent of American adults use deep-breathing exercises, 2.9 percent used progressive relaxation, and 2.2 percent used guided imagery for health purposes. Most of those people reported using a book to learn the techniques rather than seeing a practitioner.

To understand how consciously producing the relaxation response may affect your health, it is helpful to understand how your body responds to the opposite of relaxation—stress. When you're under stress, your body releases hormones that produce the "fight-or-flight response:" Heart rate and breathing rate go up and blood vessels narrow (restricting the flow of blood). This response allows energy to flow to parts of your body that need to take action, for example the muscles and the heart. However useful this response may be in the short term, there is evidence that when your body remains in a stress state for a long time, emotional or physical damage can occur. Long-term or chronic stress (lasting months or years) may reduce your body's ability to fight off illness and lead to or worsen certain health conditions. Chronic stress may lead to high blood pressure, headaches, stomach ache, and other symptoms. Stress may worsen certain conditions, such as asthma. Stress also has been linked to depression, anxiety, and other mental illnesses.

In contrast to the stress response, the relaxation response slows the heart rate, lowers blood pressure, and decreases oxygen consumption and levels of stress hormones. Because relaxation is the opposite of stress, the theory is that voluntarily creating the relaxation response through regular use of relaxation techniques could counteract the negative effects of stress.

Status of Research on Relaxation Techniques

In the past 30 years, there has been considerable interest in the relaxation response and how inducing this state may benefit health. Research has focused primarily on illness and conditions in which stress may play a role either as the cause of the condition or as a factor that can make the condition worse. Currently, there is some evidence that relaxation techniques may be an effective part of an overall treatment plan for some disorders, including:

- **Anxiety**: Studies have suggested that relaxation may assist in the treatment of phobias or panic disorder. Relaxation techniques have also been used to relieve anxiety for people in stressful situations, such as when undergoing a medical procedure.
- **Depression**: In 2008, a major review of the evidence for relaxation in the treatment of depression found that relaxation techniques were more effective than no treatment for depression, but not as effective as cognitive-behavioral therapy.
- **Headache**: There is some evidence that biofeedback and other relaxation techniques may be helpful for relieving tension or migraine headaches. In some cases, these mind and body techniques were more effective than medications for reducing the frequency, intensity, and severity of headaches.
- **Pain:** Some studies have shown that relaxation techniques may help reduce abdominal and surgery pain.

The results of research on relaxation to promote overall health or well-being or to treat other health conditions have been mixed or unclear. These conditions include:

- **High blood pressure:** A 2008 review of evidence for relaxation in the treatment of high blood pressure found some evidence that progressive muscle relaxation lowered blood pressure a small amount. However, the review found no evidence that this effect was enough to reduce the risk of heart disease, stroke, or other health issues due to high blood pressure. In a recent randomized controlled trial, 8 weeks of relaxation response/stress management was shown to reduce systolic blood pressure in hypertensive older adults, and some patients were able to reduce hypertension medication without an increase in blood pressure.
- **Asthma**: Several reviews of the literature have suggested that relaxation techniques, including guided imagery, may temporarily help improve lung function and quality of life and relieve anxiety in people with asthma. A more recent randomized clinical trial of asthma found that relaxation techniques may help improve immune function. More studies are needed to confirm this finding.
- **Nausea**: Relaxation techniques may help relieve nausea caused by chemotherapy. Fibromyalgia. Although some preliminary studies report that using relaxation or guided imagery techniques may sometimes improve pain and reduce fatigue from fibromyalgia, more research is needed. Irritable bowel syndrome. Some studies have indicated that relaxation techniques may prevent or relieve symptoms of irritable bowel syndrome (IBS) in some participants. One review of the research found some evidence that selfhypnosis may be useful in the treatment of IBS.
- **Heart disease and heart symptoms:** Researchers have looked at relaxation techniques for the treatment of angina and the prevention of heart disease. When a cardiac rehabilitation program was combined with relaxation response training in a clinic, participants experienced significant reductions in blood pressure, decreases in lipid levels, and increases in psychological functioning when compared to participants' status before the program. Although studies have shown that

relaxation techniques combined with other lifestyle changes and standard medical care may reduce the risk of recurrent heart attack, more study is needed.
- **Insomnia**: There is some evidence that relaxation techniques can help in treating chronic insomnia.

Researchers have found some evidence on the effectiveness of relaxation techniques for:

- **Temporomandibular disorder:** (pain and loss of motion in the jaw joints). A review of the literature found that relaxation techniques and biofeedback were more effective than placebo in decreasing pain and increasing jaw function.
- **Ringing in the ears:** Use of relaxation exercises may help patients cope with the condition.
- **Smoking cessation:** Relaxation exercises may help reduce the desire to smoke.
- **Overactive bladder**: Bladder re-training combined with relaxation and other exercises may help control urinary urgency.
- **Nightmare:** Relaxation exercises may be effective in treating nightmares of unknown cause and those associated with posttraumatic stress disorder.
- **Hot flashes:** Relaxation exercises involving slow, controlled deep breathing may help relieve hot flashes associated with menopause.

Researchers have found no significant change in outcomes from relaxation techniques used during cardiac catheterization. However, patients experienced less distress prior to the procedure. Future research may investigate whether this has any long-term effect on outlook and recovery. Many of the studies of relaxation therapy and health have followed a small number of patients for weeks or months. Longer studies involving more participants may reveal more about the cumulative effects of using relaxation techniques regularly.

Side Effects and Risks

Relaxation techniques are generally considered safe for healthy people. There have been rare reports that certain relaxation techniques might cause or worsen symptoms in people with epilepsy or certain psychiatric conditions, or with a history of abuse or trauma. People with heart disease should talk to their doctor before doing progressive muscle relaxation. Relaxation techniques are often used as part of a treatment plan and not as the sole treatment for potentially serious health conditions.

If You Are Thinking About Using Relaxation Techniques for Health

- Do not use relaxation techniques as a replacement for conventional care or to postpone seeing a doctor about a medical problem.
- Ask about the training and experience of the practitioner or instructor you are considering for any complementary alternative medicine practice.
- Look for published research studies on relaxation for the health condition in which you are interested. Remember that some claims for using relaxation therapies may exceed the available scientific evidence.
- Tell all your health care providers about any complementary and alternative practices you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

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2.2.3.22: Resilience

Resilience is the ability to:

- Bounce back
- Take on difficult challenges and still find meaning in life
- Respond positively to difficult situations
- Rise above adversity
- Cope when things look bleak
- Tap into hope
- Transform unfavorable situations into wisdom, insight, and compassion
- Endure

Resilience refers to the ability of an individual, family, organization, or community to cope with adversity and adapt to challenges or change. It is an ongoing process that requires time and effort and engages people in taking a number of steps to enhance their response to adverse circumstances. Resilience implies that after an event, a person or community may not only be able to cope and recover, but also change to reflect different priorities arising from the experience and prepare for the next stressful situation.

Resilience is the most important defense people have against stress. It is important to build and foster resilience to be ready for future challenges. Resilience will enable the development of a reservoir of internal resources to draw upon during stressful situations.

Research (Aguirre, 2007; American Psychological Association, 2006; Bonanno, 2004) has shown that resilience is ordinary, not extraordinary, and that people regularly demonstrate being resilient.

Resilience is not a trait that people either have or do not have. Resilience involves behaviors, thoughts, and actions that can be learned and developed in anyone. Resilience is tremendously influenced by a person's environment.

Resilience changes over time. It fluctuates depending on how much a person nurtures internal resources or coping strategies. Some people are more resilient in work life, while others exhibit more resilience in their personal relationships. People can build resilience and promote the foundations of resilience in any aspect of life they choose.

Building Resilience

Developing resilience is a personal journey. People do not react the same way to traumatic events. Some ways to build resilience include the following actions:

- Making connections with others
- Looking for opportunities for self-discovery
- Nurturing a positive view of self
- Accepting that change is a part of living
- Taking decisive actions
- Learning from the past

The ability to be flexible is a great skill to obtain and facilitates resilience growth. Getting help when it is needed is crucial to building resilience. An approach to building resilience that works for one person might not work for another. People use varying strategies. Resilience involves maintaining flexibility and balance in life during stressful circumstances and traumatic events. Being resilient does not mean that a person does not experience difficulty or distress. Emotional pain and sadness are common in people who have suffered major adversity or trauma in their lives. Stress can be dealt with proactively by building resilience to prepare for stressful circumstances, while learning how to recognize symptoms of stress. Fostering resilience or the ability to bounce back from a stressful situation is a proactive mechanism to managing stress.

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2.2.4: RELATIONSHIPS AND COMMUNICATION

Love and intimacy go hand in hand. Love is the physical, emotional, sexual, intellectual, or social affection one person holds for another. Concepts related to love include: adoration, desire, prefer, possess, care for, serve, and even worship. Intimacy, on the other hand, is a close relationship where mutual acceptance, nurturance, and trust are shared at some level. In order to understand love in human relationships, you must first understand how the socialized self either enhances or inhibits your capacity to love.

2.2.4.1: Intro to Relationships and Communication

2.2.4.2: Theories of Love

2.2.4.3: Theories of Mate Selection

2.2.4.4: Marriage

2.2.4.5: Cohabitation

2.2.4.6: Marrieds and Non-Marrieds

2.2.4.7: Violence in Relationships

2.2.4.8: Sexual Violence

2.2.4.9: Intimate Partner Violence

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2.2.4.1: Intro to Relationships and Communication

Love and intimacy go hand in hand. Love is the physical, emotional, sexual, intellectual, or social affection one person holds for another. Concepts related to love include: adoration, desire, prefer, possess, care for, serve, and even worship. Intimacy, on the other hand, is a close relationship where mutual acceptance, nurturance, and trust are shared at some level. In order to understand love in human relationships, you must first understand how the socialized self either enhances or inhibits your capacity to love.

Your socialized self develops under the supervision of your caregiver or parent(s). When you were a newborn, you were totally dependent upon the adults in your life to take care of your needs and raise you in a safe environment. You had to be fed and clothed, bathed and held, and loved and appreciated. Your caregivers provided these basic needs in your early development, and during this time, attachments were formed. An attachment is an emotional and social bond that forms between one person and another. Humans are considered highly motivated to form attachments throughout their lives.

Attachments are crucial to human existence and are essentially the emotional context of those relationships we form in life. As an infant you learned to trust those who cared for you; you learned that they returned once they were out of view and were dependable. Eventually, as your cognitive development matures, your brain allows you to love the person you are attached to and to care for them—whether or not they are caring for you. You learn then that your attachments begin to facilitate your needs and wants being met. How you attached as an infant and young child shape (at least in theory) how you will likely attach as an adult. For example, if you had strong attachments in childhood, then forming adult relationships should be easier for you; if you had weak or interrupted attachments in childhood, then forming adult relationships would be more difficult.

As adults, one of the very first symptoms that you are falling in love is that you begin to feel better about yourself when you are with the other person. It can be argued that you can only be in love as much as your self will allow you to be. Why? Because intimacy develops along with love, and intimacy requires that you have the ability to be your true self with the other person.

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2.2.4.2: Theories of Love

Love is a multidimensional concept and psychologists and sociologists have defined it in a variety of ways over the years. John Lee is perhaps the most quoted researcher on love with his six love types. Lee assumed that we all shared six core components of love and that our current loving relationship can be assessed and measured. Lee also claimed that there are qualities of love types—some more long-lasting and supportive of relationships and some pathological and defective which inhibit relationships. Lee's love types are widely used to help people understand their love styles. Lee claimed that six types of love comprised our loving experiences.

Eros

Eros is the love of sensuality: sex, taste, touch, sight, hearing, and smell. Eros love is often what we feel when turned on. Eros love is neither good nor bad; it is simply part of the overall love composite we experience with another person.

Storgé

Storgé is the love of your best friend in a normal casual context of life. Storgé is calm and peaceful, surprising to some who might have simply hung out together at one point but suddenly discovered that their friendship deepened and became more important than other friendships. "We started needing to be together, talking on the phone for hours, and missing each other when apart," are common descriptions of Storgé love.

Pragma

Pragma is the love of details and qualities in the other person. Pragma lovers are satisfied and attracted by the other because of their characteristics (e.g., athleticism, intelligence, wealth). Pragma lovers feel love at a rational level—thinking to a certain degree about the good deal.

Agapé

Agapé is the love that is selfless, other-focused, and seeks to serve others rather than receive from others. In Christian theology it's the love of God for mankind.

Ludis

Ludis is an immature love that is more of a tease than a legitimate loving relationship. Ludic lovers trick their mates into believing that they are sincerely in love, while grooming 1, 2, or even 3 other lovers at the same time. Ludic lovers typically artificially stroke their sense of self-worth by playing a cruel game on their lovers who end up feeling used and betrayed.

Mania

Mania is an insecure love that is a mixture of conflict and artificially romantic Eros expressions. Manic lovers fear abandonment and are simultaneously terrified by the vulnerabilities they feel when intimate with their lover. Thus, their daily routines typically involve extreme highs and lows including arguing, making love, sweet-talking, and fighting with their lovers.

Abraham Maslow, addressed love in terms of how our needs are met by the other person. His basic premise is that we pair-off with those whose love styles fill an unmet childhood need. In other words, Maslow said that if our childhood needs were not met in the basics of survival, safety, food, shelter, love, belonging, and even self-esteem, then we look for an adult companion that can fill those needs for us. It's like an empty cup from our childhood that our adult partner fills for us. Maslow also said that when all those basic needs are met in childhood, we are attracted to an adult partner who compliments our full development into our psychological potential.2 If in your childhood, your survival, safety, food, shelter, love, belonging, and even self-esteem needs were unmet then you will be attracted to a deficiency lover. Deficiency lovers are lovers who provide the basic level of needs for their partner while having their needs reciprocally met in a similar way. Being lovers meet their partner's aesthetic, intellectual, and physical needs while reciprocally having their needs met.

Sternberg's Triangular Theory of Love

Robert Sternberg was the "Geometry of Love" psychologist who triangulated love using intimacy, passion, and commitment by measuring the intensity of each and how intense the triangulation was for the couple. To Sternberg it was important to consider how each partner's triangle matched the other partner's. He said that a couple with all three types of love balanced, and in sufficient magnitude, would have a rare yet rewarding type of love that encompassed much of what couples seek in a loving relationship. Sternberg's consummate love is a love type that had equal measures of passion, intimacy, and commitment that is satisfactory to both lovers.

In modern day applications of love, various components have been found as the ingredients of love: commitment, passion, friendship, trust, loyalty, affections, intimacy, acceptance, caring, concern, care, selflessness, infatuation, and romance. There is a love type identified that many people are aware of called unconditional love. Unconditional love is the sincere love that does not vary regardless of the actions of the person who is loved. You often hear it expressed in greater measure among parents of children whose misbehaviors embarrass or disappoint them. The love types and patterns discussed below are taken from many sources, but fit neatly into the Lee, Maslow, Sternberg, or Chapman paradigms.

Romance

Romantic love is based on continual courtship and physical intimacy. Romantic lovers continue to date long after they marry or move in together. They often express the strong sexual attraction to each other that was there from the beginning. Romantic lovers are idealistic about their relationship and often feel that it was destined to be. They often define mundane activities such as grocery shopping or commuting to work as escapades of two lovers.

Infatuation

What happens when very young people feel love for the first time? What is puppy love or infatuation? Infatuation is a temporary state of love where the other person is overly idolized and seen in narrow and extremely positive terms. An infatuated person might think obsessively about the other, may feel a strong emotional response when they are together, may see their entire world as revolving around the other, may see them being together for the rest of their lives, may find one or two qualities of the other as being near perfect, or may be seen by others as having a crush on the other person. Regardless of the details infatuations rarely last very long. This love develops quickly much like a firework launches quickly into the night sky, puts on an emotional light show, then burns out quickly. Many define puppy love or infatuation as an immature love experienced by those who are younger and perhaps a bit credulous.

Commitment

Committed love is a love that is loyal and devoted. Two lovers may share committed love with or without: physical affection, romance, friendship, trust, loyalty, acceptance, caring, concern, care, selflessness, and or infatuation. Committed lovers have a long-term history with one another and typically combine care-giving, concern for one another's well-being, and spending much time thinking of the other. Committed lovers are there when needed by the other person.

Altruism

Altruism is a selfless type of love that serves others while not serving the one who is altruistic. True altruism is hard to find according to some. Mothers who tend their sick child throughout the night; fathers who work 3-4 decades in a job they don't love to provide for their family; and even fire fighters who sacrifice their safety to save the lives of others are all considered to be altruistic in their actions. Because so much of what we do in our relationships is considered in the larger overall equation of the fairness in a relationship, selfless acts can be seen as acts which either build a reservoir of goodwill which will later be repaid or creating a debt of sorts in which the other person owes you some selfless service in return.

Passion

Sexual or passionate lovers are focused on the intensely sensual pleasures that are found with the senses of taste, smell, touch, feel, hear, and sight. Sexual lovers lust one another and feel closest when together and being physical. Sexual lovers can be together for five minutes, five days, five weeks, or five years, but sexual love, by itself is typically short- lived. There is closeness during sex and activities leading up to sex, but not much thereafter. Sexual love when combined with other love types can be very beneficial to the couple. Sexual love is almost always the love type experienced by those having an extra- marital affair.

Friendship

Friendship love includes intimacy and trust among close friends. Today, most long-burning or enduring love types form among people who were first close friends. Friendship lovers tend to enjoy each other's company, conversation, and daily interactions. They consider one another to be "go-to" friends when advice is needed or when problems need to be talked about together. Not all friendship lovers become a couple. Many are just close or best friends. Yet many who spend the rest of their lives together will start out their relationship as friends.

Realistic Love

Criteria or realistic love is the love feelings you have when your list of a potential mate's personal traits is met in the other person. For example, women often desire their male love companions to be taller. Men and women often desire to find a partner with homogamous traits (e.g., same religion, political leanings, hobbies, etc.).

Obsession

Obsessive love is an unhealthy love type where conflict and dramatic extremes in the relationship are both the goal and the theme of the couple's love. Obsessive lovers live for storms and find peace while they rage. They are often violent or overly aggressive at different levels. Sometimes couples bring complimentary traits to the relationship which light the other's fire of madness. In other words, she may be angry and violent with him, but not with some other males. He may feel simultaneously drawn to her and repulsed, but not with other females. Their personality-chemistry contributes to the insanity and lack of peace. These couples most likely need professional counseling and would probably be better off if they broke up. At the same time, why would they seek help or leave the person whose entanglements bring them such an occupation with drama and conflict that they are freed from their boredom and entertained at the same time?

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2.2.4.3: Theories of Mate Selection

The Social Exchange Theory and its rational choice formula clarify the selection process even further. We strive to maximize rewards and minimize costs in our choices of a mate.

Rewards – Costs = Choice

When we interact with potential dates and mates, we run a mental balance sheet in our heads. She might think, “He’s tall, confident, funny, and friends with my friends.” As she talks a bit more she might say, “But, he chews tobacco, only wants to party, and just flirted with another woman while we were talking.” The entire time we interact with potential dates and mates we evaluate them on their appearance, disposition, goals and aspirations, and other traits. This while simultaneously remembering how we rate and evaluate ourselves. Rarely do we seek out the best looking person at the party unless we define ourselves as an even match for him or her. More often we rank and rate ourselves compared to others and as we size up and evaluate potentials we define the overall exchange rationally or in an economic context where we try to maximize our rewards while minimizing our losses.

The overall evaluation of the deal also depends to a great extent on how well we feel matched on racial and ethnic traits, religious background, social economic class, and age similarities. The complexity of the date and mate selection process includes many obvious and some more subtle processes that you can understand for yourself. If you are single you can apply them to the date and mate selection processes you currently pursue.

How do strangers transition from not even knowing one another to eventually cohabiting or marrying together? From the very first encounter, two strangers begin a process that either excludes one another as potential dates or mates or includes them and begins the process of establishing intimacy. Intimacy is the mutual feeling of acceptance, trust, and connection to another person, even with the understanding of personal faults of the individual. In other words, intimacy is the ability to become close to one another, to accept one another as is, and eventually to feel accepted by the other. Intimacy is not sexual intercourse, although sexual intercourse may be one of many expressions of intimacy. When two strangers meet they have a stimulus that alerts one or both to take notice of the other.

Effective Communication

Effective communication is critical to successful relationships. Researchers and therapists have found at least nine skills that can help couples learn to talk effectively about important issues (Gottman 1994; Markman, Stanley, and Blumberg 2010; Schramm and Harris 2011). How we interact about issues such as time spent together/apart, money, health, gender differences, children, family, friends, commitment, trust, and intimacy affects our ability to develop and maintain lasting marital friendships. If learned well, these nine skills can help put our relationships on a positive trajectory for success. (Note: The word "marriage" is interchangeable with "relationship," if you are not married.)

What Do Couples Talk About?

- Time Together/Apart. Both the quantity and quality of time we spend together influence the wellbeing of our marital friendships. Spending time apart participating in other activities also influences the well-being of our relationships.
- Money. How we think and talk about money, our spending habits, and our ability to budget, invest, and plan for the future impact couple financial management processes and practices.
- Health. Couples must talk about many health-related issues, including nutrition, exercise, illness, disease, accidents, health care, mortality, and death.
- Men/Women. Because men tend to be more task-oriented in their communication styles and women tend to be more process-oriented, men tend to want to solve issues immediately, while women tend to want to talk about them more and come to a consensus about what should be done.
- Children. How children develop physically, socially, emotionally, intellectually, and spiritually are often topics of discussion. Focusing on the best ways to consistently meet children's needs is considered being child-centered.
- Family/In-Laws/Friends. Couples often talk about situations and circumstances surrounding the interactions they have with their closest relationships.

What do couples communicate when they are communicating?

- Commitment. How we "hang in there" and contribute to our marital friendship, even when things aren't going particularly well, is a sign of how committed we are to our relationship. Loyalty and fidelity are aspects of commitment and trust.
- Trust. Trusting relationships are relationships in which both partners are dependable, available to support each other, and responsive to each other's needs. An ability to negotiate conflict and a positive outlook about the future of the relationship are also components of trust.
- Intimacy. The social, intellectual, emotional, spiritual, and physical connections we make with each other determine the levels of intimacy we experience in our relationships.

What do couples argue about?

Because the items listed above are some of the major topics couples talk about, it follows that they are also the same topics that can spur disagreements. For instance, it is a familiar joke that people can have difficulties in their relationships with in-laws. Take for example, “What is the difference between in-laws and outlaws? Answer: One is 'Wanted!'” Sayings such as these underscore the importance of knowing how your relationships with others can affect your marriage and could potentially become the topic of a marital conflict.

Learning and Practicing New Habits

Effective communication isn't easy. Teaching and learning new communication skills take patience, patience, patience, as well as practice, practice, practice. Taking the time to talk is important. Your relationship provides a safe place to share feelings, thoughts, fears, dreams, and hopes. Make a special effort to find time to talk to your partner more frequently. In tough times, people feel overwhelmed with worries and responsibilities.

Time together as a couple is often the last thing on our minds as we deal with the hassles of daily life. Although you may be busy, stressed, and worried, take the time to focus on your partners' needs and spend quality time together without interruption. Even a few minutes a day talking about what has occurred can be a relief from stress. Be thoughtful by considering whether those difficult or problem-solving discussions could be reserved for other times when you and your partner are not tired or distracted.

You may need to be the one who starts conversations. It is worth it to be the one who initiates conversations. You can find many ways to open the door for communication if you are sensitive to changes in your partner's feelings and needs. Taking the time to listen keeps the lines of communication open and improves your relationship.

Finding Time to Talk

- Spend time talking with limited interruptions.
- Make a date to talk to your partner.
- Plan at least one routine family time each week.
- Talk instead of watching TV.
- Talk when you take a walk together.
- Talk while you work together on household chores.
- Talk in the car while traveling to activities.

Summing It Up

In good times and bad, couples need each other. Good communication does not mean that your family won't have any problems, or that your partner will always like what you have to say. Good communication means the chances of solving problems are much higher if you and your partner can express yourselves openly and freely with each other.

For couples today, there is an abundance of information on how to sustain healthy, happy marital relationships. From how-to books to advice given on television and radio, couples are bombarded with strategies, tips, and techniques focused on “what to do” in their relationships. Most of this information assumes that if couples follow a few short rules, then they can have happy relationships. What most fail to realize is that these new, positive practices won't work without recognizing and addressing what has been done and what is not working. Most information available to couples falls short on giving examples of “what not to do” in a relationship. Communication is the key, but it is difficult to apply effective strategies to harmful interactions.

Four negative patterns of interaction have been demonstrated as major destroyers of marital relationships:

- Criticism
- Contempt
- Defensiveness
- Stonewalling

Criticism

Criticism is using hurtful or judgmental comments aimed at your partner's character or personality. With criticism, the blame is placed on the person and not the problematic behavior. Criticism tends to be a repetitive cycle—a single critical moment can end up in a continued exchange. Most critical statements can be recognized by the phrases, “you always” or “you never.” The following are some examples of criticism:

- You never finish any project that you start. You're so lazy.
- When we go out to eat, you always embarrass me with your table manners.

Contempt

Contempt is a more complex negative interaction. It is an effort to psychologically abuse your partner through disrespectful statements and actions. Contempt has both verbal and non-verbal deliveries. Verbal examples of contempt include sarcasm, hostile humor, and mockery. For example, nonverbal displays of contempt include rolling of the eyes and sucking of the teeth during conflict. Contempt sends your partner a message of scorn—that they are inferior and worthless.

Defensiveness

Defensiveness is often a natural response to receiving criticism and contempt. When faced with criticism and contempt, most people find a need to defend themselves. However, couples can be defensive even when criticism is constructive. Defensiveness may be a response to previous, current, and/or future attacks. If one or both persons are acting defensively, it is most likely the case they are not listening. Defensiveness may take many forms including:

- Making excuses for behavior
- Repeating a statement for effect
- Denying responsibility for actions
- Answering a complaint with another complaint

Stonewalling

The final negative pattern of interaction is stonewalling. As the name implies, this occurs when partners “put a wall” around themselves, either physically or psychologically. Stonewalling is often used to decrease conflict, and when delivered in moderation, can be healthy. On the other hand, continual failure to respond and/or engage in conversation escalates rather than reduces conflict. Examples of stonewalling include:

- Leaving the room
- Putting a physical barrier between you and your partner (newspaper, book, child)
- Focusing intently on something other than your partner during a discussion
- Failure to actively listen
- Responding with a blank stare

What can be done?

All of the above can become patterns of interaction within a relationship. One negative interaction leads to another, often in a repetitive cycle. The following suggestions can be used to break the cycle and promote a healthy relationship:

1. Eliminate criticism. Use complaints. It is okay to complain about troublesome behaviors. Discussing your feelings about the behavior is okay as long as there are no personal attacks. Use the word I instead of you and describe how the behavior makes you feel. Talk about the behavior and not the person.
    - Example: “When we go out to eat, you always embarrass me,” becomes “I feel hurt and ashamed when you make fun of me in public.
2. Build on your friendship base. Validate your partner and his/her feelings, thoughts, needs, and desires, etc.
    - Example: "I recognize that you need to talk more about our relationship. What is on your mind?”
3. Take accountability and responsibility for your own actions. Do not make excuses. Apologize and correct the behavior (if

possible).
    - Example: “I'm sorry that I yelled at you earlier. I've been under a lot of pressure at work, but it is unfair to take it out on you.”
4. Use reflective listening. Repeat what your partner has stated and then respond. Show them that you are listening and hearing them.
    - Example: Partner 1: "I would appreciate it if you would talk to me before you discipline the kids. That way we can be a united front." Partner 2: "What I'm hearing is that you would like for us to talk about disciplining the kids before I make any decisions. I think that is a good idea.
5. Continue dating. Make a point to rekindle the dating aspect of your relationship.
    - Example: Go for walks, hold hands, act silly, etc. Find ways to show appreciation to your partner throughout the day (i.e., e-mails, notes, phone calls, etc.)
6. Seek help if needed. If you can identify these negative interactions in your relationship or you think you may need help, see a licensed marriage and family therapist or other professional. Do not try and fix everything on your own.
    - Example: Talk to a trusted family member, friend, or your local extension agent in order to find resources in your area.

Before a couple can learn and/or practice new routines in their relationship, they must rid themselves of the old ways that aren't working. It is important to first identify negative patterns and destructive behaviors and target them for change. At that point, the couple can begin rebuilding their relationship.

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2.2.4.4: Marriage

Marriage is very popular among U.S. adults, in part because it does offer many rewards that unmarried people don't enjoy. Marriage has become socially controversial in part because of the intense political efforts to legalize marriage for same-sex couples. Regardless of your moral position on the issue of same-sex marriage, you can see the political quest for it as an indicator of just how rewarding it is to be legally a “married couple.”

There are numerous studies and books on the benefits of marriage to married individuals. Below are the Top Ten Benefits of Being Married in Contrast to Being Single:

1. Better physical and emotional health
2. More wealth and income
3. Positive social status
4. More and safer sex
5. Life-long continuity of intimate relationships
6. Safer circumstances for children
7. Longer life expectancy
8. Lower odds of being crime victims
9. Enhanced legal and insurance rights and benefits (tax, medical, and inheritance)
10. Higher self-reported happiness

Marriage is a legal union between a man and a woman as recognized by most of the United States. Internationally, and in certain U.S. political regions, a man and another man or a woman and another woman can be legally recognized as a married couple. What are typical marriage structures? The U.S. and world-wide culturally preferred marriage type today is monogamy. Monogamy is the marriage form permitting only one spouse at a time. Almost all who have married in the U.S. have done so monogamously since the original colonies in the 1600s. Monogamy implies a 1:1 relationship and is typically desired both by married couples and by opposite and same-sex cohabiters.

Polygyny is a form of marriage permitting more than one wife at the same time. Polygyny is still common and legal in many African, Middle Eastern, Muslim, and Indian nations. It was a deep part of China's history and prior to World War II it was common for a Chinese man to have multiple wives and many children.

Polyandry is a marriage form permitting more than one husband at the same time. This is historically and currently rare, and, if or when it was practiced, it often includes the marriage of one wife to a set of brothers with all husbands having sexual access to the wife. Polyandry was found among some Pacific Island cultures and among the pre-Taliban Afghanis.

What if a person marries, divorces, marries, divorces, etc.? Serial Monogamy or Serial Polygamy is the process of establishing intimate marriage or cohabiting relationships that eventually dissolve and are followed by another intimate marriage or cohabiting relationship that eventually dissolve, etc. in a series. Thus polygamists have simultaneous multiple spouses while serial monogamists or serial polygamists have multiple spouses in a sequence of relationships. Millions of U.S. adults will experience serial marriages and divorces. Many marry then divorce, yet still want to be married again. Many others who suffered through their parents’ unhealthy marriages and divorces also want to marry, knowing firsthand how risky that might be.

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2.2.4.5: Cohabitation

Cohabitation is the heterosexual, bisexual, and homosexual moving in together of two partners without going through the formalities of legal marriage. Although similar in form and function, cohabitating couples live differently in many significant day-to-day aspects when compared to married couples. Also, many cohabiting couples eventually choose to marry, but their risk of divorce is higher than among couples that never cohabited.

Cohabitation has been studied extensively for the last three decades, especially in contrast between cohabiting and married couples. Clear findings consistently show that cohabiting and marriage are two different creatures. Those who cohabit have less clarity on the intention and direction of the relationship than married couples. Further, people who cohabit, then later marry, are more likely to divorce than those who never cohabited. In 2010 the U.S. Center for Disease Control reported that cohabitation is very common “Among both men and women aged 15-44 who had ever cohabited and or married, the largest proportion cohabited before their first marriage. Approximately 28% of men and women cohabited before their first marriage, whereas 23% of women and 18% of men married without ever cohabiting. About 15% of men and women had only cohabited (without ever marrying), and less than seven percent of men and women first cohabited after their first marriages ended.” This report also stated that some of the cohabitation relationships dissolved while others transitioned to marriage. Less educated cohabiters cohabited longer while college- graduated cohabiters transitioned to marriage more.

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2.2.4.6: Marrieds and Non-Marrieds

There are known benefits to being married and in a long-term relationship rather than being single, divorced, or cohabiting. The list below shows health benefits from the cohabitation and marriage study of the National Survey of Family Growth. Better mental and physical health with better medical insurance coverage prove to be crucial qualities for marrieds. As far as children are concerned, having better care and better adult outcomes are crucial factors.

Health Benefits Known to be an Advantage among Married Persons in the U.S.

1. Generally better mental and physical health outcomes
2. Longer lives
3. Higher rates of health insurance coverage
4. Lower prevalence of cardiovascular disease
5. Better health and well-being of children
6. Children born to unmarried mothers are at greater risk for poverty, teen childbearing, poor school achievement, and marital disruption in adulthood than children born to married mothers

There are also known financial benefits when comparing marrieds to non-marrieds. More wealth accumulation, higher assets, and higher monthly income are consistent among marrieds. The first thing you notice is that marrieds have consistently higher annual incomes. In 2007 specifically, marrieds had $28,231 more income than single men and $42,293 more than single women. The difference is even more pronounced if both incomes are taken into consideration for dual income marrieds (i.e., in 2007 dual income couples had $86,435 which is $42,077 higher than single men and $56,139 more than single women).

Married people are also safer and less prone to get into trouble than others. There is a buffering effect that accompanies having a life-long devoted spouse who helps deflect stress and hardships on a daily basis. Thus some of the health benefits of longer life, less suicide, more stable health coverage, and less illness and addiction. Also, marrieds have more social support, more continuity in long-term relationships, and especially more closeness for men in intimate family relationships. Husbands are less likely to abuse and be violent toward their wives than are boyfriends and partners. Married people have clear life-long goals and tend to buy homes, invest, and plan for retirement more than others. The government and military recognize spouses and reward them with tax breaks, benefits, and other sources of coverage and support more than others. In later life, many elderly report that their family relationships are very supportive and important to them. Studies show that the elderly enjoy their human investment in their children and grandchildren that yields emotional and social rewards throughout their golden years.

Known Benefits Enjoyed by Married Couples in Comparison to Non-Married Persons.

1. Less likely to become victims of crime
2. Less likely to commit crimes
3. Less addiction
4. Fewer accidents (especially among men)
5. Less suicide
6. Better stress management because spouse is a buffer to life's stresses
7. More social and emotional support (less loneliness)
8. More intimate connections to family members
9. Long-term continuity in family relationships of children, in-laws, grandchildren, etc.
10. Lower risk of domestic violence for women
11. Longer life expectancies
12. More and better self-rated sex
13. More emotional and financial security (for both spouses)
14. Less uncertainty about direction of life and goals
15. More cost effective to live in married versus single circumstances
16. Tax deductions
17. More military benefits
18. More accumulated belongings and investments
19. More medical benefits
20. More legal rights

To legally marry in the United States today, one simply goes to the local county or state office and applies for a state marriage license. The state also claims authority in granting divorce rights to couples. Divorce is the legal dissolution of a previously granted marriage. Most marriages still endure, and the odds are that divorce won't happen to most marriages. It is a myth that one in two marriages eventually ends in divorce. There are a few myths about U.S. divorce trends that will be dispelled in this chapter. You might have heard the myth of the Seven Year Itch where divorce happens prior to or shortly after the 7th year. Current government estimates indicate that about 75% of couples make their ten-year anniversary in their first marriage. The myths are false, but divorce does happen more today than it did 50 years ago and more people today are currently divorced than were currently divorced 50 years ago.

Ten Actions to Minimize the Risk of Divorce:

1. Wait until at least 20 years old to marry, 25 is better.
2. Avoid premarital pregnancy and don't marry just because of a pregnancy.
3. Become proactive in maintaining your marriage (books, seminars, counseling).
4. Understand risks of cohabitation (cohabitation ≠ divorce).
5. Once married, leave the marriage market; don't keep an eye open for something better.
6. Learn to compromise with each other. Work around those irreconcilable differences.
7. Keep a positive outlook and look beyond today.
8. Take your time in selecting a mate. Don't rush into marriage.
9. Take the media with a grain of salt. Don't assume your marriage will be like the headlines.
10. Focus on the positive benefits of being married and don't dwell on the negatives.

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2.2.4.7: Violence in Relationships

Violence is a serious public health problem in the United States. From infants to the elderly, it affects people in all stages of life. In the United States, violence accounts for approximately 51,000 deaths annually. In 2007, more than 18,000 people were victims of homicide and more than 34,000 took their own life. Estimating the size of this economic burden is helpful in understanding the resources that could be saved if cost-effective violence prevention efforts were applied. The cost of these deaths totaled to $47.2 billion ($47 billion in work loss costs and $215 million in medical treatment). The number of violent deaths tells only part of the story. Many more survive violence and are left with permanent physical and emotional scars. Violence also erodes communities by reducing productivity, decreasing property values, and disrupting social services.

Understanding Violence

Interpersonal violence is defined as the actual or threatened intentional use of force— physical, sexual, or emotional—against another person, group, or community. It may result in physical injury, psychological harm, or even death. Violence also includes suicide and nonfatal acts of self-harm.

Unfortunately, violence is a part of our daily life. It exists in all corners of our nation. It affects us all regardless of our age, gender, race, ethnicity, or socio-economic status. More than 50,000 violent deaths occur each year in the United States. The deaths only tell part of the story. Millions of others are left with debilitating physical and emotional injuries. These injuries negatively affect the health of victims for the rest of their lives.

Violence also erodes the fabric of our communities. It can threaten productivity in the workplace, decrease the value of our homes and businesses, and disrupt essential public and social services. The economic cost of violence is staggering. In 2000, the medical costs and productivity losses associated with nonfatal violence-related injuries and deaths were estimated at more than $70 billion each year. The total burden to society is far greater.

The good news is that violence is a problem with a solution. It can be prevented by using a thoughtful and systematic approach. While the field of violence prevention is still developing, our knowledge of “what works” increases every day.

Types of Violence

- Child Maltreatment (e.g., child abuse and neglect)
- Intimate Partner Violence (e.g., violence by a current or former spouse, boy/girlfriend)
- Sexual Violence (e.g., rape, sexual assault, sexual harassment)
- Suicide (e.g., fatal and nonfatal suicide behavior)
- Youth Violence (e.g., bullying, gang violence, peer violence)

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2.2.4.8: Sexual Violence

Sexual Violence (SV) refers to sexual activity where consent is not obtained or freely given. Anyone can experience SV, but most victims are female. The person responsible for the violence is typically male and is usually someone known to the victim. The person can be, but is not limited to, a friend, coworker, neighbor, or family member.

There are many types of SV. Not all include physical contact between the victim and the perpetrator (person who harms someone else) – for example, sexual harassment, threats, and peeping. Other SV, including unwanted touching and rape, includes physical contact.

SV can impact health in many ways. Some ways are serious and can lead to long-term health problems. These include chronic pain, headaches, stomach problems, and sexually transmitted diseases.

SV can have an emotional impact as well. Victims often are fearful and anxious. They may replay the attack over and over in their minds. They may have problems with trust and be wary of becoming involved with others. The anger and stress that victims feel may lead to eating disorders and depression. Some even think about or attempt suicide.

SV is also linked to negative health behaviors. For example, victims are more likely to smoke, abuse alcohol, use drugs, and engage in risky sexual activity.

Why is sexual violence a public health problem?

SV is a significant problem in the United States:

- Among high school students surveyed nationwide, about 8% reported having been forced to have sex. The percentage of those having been forced to ever have sex was higher among female (11%) than male (5%) students.
- An estimated 20% to 25% of college women in the United States have experienced an attempted or complete rape during their college career
- Nearly 1 in 5 women and 1 in 71 men in the United States have been raped at some time in their lives.

These numbers underestimate the problem. Many cases are not reported because victims are afraid to tell the police, friends, or family about the abuse. Victims also think that their stories of abuse will not be believed and that police cannot help them. They may be ashamed or embarrassed. Victims may also keep quiet because they have been threatened with further harm if they tell anyone.

Certain factors can increase the risk for SV. However, the presence of these factors does not mean that SV will occur.

Risk factors for perpetration (harm to someone else):

- Being male
- Having friends that are sexually aggressive
- Witnessing or experiencing violence as a child
- Alcohol or drug use
- Being exposed to social norms, or shared beliefs, that support sexual violence.

It is important to understand what factors protect people or put them at risk for experiencing or perpetrating violence. Why are risk and protective factors useful? They help identify where prevention efforts need to be focused.

Risk factors do not cause violence. The presence of a risk factor does not mean that a person will always experience violence. Victims are never responsible for the harm inflicted upon them.

- Risk Factor - Characteristic that increases the likelihood of a person becoming a victim or perpetrator of violence.
- Protective Factor - Characteristic that decreases the likelihood of a person becoming a victim or perpetrator of violence because it provides a buffer against risk.

How can we prevent sexual violence?

The ultimate goal is to stop SV before it begins. Efforts at many levels are needed to accomplish this. Some examples include:

- Engaging high school students in mentoring programs or other skill-based activities that address healthy sexuality and dating relationships.
- Helping parents identify and address violent attitudes and behaviors in their kids.
- Creating policies at work, at school, and in other places that address sexual harassment.
- Developing mass media (e.g., radio, TV, magazines, newspapers) messages that promote norms, or shared beliefs, about healthy sexual relationships.

Sexual Violence: Risk and Protective Factors

Risk factors are associated with a greater likelihood of sexual violence (SV) perpetration. They are contributing factors and may or may not be direct causes. Not everyone who is identified as "at risk" becomes a perpetrator of violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming a perpetrator of SV. Understanding these multilevel factors can help identify various opportunities for prevention.

Risk Factors for Perpetration

Individual Risk Factors

- Alcohol and drug use
- Coercive sexual fantasies
- Impulsive and antisocial tendencies
- Preference for impersonal sex
- Hostility towards women
- Hypermasculinity
- Childhood history of sexual and physical abuse
- Witnessed family violence as a child

Relationship Factors

- Association with sexually aggressive and delinquent peers
- Family environment characterized by physical violence and few resources
- Strong patriarchal relationship or familial environment
- Emotionally unsupportive familial environment

Community Factors

- Lack of employment opportunities
- Lack of institutional support from police and judicial system
- General tolerance of sexual violence within the community
- Weak community sanctions against sexual violence perpetrators

Societal Factors

- Poverty
- Societal norms that support sexual violence
- Societal norms that support male superiority and sexual entitlement
- Societal norms that maintain women's inferiority and sexual submissiveness
- Weak laws and policies related to gender equity
- High tolerance levels of crime and other forms of violence

Sexual Violence: Prevention Strategies

Sexual violence is a serious problem that can have lasting, harmful effects on victims and their family, friends, and communities. The goal of sexual violence prevention is simple-to stop it from happening in the first place. However, the solutions are just as complex as the problem.

Prevention efforts should ultimately decrease the number of individuals who perpetrate sexual violence and the number of individuals who are sexual violence victims. Many prevention approaches aim to reduce risk factors and promote protective factors for sexual violence. In addition, comprehensive prevention strategies should address factors at each of the levels that influence sexual violence -the individual, relationship, community, and society.

The most common prevention strategies currently focus on the victim, the perpetrator, or bystanders.

- Strategies that aim to equip the victim with knowledge, awareness, or self-defense skills are referred to as risk reduction techniques.
- Strategies targeting the perpetrator attempt to change risk and protective factors for sexual violence in order to reduce the likelihood that an individual will engage in sexually violent behavior.
- The goal of bystander prevention strategies is to change social norms supporting sexual violence and empower men and women to intervene with peers to prevent an assault from occurring.
- Other prevention strategies may target social norms, policies, or laws in communities to reduce the perpetration of sexual violence across the population.

Effective and Promising Programs

Unfortunately, little is known about what works to prevent sexual violence. To date, only one prevention program, Safe Dates, has been shown in a randomized controlled trial to prevent or interrupt sexual violence perpetration. Other programs are accumulating evidence for effectiveness and are moving towards or are currently conducting rigorous evaluations. Until more is known about what works and for whom, program planners can use prevention principles to strengthen their approach and evaluation to determine the effectiveness of new or existing programs.

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2.2.4.9: Intimate Partner Violence

Figure 2.2.4.9.1 Couple

Intimate partner violence (IPV) is a serious, preventable public health problem that affects millions of Americans. The term “intimate partner violence” describes physical, sexual, or psychological harm by a current or former partner or spouse. This type of violence can occur among heterosexual or same-sex couples and does not require sexual intimacy.

The goal is to stop IPV before it begins. There is a lot to learn about how to prevent IPV. We do know that strategies that promote healthy behaviors in relationships are important. Programs that teach young people skills for dating can prevent violence. These programs can stop violence in dating relationships before it occurs. IPV can vary in frequency and severity. It occurs on a continuum, ranging from one episode that might or might not have lasting impact to chronic and severe episodes over a period of years. There are four main types of IPV:

1. **Physical violence** is the intentional use of physical force with the potential for causing death, disability, injury, or harm. Physical violence includes, but is not limited to, scratching; pushing; shoving; throwing; grabbing; biting; choking; shaking; aggressive hair pulling; slapping; punching; hitting; burning; use of a weapon; and use of restraints or one’s body, size, or strength against another person. Physical violence also includes coercing other people to commit any of the above acts.
2. **Sexual violence** is divided into five categories. Any of these acts constitute sexual violence, whether attempted or completed. Additionally all of these acts occur without the victim’s freely given consent, including cases in which the victim is unable to consent due to being too intoxicated (e.g., incapacitation, lack of consciousness, or lack of awareness) through their voluntary or involuntary use of alcohol or drugs.
    1. **Rape or penetration of victim** – This includes completed or attempted, forced or alcohol/drug-facilitated unwanted vaginal, oral, or anal insertion. Forced penetration occurs through the perpetrator’s use of physical force against the victim or threats to physically harm the victim.
    2. **Victim was made to penetrate someone else** – This includes completed or attempted, forced or alcohol/drug-facilitated incidents when the victim was made to sexually penetrate a perpetrator or someone else without the victim’s consent.
    3. **Non-physically pressured unwanted penetration** – This includes incidents in which the victim was pressured verbally or through intimidation or misuse of authority to consent or acquiesce to being penetrated.
    4. **Unwanted sexual contact** – This includes intentional touching of the victim or making the victim touch the perpetrator, either directly or through the clothing, on the genitalia, anus, groin, breast, inner thigh, or buttocks without the victim’s consent
    5. **Non-contact unwanted sexual experiences** – This includes unwanted sexual events that are not of a physical nature that occur without the victim’s consent. Examples include unwanted exposure to sexual situations (e.g., pornography); verbal or behavioral sexual harassment; threats of sexual violence to accomplish some other end; and /or unwanted filming, taking or disseminating photographs of a sexual nature of another person.
3. **Stalking** is a pattern of repeated, unwanted, attention and contact that causes fear or concern for one’s own safety or the safety of someone else (e.g., family member or friend). Some examples include repeated, unwanted phone calls, emails, or texts; leaving cards, letters, flowers, or other items when the victim does not want them; watching or following from a distance; spying; approaching or showing up in places when the victim does not want to see them; sneaking into the victim’s home or car; damaging the victim’s personal property; harming or threatening the victim’s pet; and making threats to physically harm the victim.
4. **Psychological Aggression** is the use of verbal and non-verbal communication with the intent to harm another person mentally or emotionally, and/or to exert control over another person. Psychological aggression can include expressive aggression (e.g., namecalling, humiliating); coercive control (e.g., limiting access to transportation, money, friends, and family; excessive monitoring of whereabouts); threats of physical or sexual violence; control of reproductive or sexual health (e.g., refusal to use birth control; coerced pregnancy termination); exploitation of victim’s vulnerability (e.g., immigration status, disability); exploitation of perpetrator’s vulnerability; and presenting false information to the victim with the intent of making them doubt their own memory or perception (e.g., mind games).

Risk Factors for Intimate Partner Violence

Persons with certain risk factors are more likely to become perpetrators or victims of intimate partner violence (IPV). Those risk factors contribute to IPV but might not be direct causes. Not everyone who is identified as “at risk” becomes involved in violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming an IPV perpetrator or victim. Understanding these multilevel factors can help identify various opportunities for prevention.

Individual Risk Factors

- Low self-esteem
- Low income
- Low academic achievement
- Young age
- Aggressive or delinquent behavior as a youth
- Heavy alcohol and drug use
- Depression
- Anger and hostility
- Antisocial personality traits
- Borderline personality traits
- Prior history of being physically abusive
- Having few friends and being isolated from other people
- Unemployment
- Emotional dependence and insecurity
- Belief in strict gender roles (e.g., male dominance and aggression in relationships)
- Desire for power and control in relationships
- Perpetrating psychological aggression
- Seeing or being a victim of physical or psychological abuse (consistently one of the strongest predictors of perpetration)
- History of experiencing poor parenting as a child
- History of experiencing physical discipline as a child

Relationship Factors

- Marital conflict-fights, tension, and other struggles
- Marital instability-divorces or separations
- Dominance and control of the relationship by one partner over the other
- Economic stress
- Unhealthy family relationships and interactions

Community Factors

- Poverty and associated factors (e.g., overcrowding)
- Low social capital-lack of institutions, relationships, and norms that shape a community's social interactions
- Weak community sanctions against IPV (e.g., unwillingness of neighbors to intervene in situations where they witness violence)

Societal Factors

- Traditional gender norms (e.g., women should stay at home, not enter workforce, and be submissive; men support the family and make the decisions)

Protecting Yourself from Relationship Violence

It can be hard to know if your relationship is headed down the wrong path. While it's not always possible to prevent relationship violence, there are steps you can take to protect yourself.

If you think your partner might be controlling or abusive, it's important to:

- Trust your feelings. If something doesn't seem right, take it seriously.
- Learn the warning signs of someone who might become controlling or violent.
- Get help. Talk to experts in relationship violence.

If your partner is controlling or abusive, it's better to get help now than to wait. Controlling or violent relationships usually get

worse over time.

Remember: if your partner hurts you, it's not your fault.

What is relationship violence?

Relationship violence is when one person in a relationship is abusive or controlling toward the other person – especially when they disagree about something.

Relationship violence is sometimes called dating violence, **domestic violence**, or **intimate partner violence**. In some relationships, both partners act in abusive or controlling ways. When many people think about relationship violence, they think about physical violence, like hitting or pushing. But people can also use other methods, like threats or insults, to control their partners.

Relationship violence can include:

- Physical violence, like pushing, hitting, or throwing things
- Sexual violence, like forcing or trying to force someone to do something sexual
- Threats of physical or sexual violence, which may include threatening to hurt another person or a pet
- Emotional abuse, like embarrassing a partner or keeping that person away from family and friends

If you feel controlled by or afraid of your partner – even if you haven't been hurt physically – trust yourself. There are people who can help you figure out what to do next.

How do I know if my relationship might become violent?

Relationship violence can start slowly and be hard to recognize at first. For example, when people first start dating, it's common to want to spend a lot of time together. But spending less time with other people can also be a sign that your partner is trying to control your time.

Try asking yourself these questions:

- Does my partner respect me?
- Does my partner blame me for everything that goes wrong?
- Does my partner make most of the decisions in our relationship?
- Am I ever afraid to tell my partner something?
- Do I ever feel forced to do things that I don't want to do?
- Have I ever done anything sexual with my partner when I didn't want to?
- Does my partner promise to change and then keep doing the same things?

What if I'm not sure if my relationship is violent?

It's okay if you aren't sure – you can still get help. Domestic violence agencies have counselors who are experts at helping people with questions about their relationships. You don't even have to give your name.

If you have questions about your relationship, call the National Domestic Violence Hotline at 1-800-799-SAFE (1-800-799-7233) or chat online with a trained advocate.

If you are in danger right now, call 911.

Take Action!

If you think your partner is controlling or abusive, take steps to protect yourself.

Trust your instincts.

You are the expert on your life and relationships. If you think your relationship is unhealthy or you are worried about your safety, trust your gut.

Plan for your safety.

If you are in a relationship with someone who is violent or might become violent, make a plan to keep yourself safe. This is important whether you are planning to leave your partner or not.

Start with a phone call.

If you need help or have questions about your relationship, call the National Domestic Violence Hotline at 1-800-799-SAFE (1-800-799-7233). You'll be able to find a domestic violence agency near you or talk to a counselor over the phone. ***If you are in danger right now, call 911.***

What kind of help can I get?

Domestic violence agencies provide:

- Emotional support
- Safety planning
- A safe place to stay in an emergency
- Legal help
- Help with housing

What about cost?

Domestic violence agencies offer free services, like hotlines, counseling, and help finding resources such as housing or lawyers.

Healthy vs. unhealthy relationships

Sometimes a relationship might not be abusive, but it might have some serious problems that make it unhealthy. If you think you might be in an unhealthy relationship, you should be able to talk to your partner about your concerns. If you feel like you can't talk to your partner, try talking to a trusted friend, family member, or counselor. Consider calling a confidential hotline to get the support you need and to explore next steps. If you're afraid to end the relationship, call a hotline for help (1-800-799-SAFE).

Signs of an unhealthy relationship include:

- Focusing all your energy on your partner
- Dropping friends and family or activities you enjoy
- Feeling pressured or controlled a lot
- Having more bad times in the relationship than good
- Feeling sad or scared when with your partner

Signs of a healthy relationship include:

- Having more good times in the relationship than bad
- Having a life outside the relationship, with your own friends and activities
- Making decisions together, with each partner compromising at times
- Dealing with conflicts by talking honestly
- Feeling comfortable and able to be yourself
- Feeling able to take care of yourself
- Feeling like your partner supports you

If you feel confused about your relationship, a mental health professional can help.

Remember, you deserve to be treated with respect.

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2.2.5: GENDER AND SEXUALITY

By far, sex and gender have been two of the most socially significant factors in the history of the world and the United States. Sex is one's biological classification as male or female, which is biologically determined at the moment the sperm fertilizes the egg. Sex can be precisely defined at the genetic level with females having two X chromosomes (XX), while males posses an XY pairing. The female's eggs contain only an X chromosome, while the male's sperm contains half X and half Y chromosomes. Therefore, the sperm that fertilizes the egg determines whether a person has XX (female) or XY (male) pairing of chromosomes. The main difference between sexes is the reproductive body parts assigned to each (including their functions and corresponding hormones).

Gender is culturally-based and varies in a thousand subtle ways across the many diverse cultures of the world. Gender has been shaped by social norms, politics, religion, philosophy, language, tradition and other cultural forces for many years. Gender identity is our personal internal sense of our own maleness or femaleness. Every society has a slightly different view of what it means to be male/masculine and female/feminine. Masculine traits are those we associate with being male, such as aggressiveness, directness, independence, objectiveness, and leadership. Feminine traits are being talkative, submissive, nurturing, emotional, and illogical. Androgyny is when a person shares both masculine and feminine traits. They fit their behavior to the situation; so an androgynous person might cry at a wedding or funeral, but can also change the tire on a car.

2.2.5.1: Sexual Scripts

2.2.5.2: Genital Development

2.2.5.3: The Importance of Sexuality

2.2.5.4: Sexual Anatomy

2.2.5.5: The Sexual Response

2.2.5.6: The Sexual Experience

2.2.5.7: Sex and Gender

2.2.5.8: Sexuality

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2.2.5.1: Sexual Scripts

A script is what actors read or study and what guides their behavior in a certain role. A script is a blueprint for what we "should do" in our roles. Sexual scripts are blueprints and guidelines for what we define as our role in sexual expression, sexual orientation, sexual behaviors, sexual desires, and the sexual component of our self-definition. All of us are sexual beings, yet none of us is exactly identical to another in our sexual definitions and script expectations. Having said that, keep in mind that we are not just born with sexual scripts in place; they are learned. Sexual socialization is the process by which we learn how, when, where, with whom, why, and with which motivations we are sexual beings.

We are all born with drives, which are biological needs that demand our attention and behavioral responses to them. The most powerful drives are circulation, breathing, voiding our urine and other waste, eating, drinking, sleeping, and sexual involvement. Sexual drives are biological urges to participate in sexual activity and in certain sexual roles. Sexual scripts, once learned, will shape how that drive is answered. Sexuality is learned via culture and socialization. There are as many unique sexual scripts as there are people, yet some of these scripts have common themes and can be viewed as a collective pattern or trend in the larger social level.

Many of us learn our sexual scripts in a passive way. In other words, we don't learn from experience, but from a synthesis of concepts, images, ideals, and sometimes misconceptions. For example, the commonly held belief that men and women are two different creatures, perhaps even from different planets, was a very successful fad in recent years that led an entire generation to believe that men might be from "Mars" while women might be from "Venus."

Today more and more people living in the U.S. have less religious values and more diverse experiences with sexuality. Further, much of the younger generations' focus on sex is on the orgasm. An orgasm is the sexual climax that accompanies sexual intercourse and includes muscle tightening in the genital area, electrical sensations radiating from the genitals, and a surge of a variety of pleasure-producing hormones throughout the body. Many cultures have records of sexual expression and some even have records of sexual pleasure maximization.

Some traditional sexual scripts that have been studied include a number of problematic assumptions. Some of these assumptions include but are not limited to: the man must be in charge, the woman must not enjoy (or let on that she enjoys) the sexual experience, the man is a performer whose skills are proven effective upon arrival of his partner's orgasm, men are sexual while women are not, women can't talk about it and turn to men for sexual interests and direction, and finally sex always leads to a female orgasm (her orgasm being proof of his sexual capacity). Numerous studies have shown that most of these traditional scripts are not realistic, healthy, conducive to open communication, nor negotiation of sexual needs and desires for couples. In sum, rather, these traditional notions can be an undermining influence in a couple's intimacy. Scripts that are more contemporary include these simple ideas:

1. Both partners need to learn to take ownership of the couple's sexual experiences.
2. Both partners need to learn to communicate openly and honestly about their feelings.
3. Both partners need to learn to meet one another's desires, needs, and wishes while making sure that their own needs are being met.

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2.2.5.2: Genital Development

Many people think of male versus female reproductive and sexual body parts in terms of opposites. In sexual matters, men and women are very much alike from a physiological and biological point of view. We are even alike in our fetal development with our genitals developing from identical tissues, regardless of being male or female. Have you ever wondered why a pregnant woman can't get an accurate ultrasound until the second month to determine the fetus's sex being male or female? In part, technicians want to give the fetus enough time to develop genitals that coincide with the particular sex of the baby. More importantly, the fetus has identical genitals until about the 5th-6th week. That means it would require a DNA test to distinguish which sex the fetus is up until that point.

Sexually, males and females start with identical genital buds that usually form into the male or female reproductive organs. Please note that sexual development is a natural yet extremely complex process that yields a mostly predictable outcome among newborns. That means most females are born with nearly identical sexual parts. Likewise most males are born with nearly identical parts.

With an XY male genetic configuration, the glans area will develop into the penis. The urethral fold will form the urethral meatus or opening in the penis. The urethral groove and lateral buttress will fold onto itself and fuse into the shaft of the penis with the urethra connecting the bladder to the urethral meatus or opening of the penis. The anal tubercle will form into the anus and external sphincter. The male glands (prostate, cowper's, and seminal vesicles) develop in another process as do the testicles, which develop inside the abdomen then drop into the scrotum.

For the XX female genetic configuration, the glans becomes the clitoral glans; the urethral fold becomes the urethral meatus; the urethral groove and lateral buttress become the labia minora and majora (labia means lips); and the anal tubercle becomes the anus and external sphincter. The vagina, cervix, ovaries, and uterus form from other tissues.

Interestingly, ovaries develop inside the abdomen. These basic fetal tissues differentiate because of the X or Y. In adult sexual partners these sexual parts function in very similar ways even though their placement and structure differ.

There are some variations when the actual physical sexual development does not follow expected patterns. Hermaphroditism is found among those variations and is reported in two forms. First, true hermaphroditism is an extremely rare condition wherein both reproductive organs of both males and females are in one person's body and functioning to some degree or another (this includes, penis, testicles, prostate gland, vagina, uterus, and ovaries). Second, pseudohermaphroditism (false or near Hermaphroditism) is a rare condition wherein some of both reproductive organs for males or females are present in one person's body, but neither male nor female organs are completely present and/or fully functioning.

As is mentioned earlier, not all fetal sexual development occurs uniformly. Though not discussed here in great detail, there are five common sexual development variations reported among newborns: Turner's syndrome, Klinefelter's Syndrome; Androgen Insensitivity Syndrome; Fetally Androgenized Females; and DHT-deficient Males. In most cases of fetal development, sexual development is predictable and follows the above mentioned pattern of originating from nearly identical tissues.

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2.2.5.3: The Importance of Sexuality

Sexuality is important to us because it represents an activity that is a rite of passage into adulthood, because it is very pleasurable, and because it reinforces our roles and aspirations as males and females. Yet sexuality is truly a passive part of our daily lives.

Samuel and Cynthia Janus published The Janus Report on Sexual Behavior in 1993. They studied a scientific sample of 2,765 men and women and reported some general trends in U.S. sexual practices and patterns. They found that age-based estimates indicate a great deal of similarity in sexual frequency between age groups with 2-3 sexual encounters per week.

Sex is a minor (yet important) part of our daily time allocation. People with a sexual partner available have sex about 3 times per week, taking about 25 minutes per experience. That means about 75 minutes per week or 3,900 minutes per year is spent having sex. Divide 3,900 by 60 minutes, and it equals about 65 hours per year having sex. At first glance that sounds like a great deal of time allocation, but keep in mind that in comparison, most of us spend most of our lives doing nonsexual things.

Consider these estimates: if the average person sleeps about eight hours in a 24 hour period, works 8.5 hours, eats 1.5 hours, commutes .5 hour, watches TV for three hours, and spends about 2.5 hours for miscellaneous activities, then compared to routine non-sexual activities, sexual intercourse comprises a relatively small portion of our time.

Relatively speaking sexual intercourse is a passive part of the average person's life accounting for only 65 yearly hours of involvement per year. Many people refrain from regular sexual intercourse until their twenties and are less likely to participate in it if they are not married than are married people. These estimations don't take into account those with no sexual partner and those who abstain from sexual intercourse. The average would be much lower if those categories of people were averaged into the equation.

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2.2.5.4: Sexual Anatomy

To understand our own bodies and also understand enough about sexuality to teach our children, we must understand the basics of female and male anatomy. Figure 3 shows an artist's depiction of a cross section of female reproductive and sexual anatomy. The clitoris is extremely sensitive and is protected by the clitoral hood (not shown here). It sits above the vagina. In females, urine exits the body at the external urethral orifice (also called meatus). The vaginal orifice simply means the opening to the vagina itself. The labia are in two places, closer to the vaginal orifice (labia minora) and further away from the vaginal orifice (labia majora).

The urinary bladder sits behind the pubic bone and during urination travels an inch or two out of the body via the external urethral orifice. In the back and top of the vagina sits the cervix. The cervix is simply the window into the uterus. It is round, muscular and thick and has a small opening in it. The cervix is the bottom portion of the uterus (the uterus is where a fetus or baby would grow and develop during pregnancy).

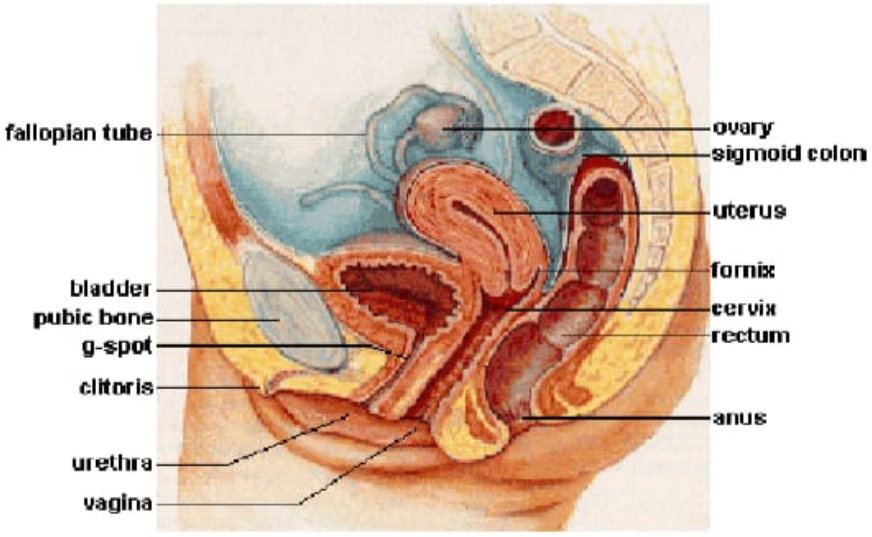


Figure 2.2.5.4.1. Diagram of a Woman's reproductive Organs

The uterus leans forward toward the pubic bone. Inside the uterus on the left and the right sides are two small openings where the fallopian tube connects the ovaries to the uterus. There are two ovaries that have thousands of eggs in them at birth. A woman may release as many as 450 eggs during her reproductive years. After an egg is released from the ovary (ovulation), the fallopian tube carries the egg from the ovary down to the uterus. When pregnancy occurs it is often because sperm met the egg in the fallopian tube and fertilized it. Later, if the fertilized egg travels down the fallopian tube and implants into the uterus, then conception has taken place.

The vagina is approximately three inches long and is made of tissues that are epithelial and mucosal. This means that when blood flow increases to the pelvis the vagina produces a lubricant in the form of moisture. The vagina is not hollow in the sense that a tube is round and hollow. The vagina is relatively flat and has potential space rather than constantly open space. The vagina has a band of pelvic floor muscles that surround it. One set of muscles is called the puboccocceygeus muscle (PC muscle) which is located approximately 1 inch inside the vagina and which also plays a role in sexual pleasure for both partners.

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2.2.5.5: The Sexual Response

To truly understand how these parts function during sexual intercourse, we need to consider a research-based paradigm developed by Masters and Johnson years ago which they called the sexual response cycle. The sexual response cycle is a model that explains how most people experience three phases when they engage in sexual intercourse: excitement, plateau, and then orgasm.

Masters and Johnson are quick to point out that each individual has a unique and varied sexual response so much so that no two sexual encounters would be expected to be perfectly identical between the same people. Nevertheless, these three phases are very common among most people.

As sexual intercourse begins both males and females pass through three phases. Excitement phase is when blood flows to the pelvis bringing, more lymphatic fluid and plasma to the region. Because of hormonal and psychological stimuli there is generally swelling in the sexual parts. While this is happening, the plateau phase begins which is when more hormones are released, moisture increases, heart rate increases, intensity of sensory perception increases (touch, smell, sight, hearing, and taste). In the orgasm phase an electrical build up of energy is released that is associated with a rhythmic contraction of the pelvic floor muscles, the urinary and anal sphincters, and of various glands for males. This is called an orgasm. After the orgasm finishes, resolution eventually allows the sexual parts to return to pre-excitement conditions. These are almost identical in every way between males and females, except that there are differing sexual parts for each.

Thus, a sexual response in a typical female would typically follow a pattern similar to this one.

In the excitement phase, blood and lymphatic fluids increase swelling inside the vagina. Hormones are secreted which lead to a mild uterine contractions which raise the uterus away from the pubic bone. The labia swell and the clitoris becomes hard. The vaginal tissues secrete moisture and the vagina itself lengthens and expands slightly inward. The plateau phase begins as excitement continues. This causes the labia to become fully swollen, the clitoris to recede under the clitoral hood, and the uterus to become fully elevated (the hormone is called Oxytocin). The vagina is fully lengthened into the body, and, just before orgasm, lubrication ceases. During orgasm, the pelvis of the female experiences a series of contractions which occur every 8/10ths of second and can number anywhere from 1-20 or more in the sequence. The contractions include anal and urinary sphincter contractions, the smooth muscles in the inward portion of the vagina contraction, the puboccocceygeus muscle contraction, the uterine contractions which cause the uterus and cervix to dip down into the vagina, and general muscles contractions in the body.

Further, an electrical sensation surges from the clitoris radiating throughout the body and stimulates the pleasure centers of the brain and a release of the hormone called Oxytocin. When the orgasm ends, the body eventually returns to its pre-excitement state. In general, females have more capacity to experience more contractions over a longer period of time than do males.

Females have been found to have much more capacity for sexual intercourse than males. This means females can have more sexual intercourse, more often, and with more orgasms than can the average male.

The male anatomy is presented in Figure 4. The male has a penis which is comprised of 3 spongy-like tissue columns that engorges with blood during excitement. A cross-section of the penis shows two outer columns and one column on the underneath side. The average male penis is just that—average. About 4-6 inches reported by Masters and Johnson. Since the vagina is 3 inches in length and has very sensitive regions near the outside of the vagina and not so sensitive regions deeper inside, the average male can satisfy the average female in heterosexual intercourse. Urine passes from the urinary bladder and exits at the external urethral orifice at the tip of the penis. The penis is attached inside the body to the pubic bone.

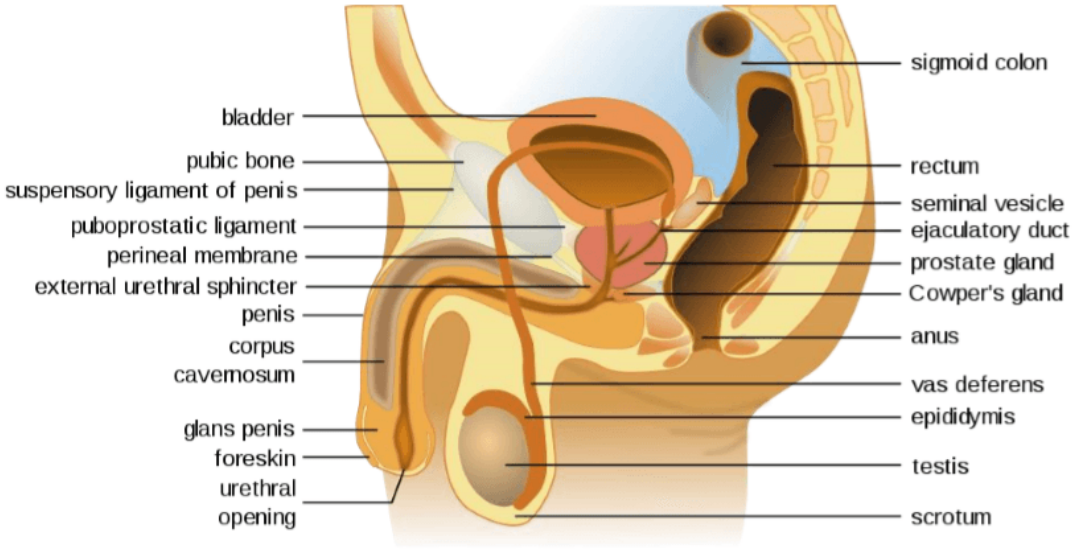


Figure 2.2.5.5.1. Male Reproductive and Sexual Anatomy, Cross-sectional View

There are two testicles inside a pouch called the scrotum. One testicle sits higher than the other. On the back of the testicle is a storage compartment where mature sperm end up before ejaculation. This is called the epididymis. There is a muscle called the dartos muscle (not shown) which elevates and lowers the testicle based on temperature and sexual pleasure. Sperm grow best at about 91 degrees Fahrenheit and most males are at about 98 degrees, so the dartos will raise and lower the testicles if in colder or warmer temperatures.

The testicles produce about 125-250,000,000 sperm every 3-4 days. More importantly, the testicles produce the sex-drive hormone called Testosterone. In males and females, higher levels of testosterone typically mean a higher sex drive (another similarity). The vas deferens will eventually carry the sperm from the epididymis out of the body during the orgasm. The prostate gland swells during excitement and fills with prostatic fluid. The seminal vesicle located above the prostate gland also swells and produces a fluid filled with natural sugars.

For males, in the excitement phase, blood and lymphatic fluids increase swelling inside the prostate, seminal vesicle, testicle, scrotum, and the penis. Hormones are secreted which lead to a higher volume of blood flowing into the spongy tissue columns of the penis than flow out. The penis erects this way (sometimes the penis will leak fluid and/or sperm before the orgasm, regularly referred to as pre-ejaculate or “pre-cum”). The scrotum and dartos muscle draw both testicles up toward the pubic bone pressing the epididymis upward. As stimulation continues the swelling and fluid production continues to increase.

The plateau continues until just before the orgasm. When orgasm begins for males the penis is most erect. Males reach a point of no return in their orgasms (females do not). The ejaculation of sperm and fluids will continue in males, regardless of continued or interrupted stimulation.

Females would experience an interruption of the orgasm when stimulation is interrupted. For males, the orgasm also includes a series of contractions which occur every 8/10ths of second and can number anywhere from 1-10. Most males will have 5-6.

The contraction includes: anal and urinary sphincter contractions; prostate and seminal vesicle contractions, dartos and scrotum contractions, pelvic floor muscle contractions; penile contractions; and a rhythmic sequence of these in such a way that the ejaculate is expelled from the body out through the penis. The sperm are released from the epididymis and travel through the vas deferens up and around the bladder then through the ejaculatory duct (where it picks up prostate and seminal fluids) and finally out of the penis. An electrical sensation surges from the prostate gland throughout the body and stimulates the pleasure centers of the brain and a release of the hormone called Oxytocin. For males and females Oxytocin brings a feeling of emotional connection.

After an orgasm, males may continue to experience an erection, but will have to wait a while for the central nervous system to reset before they can ejaculate or orgasm again. Most males wait less time when younger and more time when older. For males, an ejaculation during orgasm would be expected, but sometimes ejaculations happen with or without orgasms, and orgasms may happen without ejaculations.

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2.2.5.6: The Sexual Experience

Even though the physiological component of sexuality is common between males and females, the male and female sex drives are NOT identical. Studies consistently show that sexual desire for women is more sensitive to the context (meaningful or intimate connection) and the social and cultural environment (quality of relationships, stresses of the day, etc.). Generally speaking most men seek more sex than most women throughout most of the life span. Also, most men are more easily aroused by visual stimulation than are most women.

The Janus Report reported that 65% of men have an orgasm every time during love-making while females reported a much lower 15% every time. About 46% of women report “often” having an orgasm during love-making, compared to only 28% of men. These sex drive differences also emerged in self-reported masturbation frequencies. About 55% of men and 38% of women masturbate on a daily-monthly basis.

When filling out official documents, you are often asked to provide your name, birth date, and sex or gender. But have you ever been asked to provide your sex and your gender? It may not have occurred to you that sex and gender are not the same. However, sociologists and most other social scientists view sex and gender as conceptually distinct. Sex denotes biological characteristics and exists along a spectrum from male to female. Gender, on the other hand, denotes social and cultural characteristics that are assigned to different sexes. Sex and gender are not always synchronous, meaning they do not always line up in an easy-to-categorize way.

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2.2.5.7: Sex and Gender

“Sex” refers to physiological differences found among male, female, and various intersex bodies. Sex includes both primary sex characteristics (those related to the reproductive system) and secondary sex characteristics (those that are not directly related to the reproductive system, such as breasts and facial hair). In humans, the biological sex of a child is determined at birth based on several factors, including chromosomes, gonads, hormones, internal reproductive anatomy, and genitalia. Biological sex has traditionally been conceptualized as a binary in Western medicine, typically divided into male and female. However, anywhere from 1.0 to 1.7% of children are born intersex, having a variation in sex characteristics (including chromosomes, gonads, or genitals) that do not allow them to be distinctly identified as male or female. Due to the existence of multiple forms of intersex conditions (which are more prevalent than researchers once thought), many view sex as existing along a spectrum, rather than simply two mutually exclusive categories.

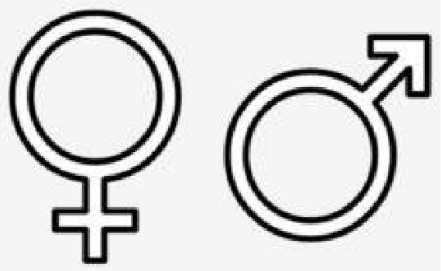


Figure 2.2.5.7.1 Female and Male Sex Symbols

Male, Female, and the spectrum of sex

In humans, sex is typically divided into male, female, or intersex (i.e., having some combination of male and female sex characteristics). The symbols (to the left) represent female on the left and male on the right.

Gender

A person’s sex, as determined by his or her biology, does not always correspond with their gender; therefore, the terms “sex” and “gender” are not interchangeable. “Gender” is a term that refers to social or cultural distinctions associated with being male, female, or intersex. Typically, babies born with male sex characteristics (sex) are assigned as boys (gender); babies born with female sex characteristics (sex) are assigned as girls (gender). Because our society operates in a binary system when it comes to gender (in other words, seeing gender as only having two options), many children who are born intersex are forcibly assigned as either a boy or a girl and even surgically “corrected” to fit a particular gender. Scholars generally regard gender as a social construct—meaning that it does not exist naturally, but is instead a concept that is created by cultural and societal norms.

Gender identity is a person’s sense of self as a member of a particular gender. Individuals who identify with a role that corresponds to the sex assigned to them at birth (for example, they were born with male sex characteristics, were assigned as a boy, and identify today as a boy or man) are cisgender. Those who identify with a role that is different from their biological sex (for example, they were born with male sex characteristics, were assigned as a boy, but identify today as a girl, woman, or some other gender altogether) are often referred to as transgender. The term “transgender” encompasses a wide range of possible identities, including agender, genderfluid, genderqueer, two-spirit (for many indigenous people), androgynous, and many others.

The continuum of sex and gender

Those who identify with a gender that is different from their biological sex are referred to as transgender.



Figure 2.2.5.7.2 The Transgender Sex Symbol

Modern scholars such as Anne Fausto-Sterling and Bonnie Spanier criticize the standard binaries of sex and gender, arguing that sex and gender are both fluid concepts that exist along a spectrum, rather than as binaries.

Cultural Variations of Gender

Since the term “sex” refers to biological or physical distinctions, characteristics of sex will not vary significantly between different human societies. For example, persons of the female sex, in general, regardless of culture, will eventually menstruate and develop breasts that can lactate. Characteristics of gender, on the other hand, may vary greatly between different societies. For example, in American culture, it is considered feminine (or a trait of the female gender) to wear a dress or skirt. However, in many Middle Eastern, Asian, and African cultures, dresses or skirts (often referred to as sarongs, robes, or gowns) can be considered masculine. Similarly, the kilt worn by a Scottish male does not make him appear feminine in his culture.

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2.2.5.8: Sexuality

Numerous studies show that men and women enjoy sex most in a meaningful relationship, typically long-term committed ones. These studies indicate that the pleasure is more meaningful and enjoyable in long-term committed relationships. Those who abstain from all sexual activity are in the lower left corner with no intimacy and no pleasure. Those who solo masturbate (by themselves) derive pleasure without intimacy. Those who purchase prostitution services derive pleasure, yet have very little intimacy. Finally, those who have one-time sexual encounters in a “one-night stand” also derive pleasure with little intimacy over time.

For married or cohabiting couples, sexual intercourse includes both pleasure and intimacy. Newlyweds typically have their honeymoon night, and sex becomes a rite of passage that marks the beginning of their full emersion into the marital relationship. Sometimes one spouse has sex to meet the needs or wants of their partners. At other times sex is a healthy and fun stress relief. Sometimes sex is a convenient way to be affectionate as a giver and a receiver. In relationships, sexual intercourse has many functions including reinforcing commitment and loyalty with one another. To give and receive is pleasurable and bonding during sexual intercourse.

Some couples seeking parenthood will have sex to pleasure themselves while getting pregnant. Many report enhancements of intimacy with less focus on pleasure at moments such as these. Others get distracted because sex becomes goal-oriented rather than simply expressive while trying to make a baby. For long-term relationships that have endured challenges such as hardship, betrayals, offenses, anger, arguments and ultimately forgiveness, sexual intercourse takes on a profoundness of its own. Those who have short- term relationships miss out on the intimacy payoff that sex provides to those in long-term relationships. Sex becomes a unique way of enhancing trust and closeness while sometimes providing sexual healing to wounded egos and feelings.

Extramarital affairs are intimate relationships with a person other than one’s spouse that may be sexual or nonsexual. Most U.S. extramarital affairs are sexual and non-consented to by one’s spouse. In spite of a variety of estimates on how many married people were ever unfaithful to their spouse, all scientific studies have found that men were more likely than women to have an extramarital affair and that most men and women do NOT ever have an affair.

Marital infidelity has been and continues to be disapproved of by the general public. Many in the U.S. who disapprove of affairs, simultaneously understand the frailties of the human experience and sympathize to some degree with those who make this “mistake.” Such was found to be true with politicians, movie and TV stars, and sports celebrities (you can pick any one from the online list available on the Internet when you search “celebrity affairs”). Affairs don’t always lead to marital or relational dissolution, but in most cases it is better if the offending spouse or partner confesses the infidelity rather than simply gets caught.

Sexual Identity and Orientation

Human beings are socialized into their adult roles and learn their sexual identities along with their gender roles, work roles, and family roles. Sexual orientation is the sexual preference one has for their partner: male, female, both, or neither. There are a few common sexual orientations that can be seen at the societal and personal level. Heterosexuality is the sexual attraction between a male and a female. Homosexuality is a sexual attraction between a male to another male or a female to another female. Bisexuality is a sexual attraction to both male and female sexual partners.

There is a difference in these three dimensions of sexuality: sexual orientation, sexual desire, and sexual behaviors. Sexual desire is the attractions we have for sexual partners and experience that exist independent of our behaviors. Sexual behaviors are our actual sexual actions and interactions. It is important to note that orientations, desires, and behaviors are not always the same thing. They do overlap at times. For example, a heterosexual male may have had a homosexual experience in the past, or not. He may at times desire males and females regardless of his actual sexual activities. A lesbian female may have had a short-term heterosexual relationship, yet define herself as a lesbian.

Edward O. Laumann et al. wrote the largest sociological study of U.S. sexuality ever published. In this book he wrote about the prevalence of self-identified sexual orientations. Laumann and the other researchers surveyed about 3,400 respondents. By far, most members of U.S. society are heterosexual. Laumann avoided the use of the words “heterosexual” or “homosexual.” He found that 7.1% of males and 3.8% of females have had sex with a partner of the same sex. Laumann also reported that over 96% of males and 98% of females identified themselves as heterosexual. Only two percent of males and 0.9% of females identified themselves as homosexual, while 0.8% of males and 0.5% of females reported bisexuality.

The Janus Report also reported their findings on sexual behaviors and sexual orientation. Their sample reported 22% of men and 17% of women said yes to the question, “Have you had a homosexual experience?” Janus also reported that 91% of men and 95% of women claimed to be heterosexual; four percent of men and two percent of women claimed to be homosexual; and five percent of men and three percent of women claimed to be bisexual. Heterosexuality is by far the most common identification in studies where respondents are asked to identify their sexual orientation. Yet, heterosexuals may have had a variety of sexual experiences in a variety of context and still consider themselves to be heterosexual in spite of dimensional discontinuity or continuity. Generally speaking Janus and Laumann found that the U.S. is a very sexual nation. They reported that very few men and women reported never having had vaginal sexual intercourse (less than five percent). They reported that men typically have sex sooner than women and that most had sex by age 20. Janus specifically reported that only nine percent of men and 17% of women had NO sexual experience before marriage.

Sexuality and Politics

Sexual orientation, desires, and behaviors have become extremely politicized. The largest sexual political action committee is the Human Rights Campaign, which emerged in the 1980s as a Gay Community Rights organization. LGBT and LGBTQ have replaced Gay Community as the collective acronym. LGBT stands for Lesbian, Gay, Bisexual, and Transgender (occasionally Queer is added by some interest groups). The Human Rights Campaign has become the central political action organization for LGBTQ interest groups. Marriage between same-sex couples became an emotionally charged political issue during the California Proposition 8 referendum and constitutional amendment that Passed November 2008.

Because it passed, the California Section 7.5 of the Declaration of Rights to the State Constitution read, “Only marriage between a man and a woman is valid or recognized in California.” This set a strong national precedence against rights to same-sex couples to have legally recognized marriage on par with heterosexual married couples. Estimates are that over $80 million was spent on this proposition alone on both the for and against efforts.

The Prop 8 initiative originated from a political action committee called ProtectMarriage.com. It self-describes as a “...broad-based coalition of California families, community leaders, religious leaders, pro-family organizations and individuals...to restore the definition of marriage as between a man and a woman.” Proposition 8 was ultimately ruled unconstitutional by a federal court in 2010, although the court decision did not go into effect until June 26, 2013, following the conclusion of proponents' appeals.

In the past same-sex marriage in the United States was established on a state-by-state basis, expanding from 1 state in 2004 to 36 states in 2015, when, on June 26, 2015, same-sex marriage was established in all 50 states as a result of the ruling of the Supreme Court of the United States in the landmark civil rights case *Obergefell v. Hodges,* in which it was held that the right of same-sex couples to marry on the same terms and conditions as opposite-sex couples, with all the accompanying rights and responsibilities, was guaranteed by both the Due Process Clause and the Equal Protection Clause of the Fourteenth Amendment to the United States Constitution.

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2.2.6: SEXUAL HEALTH

Sexual health is a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence.

2.2.6.1: Sexuality

2.2.6.2: Public Health Approach to Sexual Health

2.2.6.3: Stigma

2.2.6.4: Sexual Dysfunction

2.2.6.5: Sexual Frequency

2.2.6.6: Sex and Health

2.2.6.7: Sexual Happiness

2.2.6.8: Sexual Bias and Misconceptions

2.2.6.9: Reproductive Health

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2.2.6.1: Sexuality

Sexuality is a major part of being human. Love, affection and sexual intimacy all play a role in healthy relationships. They also contribute to your sense of well-being. A number of disorders can affect the ability to have or enjoy sex in both men and women. Concerns about infertility or fear of unplanned pregnancy can also come into play. In addition, a number of diseases and disorders affect sexual health. These include sexually transmitted diseases and cancer. In men, treatment of prostate cancer can cause erectile dysfunction. In women, cervical, uterine, vaginal, vulvar or ovarian cancer may have sexual effects.

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2.2.6.2: Public Health Approach to Sexual Health

Sexuality affects individuals and society across a broad spectrum of activities: through health, but also through factors at multiple levels, such as gender relations, reproduction, and economics. Physiological, behavioral, and affective measurement of sexuality and sexual behavior is complicated by cultural values and norms, but is essential to individual health (including happiness) as well as public health.

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2.2.6.3: Stigma

Cultural or structural norms that stigmatize aspects of sexuality, such as sexual orientation, have adverse effects on individuals across their lifespan, with homophobia being a prominent example of such. In addition, survey data reveal several individual and relationship factors that are important to sexual health at all levels, with overall health noted as the greatest predictor of sexual satisfaction.

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2.2.6.4: Sexual Dysfunction

Sexual dysfunction can pose public health problems, as it is related to public health issues and affects people's happiness and general well-being.

According to the National Health and Social Life Survey:

- The prevalence of sexual dysfunction was found to be higher among women than men.
- Lack of sexual desire is the most common problem among women
- For men, the most common sexual problem is premature ejaculation, not erectile dysfunction.
- Sexual problems increase with age, but sex-related personal distress decreases.

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2.2.6.5: Sexual Frequency

Sexual frequency is important for sexual relationship satisfaction. Sexual intercourse frequency is noted as being the most important factor when predicting sexual satisfaction. Satisfaction declines with age but not as steeply as sexual frequency declines. However, although satisfaction is lower in women, satisfaction levels do not change over time among women, compared with men.

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2.2.6.6: Sex and Health

Duration and age matter, but health matters most of all. Health proves to be a critical predictor of sexual satisfaction. Among those indicating their health is at least “very good,” more than half say they are satisfied with their sex lives. The majority of older Americans do not practice safe sex, even if they have multiple partners. It was reported that only 1 in 5 sexually active, dating singles use condoms regularly. Many older Americans report dating more than one person at a time and being sexually active with more than one sex partner (6% of men and 1% of women).

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2.2.6.7: Sexual Happiness

The most important indicator of the sexual happiness of older Americans is having a steady sex partner. That indicator is less important than the frequency of sexual intercourse, good health, low levels of stress, and the absence of financial worries. There are still behavioral differences between older men and women, and older men and women continue to rank the importance of sex and the enjoyment of sex differently—even as they age. Older men continue to have more sex and think about sex more than older women; they see it as more important to their quality of life. Older men report having more frequent orgasms than women (2 out of 3 men, compared with 1 in 3 women), but their frequency of orgasm drops with age. Older men are twice as likely (21% compared with 11%) to admit sexual activity outside their relationship than women.

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2.2.6.8: Sexual Bias and Misconceptions

People who are lesbian, gay, bisexual, or transgender (LGBT) are members of every community. They are diverse, come from all walks of life, and include people of all races and ethnicities, all ages, all socioeconomic statuses, and from all parts of the country. The perspectives and needs of LGBT people should be routinely considered in public health efforts to improve the overall health of every person and eliminate health disparities.

In addition to considering the needs of LGBT people in programs designed to improve the health of entire communities, there is also a need for culturally competent medical care and prevention services that are specific to this population. Social inequality is often associated with poorer health status, and sexual orientation has been associated with multiple health threats. Members of the LGBT community are at increased risk for a number of health threats when compared to their heterosexual peers. Differences in sexual behavior account for some of these disparities, but others are associated with social and structural inequities, such as the stigma and discrimination that LGBT populations experience.

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2.2.6.9: Reproductive Health

Both the male and female reproductive systems play a role in pregnancy. Problems with these systems can affect fertility and the ability to have children. There are many such problems in men and women. Reproductive health problems can also be harmful to overall health and impair a person's ability to enjoy a sexual relationship.

Your reproductive health is influenced by many factors. These include your age, lifestyle, habits, genetics, use of medicines and exposure to chemicals in the environment. Many problems of the reproductive system can be corrected.

Reproductive health includes a variety of topics, such as:

- Menstruation and menopause
- Pregnancy and preconception care
- Fertility/Infertility
- Contraception

Menstruation

The menstrual cycle is the process by which a woman’s body gets ready for the chance of a pregnancy each month. The average menstrual cycle is 28 days from the start of one to the start of the next, but it can range from 21 days to 35 days.

Most menstrual periods last from three to five days. In the United States, most girls start menstruating at age 12, but girls can start menstruating between the ages of 8 and 16.

Menstruation is a woman's monthly bleeding. When you menstruate, your body sheds the lining of the uterus (womb). Menstrual blood flows from the uterus through the small opening in the cervix and passes out of the body through the vagina (see how the menstrual cycle works below). Most menstrual periods last from 3 to 5 days.

When periods (menstruations) come regularly, this is called the menstrual cycle. Having regular menstrual cycles is a sign that important parts of your body are working normally. The menstrual cycle provides important body chemicals, called hormones, to keep you healthy. It also prepares your body for pregnancy each month. A cycle is counted from the first day of 1 period to the first day of the next period. The average menstrual cycle is 28 days long. Cycles can range anywhere from 21 to 35 days in adults and from 21 to 45 days in young teens.

In the first half of the cycle, levels of estrogen (the female hormone) start to rise. Estrogen plays an important role in keeping you healthy, especially by helping you to build strong bones and to help keep them strong, as you get older. Estrogen also makes the lining of the uterus (womb) grow and thicken. This lining of the womb is a place that will nourish the embryo if a pregnancy occurs. At the same time the lining of the womb is growing, an egg, or ovum, in one of the ovaries starts to mature. At about day 14 of an average 28-day cycle, the egg leaves the ovary. This is called ovulation.

After the egg has left the ovary, it travels through the fallopian tube to the uterus. Hormone levels rise and help prepare the uterine lining for pregnancy. A woman is most likely to get pregnant during the 3 days before or on the day of ovulation. Keep in mind, women with cycles that are shorter or longer than average may ovulate before or after day 14.

A woman becomes pregnant if the egg is fertilized by a man’s sperm cell and attaches to the uterine wall. If the egg is not fertilized, it will break apart. Then, hormone levels drop, and the thickened lining of the uterus is shed during the menstrual period.

The Menstrual Cycle

- Day 1 starts with the first day of your period. This occurs after hormone levels drop at the end of the previous cycle, signaling blood and tissues lining the uterus (womb) to break down and shed from the body. Bleeding lasts about 5 days.
- Usually by Day 7, bleeding has stopped. Leading up to this time, hormones cause fluid filled pockets called follicles to develop on the ovaries. Each follicle contains an egg.
- Between Day 7 and 14, one follicle will continue to develop and reach maturity. The lining of the uterus starts to thicken, waiting for a fertilized egg to implant there. The lining is rich in blood and nutrients.
- Around Day 14 (in a 28-day cycle), hormones cause the mature follicle to burst and release an egg from the ovary, a process

called ovulation.
- Over the next few days, the egg travels down the fallopian tube towards the uterus. If a sperm unites with the egg here, the fertilized egg will continue down the fallopian tube and attach to the lining of the uterus.
- If the egg is not fertilized, hormone levels will drop around Day 25. This signals the next menstrual cycle to begin. The egg will break apart and be shed with the next period.

Pregnancy

Pregnancy is the term used to describe when a woman has a growing fetus inside of her. In most cases, the fetus grows in the uterus. Human pregnancy lasts about 40 weeks, or just more than 9 months, from the start of the last menstrual period to childbirth.

What are prenatal and preconception care and why are they important?

Prenatal care is the care woman gets during a pregnancy. Getting early and regular prenatal care is important for the health of both mother and the developing baby. In addition, health care providers are now recommending a woman see a health care provider for preconception care, even before she considers becoming pregnant or in between pregnancies.

Knowing if you are pregnant

A missed period is often the first clue that a woman might be pregnant. Sometimes, a woman might suspect she is pregnant even sooner. Symptoms such as headache, fatigue, and breast tenderness, can occur even before a missed period. The wait to know can be emotional. These days, many women first use home pregnancy tests (HPT) to find out. Your doctor also can test you.

All pregnancy tests work by detecting a special hormone in the urine or blood that is only there when a woman is pregnant. It is called human chorionic gonadotropin (kohr-ee-ONihk goh-NAD-uh-TROH-puhn), or hCG. hCG is made when a fertilized egg implants in the uterus. hCG rapidly builds up in your body with each passing day you are pregnant. Read on to learn when and how to test for pregnancy.

Home pregnancy tests

HPTs are inexpensive, private, and easy to use. Most drugstores sell HPTs over the counter. The cost depends on the brand and how many tests come in the box. They work by detecting hCG in your urine. HPTs are highly accurate. But their accuracy depends on many things. These include:

- **When you use them** – The amount of hCG in your urine increases with time. So, the earlier after a missed period you take the test the harder it is to spot the hCG. Some HPTs claim that they can tell if you are pregnant one day after a missed period or even earlier. But a recent study shows that most HPTs don't give accurate results this early in pregnancy. Positive results are more likely to be true than negative results. Waiting one week after a missed period will usually give a more accurate result. You can take the test sooner. But just know that a lot of pregnant women will get negative test results during the first few days after the missed period. It's a good idea to repeat the test again after a week has passed. If you get two negative results but still think you're pregnant, call your doctor.
- **How you use them** – Be sure to check the expiration date and follow the directions. Many involve holding a test stick in the urine stream. For some, you collect urine in a cup and then dip the test stick into it. Then, depending on the brand, you will wait a few minutes to get the results. Research suggests waiting 10 minutes will give the most accurate result. Also, testing your urine first thing in the morning may boost the accuracy. You will be looking for a plus sign, a change in color, or a line. A change, whether bold or faint, means the result is positive. New digital tests show the words "pregnant" or "not pregnant". Most tests also have a "control indicator" in the results window. This line or symbol shows whether or not the test is working. If the control indicator does not appear, the test is not working properly. You should not rely on any results from a HPT that may be faulty.
- **Who uses them** – The amount of hCG in the urine is different for every pregnant woman. So, some women will have accurate results on the day of the missed period while others will need to wait longer. Also, some medicines affect HPTs. Discuss the medicines you use with your doctor before trying to become pregnant.
- **The brand of test** – Some HPT tests are better than others at spotting hCG early on.

The most important part of using any HPT is to follow the directions exactly as written. Most tests also have toll-free phone numbers to call in case of questions about use or results.

If a HPT says you are pregnant, you should call your doctor right away. Your doctor can use a more sensitive test along with a pelvic exam to tell for sure if you're pregnant. Seeing your doctor early on in your pregnancy can help you and your baby stay healthy.

Unplanned Pregnancy

Unplanned pregnancy is common. About 1 in 2 pregnancies in America are unplanned. Ideally, a woman who is surprised by an unplanned pregnancy is in good preconception health and is ready and able to care for a new child. But this sometimes isn't the case.

If you have an unplanned pregnancy, you might not know what to do next. You might worry that the father (or mother) won't welcome the news. You might not be sure you can afford to care for a baby. You might worry if past choices you have made, such as drinking or drug use, will affect your unborn baby's health. You might be concerned that having a baby will keep you from finishing school or pursuing a career.

If you are pregnant after being raped, you might feel ashamed, numb, or afraid. Unplanned pregnancy is common among abused women. Research has found that some abusers force their partners to have sex without birth control and/or sabotage the birth control their partners are using, leading to unplanned pregnancy.

You might wonder what options you have. Here are some next steps to help you move forward:

- Start taking care of yourself right away. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) folic acid every. Stop alcohol, tobacco, and drug use.
- Make a doctor's visit to confirm your pregnancy. Discuss your health and issues that could affect your pregnancy. Ask for help quitting smoking. Find out what you can do to take care of yourself and your unborn baby.
- Ask your doctor to recommend a counselor who you can talk to about your situation.
- Seek support in someone you trust and respect.

Trying to Get Pregnant

How do you figure out when you're fertile and when you're not? Wondering if you or your partner is infertile? Read on to boost your chances of conception and get help for fertility problems.

Fertility awareness

The menstrual cycle

Being aware of your menstrual cycle and the changes in your body that happen during this time can help you know when you are most likely to get pregnant.

The average menstrual cycle lasts 28 days. But normal cycles can vary from 21 to 35 days. The amount of time before ovulation occurs is different in every woman and even can be different from month to month in the same woman, varying from 13 to 20 days long. Learning about this part of the cycle is important because it is when ovulation and pregnancy can occur. After ovulation, every woman (unless she has a health problem that affects her periods or becomes pregnant) will have a period within 14 to 16 days.

Charting your fertility pattern

Knowing when you're most fertile will help you plan pregnancy. There are three ways you can keep track of your fertile times. They are:

1. **Basal body temperature method** – Basal body temperature is your temperature at rest as soon as you awake in the morning. A woman's basal body temperature rises slightly with ovulation. So by recording this temperature daily for several months, you'll be able to predict your most fertile days.
2. Basal body temperature differs slightly from woman to woman. Anywhere from 96 to 98 degrees Fahrenheit orally is average before ovulation. After ovulation most women have an oral temperature between 97 and 99 degrees Fahrenheit. The rise in temperature can be a sudden jump or a gradual climb over a few days.
3. Usually a woman's basal body temperature rises by only 0.4 to 0.8 degrees Fahrenheit. To detect this tiny change, women must use a basal body thermometer. These thermometers are very sensitive. Most pharmacies sell them for about $10. You can then record your temperature on a basal body temperature chart.

4. The rise in temperature doesn't show exactly when the egg is released. But almost all women have ovulated within three days after their temperatures spike. Body temperature stays at the higher level until the woman's period starts.
5. A woman is most fertile and most likely to get pregnant:
    - Two to three days before your temperature hits the highest point (ovulation)
    - and 12 to 24 hours after ovulation
6. A man's sperm can live for up to three days in a woman's body. The sperm can fertilize an egg at any point during that time. So if you have unprotected sex a few days before ovulation, you could get pregnant.
7. Many things can affect basal body temperature. For your chart to be useful, make sure to take your temperature every morning at about the same time. Things that can alter your temperature include:
    - Drinking alcohol the night before
    - Smoking cigarettes the night before
    - Getting a poor night's sleep
    - Having a fever
    - Doing anything in the morning before you take your temperature — including going to the bathroom and talking on the phone
8. **Calendar method**– This involves recording your menstrual cycle on a calendar for eight to 12 months. The first day of your period is Day 1. Circle Day 1 on the calendar. The length of your cycle may vary from month to month. So write down the total number of days it lasts each time. Using this record, you can find the days you are most fertile in the months ahead:
    - To find out the first day when you are most fertile, subtract 18 from the total number of days in your shortest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The X marks the first day you're likely to be fertile.
    - To find out the last day when you are most fertile, subtract 11 from the total number of days in your longest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The time between the two Xs is your most fertile window.
9. This method always should be used along with other fertility awareness methods, especially if your cycles are not always the same length.

Optional: Use this Ovulation and due date calculator to find out when you (or a woman you know) are most likely to become pregnant and to estimate your due date should conception occur.

Did you know?

The cervical mucus method is less reliable for some women. Women who are breastfeeding, taking hormonal birth control (like the pill), using feminine hygiene products, have vaginitis or sexually transmitted infections (STIs), or have had surgery on the cervix should not rely on this method.

1. **Cervical mucus method** (also known as the ovulation method) – This involves being aware of the changes in your cervical mucus throughout the month. The hormones that control the menstrual cycle also change the kind and amount of mucus you have before and during ovulation. Right after your period, there are usually a few days when there is no mucus present or "dry days." As the egg starts to mature, mucus increases in the vagina, appears at the vaginal opening, and is white or yellow and cloudy and sticky. The greatest amount of mucus appears just before ovulation. During these "wet days" it becomes clear and slippery, like raw egg whites. Sometimes it can be stretched apart. This is when you are most fertile. About four days after the wet days begin the mucus changes again. There will be much less and it becomes sticky and cloudy. You might have a few more dry days before your period returns. Describe changes in your mucus on a calendar. Label the days, "Sticky," "Dry," or "Wet." You are most fertile at the first sign of wetness after your period or a day or two before wetness begins.
2. To most accurately track your fertility, use a combination of all three methods. This is called the symptothermal (SIMP-toh-thur-muhl) method. You can also purchase over-the-counter ovulation kits or fertility monitors to help find the best time to conceive. These kits work by detecting surges in a specific hormone called luteinizing hormone, which triggers ovulation.

Infertility

Some women want children but either cannot conceive or keep miscarrying. This is called infertility. Lots of couples have infertility problems. About one-third of the time, it is a female problem. In another one-third of cases, it is the man with the fertility problem. For the remaining one-third, both partners have fertility challenges or no cause is found.

Causes of infertility

Some common reasons for infertility in women include:

Age – Women generally have some decrease in fertility starting in their early 30s. And while many women in their 30s and 40s have no problems getting pregnant, fertility especially declines after age 35. As a woman ages, normal changes that occur in her ovaries and eggs make it harder to become pregnant. Even though menstrual cycles continue to be regular in a woman's 30s and 40s, the eggs that ovulate each month are of poorer quality than those from her 20s. It is harder to get pregnant when the eggs are poorer in quality. As a woman nears menopause, the ovaries may not release an egg each month, which also can make it harder to get pregnant. Also, as a woman and her eggs age, she is more likely to miscarry, as well as have a baby with genetic problems, such as Down syndrome.

Health problems – Some women have diseases or conditions that affect their hormone levels, which can cause infertility. Women with polycystic ovary syndrome (PCOS) rarely or never ovulate. Failure to ovulate is the most common cause of infertility in women.

- With primary ovarian insufficiency (POI), a woman's ovaries stop working normally before she is 40. It is not the same as early menopause. Some women with POI get a period now and then. But getting pregnant is hard for women with POI.
- A condition called luteal phase defect (LPD) is a failure of the uterine lining to be fully prepared for pregnancy. This can keep a fertilized egg from implanting or result in miscarriage.

Common problems with a woman's reproductive organs, like uterine fibroids, endometriosis, and pelvic inflammatory disease can worsen with age and also affect fertility. These conditions might cause the fallopian tubes to be blocked, so the egg can't travel through the tubes into the uterus.

Lifestyle factors – Certain lifestyle factors also can have a negative effect on a woman's fertility. Examples include smoking, alcohol use, weighing much more or much less than an ideal body weight, a lot of strenuous exercise, and having an eating disorder. Stress also can affect fertility.

Unlike women, some men remain fertile into their 60s and 70s. But as men age, they might begin to have problems with the shape and movement of their sperm. They also have a slightly higher risk of sperm gene defects. Or they might produce no sperm, or too few sperm. Lifestyle choices also can affect the number and quality of a man's sperm. Alcohol and drugs can temporarily reduce sperm quality. And researchers are looking at whether environmental toxins, such as pesticides and lead, also may be to blame for some cases of infertility. Men also can have health problems that affect their sexual and reproductive function. These can include sexually transmitted infections (STIs), diabetes, surgery on the prostate gland, or a severe testicle injury or problem.

When to see your doctor

You should talk to your doctor about your fertility if:

- You are younger than 35 and have not been able to conceive after one year of frequent sex without birth control.
- You are age 35 or older and have not been able to conceive after six months of frequent sex without birth control.
- You believe you or your partner might have fertility problems in the future (even before you begin trying to get pregnant).
- You or your partner has a problem with sexual function or libido.

Happily, doctors are able to help many infertile couples go on to have babies.

If you are having fertility issues, your doctor can refer you to a fertility specialist, a doctor who treats infertility. The doctor will need to test both you and your partner to find out what the problem is. Depending on the problem, your doctor might recommend treatment. About 9 in 10 cases of infertility are treated with drugs or surgery. *Don't delay seeing your doctor as age also affects the success rates of these treatments.* For some couples, adoption or foster care offers a way to share their love with a child and to build a family.

Infertility treatment

Some treatments include:

- **Drugs** – Various fertility drugs may be used for women with ovulation problems. It is important to talk with your doctor about the drug to be used. You should understand the drug's benefits and side effects. Depending on the type of fertility drug and the dosage of the drug used, multiple births (such as twins) can occur.
- **Surgery** – Surgery is done to repair damage to a woman's ovaries, fallopian tubes, or uterus. Sometimes a man has an infertility problem that can be corrected by surgery.
- **Intrauterine (in-truh-YOOT-uh-ruhn) insemination (IUI), also called artificial insemination** – Male sperm is injected into part of the woman's reproductive tract, such as into the uterus or fallopian tube. IUI often is used along with drugs that

cause a woman to ovulate.
- **Assisted reproductive technology (ART)** – ART involves stimulating a woman's ovaries; removing eggs from her body; mixing them with sperm in the laboratory; and putting the embryos back into a woman's body. Success rates of ART vary and depend on many factors.
- **Third party assistance** – Options include donor eggs (eggs from another woman are used), donor sperm (sperm from another man are used), or surrogacy (when another woman carries a baby for you).

Finding the cause of infertility is often a long, complex, and emotional process. And treatment can be expensive. Many health insurance companies do not provide coverage for infertility or provide only limited coverage. Check your health insurance contract carefully to learn about what is covered. Some states have laws that mandate health insurance policies to provide infertility coverage.

Preconception Care: Why Preconception Health Matters

Preconception health is a woman's health before she becomes pregnant. It means knowing how health conditions and risk factors could affect a woman or her unborn baby if she becomes pregnant. For example, some foods, habits, and medicines can harm your baby — even before he or she is conceived. Some health problems, such as diabetes, also can affect pregnancy.

Every woman should be thinking about her health whether or not she is planning pregnancy. One reason is that about half of all pregnancies are not planned. Unplanned pregnancies are at greater risk of preterm birth and low birth weight babies. Another reason is that, despite important advances in medicine and prenatal care, about 1 in 8 babies is born too early. Researchers are trying to find out why and how to prevent preterm birth. But experts agree that women need to be healthy before becoming pregnant. By taking action on health issues and risks before pregnancy, you can prevent problems that might affect you or your baby later.

Five most important things to boost your preconception health

Women and men should prepare for pregnancy before becoming sexually active — or at least three months before getting pregnant. Some actions, such as quitting smoking, reaching a healthy weight, or adjusting medicines you are using, should start even earlier. The five most important things a woman can do for preconception health are:

1. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) of folic acid every day if you are planning or capable of pregnancy to lower your risk of some birth defects of the brain and spine, including spina bifida. All women need folic acid every day. Talk to your doctor about your folic acid needs. Some doctors prescribe prenatal vitamins that contain higher amounts of folic acid.
2. Stop smoking and drinking alcohol.
3. If you have a medical condition, be sure it is under control. Some conditions that can affect pregnancy or be affected by it include asthma, diabetes, oral health, obesity, or epilepsy.
4. Talk to your doctor about any over-the-counter and prescription medicines you are using. Note: These include dietary or herbal supplements. Be sure your vaccinations are up to date.
5. Avoid contact with toxic substances or materials that could cause infection at work and at home. Stay away from chemicals and cat or rodent feces.

Contraception

According to the Guttmacher Institute: " In 2008, there were 6.4 million pregnancies to the 62 million women of reproductive age (15–44) in the United States. Sixty-six percent of these pregnancies resulted in live births and 19% in induced abortions. And, nearly half of pregnancies among American women—more than three million each year—are unintended."

An unintended pregnancy is a pregnancy that is either mistimed or unwanted at the time of conception. It is a core concept in understanding the fertility of populations and the unmet need for contraception. Unintended pregnancy is associated with an increased risk of morbidity for women, and with health behaviors during pregnancy that are associated with adverse effects. For example, women with an unintended pregnancy may delay prenatal care, which may affect the health of the infant. Women of all ages may have unintended pregnancies, but some groups, such as teens, are at a higher risk. Efforts to decrease unintended pregnancy include finding better forms of contraception, and increasing contraceptive use and adherence.

Contraception, also known as birth control, is designed to prevent pregnancy. Some types of birth control include (but are not

limited to):

- Barrier methods, such as condoms, the diaphragm, and the cervical cap, are designed to prevent the sperm from reaching the egg for fertilization. Intrauterine device, or IUD, is a small device that is inserted into the uterus by a health care provider. The IUD prevents a fertilized egg from implanting in the uterus. An IUD can stay in the uterus for up to 10 years until a health care provider removes it.
- Hormonal birth control, such as birth control pills, injections, skin patches, and vaginal rings, release hormones into a woman's body that interfere with fertility by preventing ovulation, fertilization, or implantation.
- Sterilization is a method that permanently prevents a woman from getting pregnant or a man from being able to get a woman pregnant. Sterilization involves surgical procedures that must be done by a health care provider and usually cannot be reversed.

The choice of birth control depends on factors such as a person's overall health, age, frequency of sexual activity, number of sexual partners, desire to have children in the future, and family history of certain diseases. A woman should talk to her health care provider about her choice of birth control method.

It is important to remember that even though birth control methods can prevent pregnancy, they do not all protect against sexually transmitted diseases or HIV.

Contraception Methods

There is no "best" method of birth control. Each method has its pros and cons. All women and men can have control over when, and if, they become parents. Making choices about birth control, or contraception, isn't easy. There are many things to think about. To get started, learn about birth control methods you or your partner can use to prevent pregnancy. You can also talk with your doctor about the choices.

Before choosing a birth control method, think about:

- Your overall health
- How often you have sex
- The number of sex partners you have
- If you want to have children someday
- How well each method works to prevent pregnancy
- Possible side effects
- Your comfort level with using the method

You can choose from many methods of birth control. They are grouped by how they work:

- Continuous abstinence: This means not having sex (vaginal, anal, or oral) at any time. It is the only sure way to prevent pregnancy and protect against sexually transmitted infections (STIs), including HIV.
- Natural family planning/rhythm method: This method is when you do not have sex or use a barrier method on the days you are most fertile (most likely to become pregnant). A woman who has a regular menstrual cycle has about 9 or more days each month when she is able to get pregnant. These fertile days are about 5 days before and 3 days after ovulation, as well as the day of ovulation.

To have success with this method, you need to learn about your menstrual cycle. Then you can learn to predict which days you are fertile or "unsafe." To learn about your cycle, keep a written record of:

- When you get your period
- What it is like (heavy or light blood flow)
- How you feel (sore breasts, cramps)

This method also involves checking your cervical mucus and recording your body temperature each day. Cervical mucus is the discharge from your vagina. You are most fertile when it is clear and slippery like raw egg whites. Use a basal thermometer to take your temperature and record it in a chart. Your temperature will rise 0.4 to 0.8° F on the first day of ovulation. You can talk with your doctor or a natural family planning instructor to learn how to record and understand this information.

Barrier Methods - Put up a block, or barrier, to keep sperm from reaching the egg

Before having sex, you wet the sponge and place it, loop side down, inside your vagina to cover the cervix. The sponge is effective

for more than one act of intercourse for up to 24 hours. It needs to be left in for at least 6 hours after having sex to prevent pregnancy. It must then be taken out within 30 hours after it is inserted.

Only one kind of contraceptive sponge is sold in the United States. It is called the Today Sponge. Women who are sensitive to the spermicide nonoxynol-9 should not use the sponge.

Diaphragm, cervical cap, and cervical shield

These barrier methods block the sperm from entering the cervix (the opening to your womb) and reaching the egg.

- The diaphragm is a shallow latex cup.
- The cervical cap is a thimble-shaped latex cup. It often is called by its brand name, FemCap.
- The cervical shield is a silicone cup that has a one-way valve that creates suction and helps it fit against the cervix. It often is called by its brand name, Lea's Shield.

The diaphragm and cervical cap come in different sizes, and you need a doctor to "fit" you for one. The cervical shield comes in one size, and you will not need a fitting. Before having sex, add spermicide (to block or kill sperm) to the devices. Then place them inside your vagina to cover your cervix. You can buy spermicide gel or foam at a drug store.

All three of these barrier methods must be left in place for 6 to 8 hours after having sex to prevent pregnancy. The diaphragm should be taken out within 24 hours. The cap and shield should be taken out within 48 hours.

Female condom

This condom is worn by the woman inside her vagina. It keeps sperm from getting into her body. It is made of thin, flexible, manmade rubber and is packaged with a lubricant. It can be inserted up to 8 hours before having sex. Use a new condom each time you have intercourse. And don't use it and a male condom at the same time.

Male condom

Male condoms are a thin sheath placed over an erect penis to keep sperm from entering a woman's body. Condoms can be made of latex, polyurethane, or "natural/lambskin". The natural kind do not protect against STIs. Condoms work best when used with a vaginal spermicide, which kills the sperm. A new condom needs to be used with each sex act.

Condoms are either:

- Lubricated, which can make sexual intercourse more comfortable
- Non-lubricated, which can also be used for oral sex. It is best to add lubrication to nonlubricated condoms if you use them for vaginal or anal sex. You can use a waterbased lubricant, such as K-Y jelly. You can buy them at the drug store. Oil-based lubricants like massage oils, baby oil, lotions, or petroleum jelly will weaken the condom, causing it to tear or break.

Keep condoms in a cool, dry place. If you keep them in a hot place (like a wallet or glove compartment), the latex breaks down. Then the condom can tear or break.

Hormonal methods - Prevent pregnancy by interfering with ovulation, fertilization, and/or implantation of the fertilized egg

Oral contraceptives - combined pill ("The pill")

The pill contains the hormones estrogen and progestin. It is taken daily to keep the ovaries from releasing an egg. The pill also causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining the egg.

Some women prefer the "extended cycle" pills. These have 12 weeks of pills that contain hormones (active) and 1 week of pills that don't contain hormones (inactive). While taking extended cycle pills, women only have their period three to four times a year.

Many types of oral contraceptives are available. Talk with your doctor about which is best for you.

Your doctor may advise you not to take the pill if you:

- Are older than 35 and smoke
- Have a history of blood clots

- Have a history of breast, liver, or endometrial cancer

Antibiotics may reduce how well the pill works in some women. Talk to your doctor about a backup method of birth control if you need to take antibiotics. Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

The patch

Also called by its brand name, Ortho Evra, this skin patch is worn on the lower abdomen, buttocks, outer arm, or upper body. It releases the hormones progestin and estrogen into the bloodstream to stop the ovaries from releasing eggs in most women. It also thickens the cervical mucus, which keeps the sperm from joining with the egg. You put on a new patch once a week for 3 weeks. You don't use a patch the fourth week in order to have a period.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Shot/injection

The birth control shot often is called by its brand name Depo-Provera. With this method you get injections, or shots, of the hormone progestin in the buttocks or arm every 3 months. A new type is injected under the skin. The birth control shot stops the ovaries from releasing an egg in most women. It also causes changes in the cervix that keep the sperm from joining with the egg.

Vaginal ring

This is a thin, flexible ring that releases the hormones progestin and estrogen. It works by stopping the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining the egg. It is commonly called *NuvaRing*, its brand name. You squeeze the ring between your thumb and index finger and insert it into your vagina. You wear the ring for 3 weeks, take it out for the week that you have your period, and then put in a new ring.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Implantable devices — Devices that are inserted into the body and left in place for a few years.

Implantable rod

This is a matchstick-size, flexible rod that is put under the skin of the upper arm. It is often called by its brand name, Implanon. The rod releases a progestin, which causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining an egg. Less often, it stops the ovaries from releasing eggs. It is effective for up to 3 years.

Intrauterine devices or IUDs

An IUD is a small device shaped like a "T" that goes in your uterus. There are two types:

- |Copper IUD The copper IUD goes by the brand name ParaGard. It releases a small amount of copper into the uterus, which prevents the sperm from reaching and fertilizing the egg. It fertilization does occur, the IUD keeps the fertilized egg from implanting in the lining of the uterus. A doctor needs to put in your copper IUD. It can stay in your uterus for 5 to 10 years.
- Hormonal IUD The hormonal IUD goes by the brand name Mirena. It is sometimes called an intrauterine system, or IUS. It releases progestin into the uterus, which keeps the ovaries from releasing an egg and causes the cervical mucus to thicken so sperm can't reach the egg. It also affects the ability of a fertilized egg to successfully implant in the uterus. A doctor needs to put in a hormonal IUD. It can stay in your uterus for up to 5 years.

Sterilization implant (essure)

Essure is the first non-surgical method of sterilizing women. A thin tube is used to thread a tiny spring-like device through the vagina and uterus into each fallopian tube. The device works by causing scar tissue to form around the coil. This blocks the

fallopian tubes and stops the egg and sperm from joining.

It can take about 3 months for the scar tissue to grow, so it's important to use another form of birth control during this time. Then you will have to return to your doctor for a test to see if scar tissue has fully blocked your tubes.

Surgical sterilization

For women, surgical sterilization closes the fallopian tubes by being cut, tied, or sealed. This stops the eggs from going down to the uterus where they can be fertilized. The surgery can be done a number of ways. Sometimes, a woman having cesarean birth has the procedure done at the same time, so as to avoid having additional surgery later.

For men, having a vasectomy (vuh-SEK-tuh-mee) keeps sperm from going to his penis, so his ejaculate never has any sperm in it. Sperm stays in the system after surgery for about 3 months. During that time, use a backup form of birth control to prevent pregnancy. A simple test can be done to check if all the sperm is gone; it is called a semen analysis.

Emergency contraception

Used if a woman's primary method of birth control fails. It should not be used as a regular method of birth control. Emergency contraception (Plan B One-Step or Next Step. It is also called the "morning after pill.") Emergency contraception keeps a woman from getting pregnant when she has had unprotected vaginal intercourse. "Unprotected" can mean that no method of birth control was used. It can also mean that a birth control method was used but it was used incorrectly, or did not work (like a condom breaking). Or, a woman may have forgotten to take her birth control pills. She also may have been abused or forced to have sex. These are just some of the reasons women may need emergency contraception.

Emergency contraception can be taken as a single pill treatment or in two doses. A single dose treatment works as well as two doses and does not have more side effects. It works by stopping the ovaries from releasing an egg or keeping the sperm from joining with the egg. For the best chances for it to work, take the pill as soon as possible after unprotected sex. It should be taken within 72 hours after having unprotected sex.

A single-pill dose or two-pill dose of emergency contraception is available over-the-counter (OTC) for women ages 17 and older.

Can all types of birth control prevent sexually transmitted infections (STIs)?

No. The male latex condom is the only birth control method proven to help protect you from STIs, including HIV. Research is being done to find out how effective the female condom is at preventing STIs and HIV. For more information, see Will birth control pills protect me from sexually transmitted infections (STIs), including HIV/AIDS?

How well do different kinds of birth control work? Do they have side effects?

All birth control methods work the best if used correctly and every time you have sex. Be sure you know the right way to use them. Sometimes doctors don't explain how to use a method because they assume you already know. Talk with your doctor if you have questions. They are used to talking about birth control. So don't feel embarrassed about talking to him or her. Some birth control methods can take time and practice to learn. For example, some people don't know you can put on a male condom "inside out." Also, not everyone knows you need to leave a little space at the tip of the condom for the sperm and fluid when a man ejaculates, or has an orgasm. The misuse of contraceptives is known as human error and is the main reason why effectiveness is determined by typical use and perfect use. Below is a table showing the percentage of woman experiencing an unintended pregnancy during the fist year of typical use and the first year of perfect use of different types of contraception.

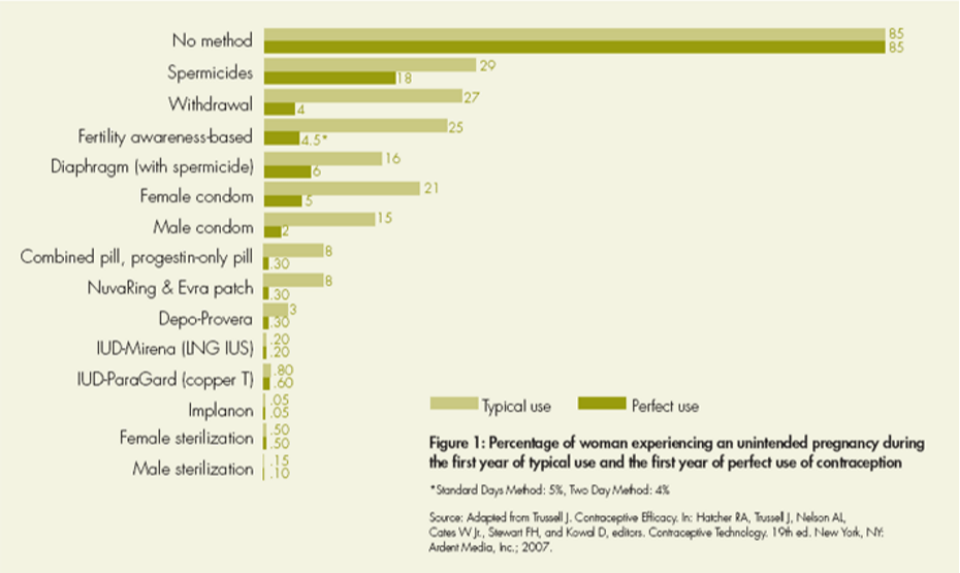


Figure 2.2.6.9.1. Success Rates of Common Contraception

Where to Get Birth Control

Where you get birth control depends on what method you choose.

You will need surgery or a medical procedure for:

- Sterilization, female and male

You need a prescription for these forms:

- Skin patch
- Diaphragm (your doctor needs to fit one to your shape)
- Cervical shield
- IUD (inserted by a doctor)
- Implantable rod (inserted by a doctor)

You can buy these forms over the counter:

- Male condoms
- Female condoms
- Sponges
- Spermicides
- Emergency contraception pills (girls younger than 17 need a prescription)
- Spermacides: They work by killing sperm. They come in many forms:
  - Foam
  - Gel
  - Cream
  - Film
  - Suppository
  - Tablet

Spermicides are put in the vagina no more than 1 hour before having sex. If you use a film, suppository, or tablet, wait at least 15 minutes before having sex so the spermicide can dissolve. Do not douche or rinse out your vagina for at least 6 to 8 hours after

having sex. You will need to use more spermicide each time you have sex.

Spermicides work best if used along with a barrier method, such as a condom, diaphragm, or cervical cap. Some spermicides are made just for use with the diaphragm and cervical cap. Check the package to make sure you are buying what you need.

All spermicides contain sperm-killing chemicals. Some contain nonoxynol-9, which may raise your risk of HIV if you use it a lot. It irritates the tissue in the vagina and anus, so it can cause the HIV virus to enter the body more freely. Some women are sensitive to nonoxynol-9 and need to use spermicides without it. Medications for vaginal yeast infections may lower the effectiveness of spermicides. Also, spermicides do not protect against sexually transmitted infections.

Withdrawal

Withdrawal is when a man takes his penis out of a woman's vagina (or "pulls out") before he ejaculates, or has an orgasm. This stops the sperm from going to the egg. "Pulling out" can be hard for a man to do. It takes a lot of self-control. Even if you use withdrawal, sperm can be released before the man pulls out. When a man's penis first becomes erect, preejaculate fluid may be on the tip of the penis. This fluid has sperm in it. So you could still get pregnant. Withdrawal does not protect you from STIs or HIV.

Dental Dams

The dental dam is a square piece of rubber that is used by dentists during oral surgery and other procedures. It is not a method of birth control. But it can be used to help protect people from STIs, including HIV, during oral-vaginal or oral-anal sex. It is placed over the opening to the vagina or the anus before having oral sex. You can buy dental dams at surgical supply stores.

Abortion

Abortion is the ending of pregnancy by removing a fetus or embryo before it can survive outside the uterus. An abortion that occurs spontaneously is also known as a miscarriage.

An abortion may be caused purposely and is then called an induced abortion, or less frequently, "induced miscarriage". The word abortion is often used to mean only induced abortions. A similar procedure after the fetus could potentially survive outside the womb is known as a "late termination of pregnancy".

When allowed by law, abortion in the developed world is one of the safest procedures in medicine. Modern methods use medication or surgery for abortions. The drug mifepristone in combination with prostaglandin appears to be as safe and effective as surgery during the first and second trimester of pregnancy. Birth control, such as the pill or intrauterine devices, can be used immediately following abortion. When performed legally and safely, induced abortions do not increase the risk of long-term mental or physical problems. In contrast, unsafe abortions (those performed by unskilled individuals, with hazardous equipment, or in unsanitary facilities) cause 47,000 deaths and 5 million hospital admissions each year. The World Health Organization recommends safe and legal abortions be available to all women.

Around 56 million abortions are performed each year in the world, with about 45% done unsafely. Abortion rates changed little between 2003 and 2008, before which they decreased for at least two decades as access to family planning and birth control increased. As of 2008, 40% of the world's women had access to legal abortions without limits as to reason. Countries that permit abortions have different limits on how late in pregnancy abortion is allowed.

Historically, abortions have been attempted using herbal medicines, sharp tools, with force, or through other traditional methods. Abortion laws and cultural or religious views of abortions are different around the world. In some areas abortion is legal only in specific cases such as rape, problems with the fetus, poverty, risk to a woman's health, or incest. In many places there is much debate over the moral, ethical, and legal issues of abortion. Those who oppose abortion often maintain that an embryo or fetus is a human with a right to life and may compare abortion to murder. Those who favor the legality of abortion often hold that a woman has a right to make decisions about her own body.

Methods of Abortion

How many weeks a woman is pregnant is usually the main factor in determining which abortion methods are practiced. Below are the two main methods for abortion.

Medical

Medical abortions are performed without entering the uterus. Instead, medical abortions terminate a pregnancy by abortifacient pharmaceuticals, which are drugs that cause abortion. These drugs induce abortion by blocking the action of progesterone, which results in the lining of the embryo being expelled from the uterus, thus terminating the pregnancy.

If medical abortion fails, surgical abortion must be used to complete the procedure. Early medical abortions account for the majority of abortions before 9 weeks gestation in Britain, France, Switzerland, and the Nordic countries. In the United States, the percentage of early medical abortions is far lower.

Medical abortion regimens using mifepristone in combination with a prostaglandin analog are the most common methods used for second-trimester abortions in Canada, most of Europe, China and India, in contrast to the United States where 96% of second-trimester abortions are performed surgically by dilation and evacuation.

Surgical

Up to 15 weeks' into a pregnancy, suction-aspiration or vacuum aspiration are the most common surgical methods of induced abortion. Manual vacuum aspiration (MVA) consists of removing the fetus or embryo, placenta, and membranes by suction using a manual syringe, while electric vacuum aspiration (EVA) uses an electric pump. These techniques differ in the mechanism used to apply suction, in how early in pregnancy they can be used, and in whether cervical dilation is necessary.

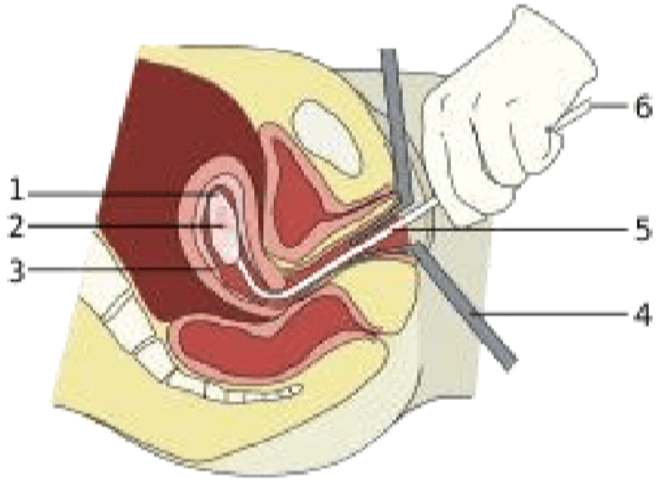


Figure 2.2.6.9.2. Vacuum Aspiration Abortion

1. Amniotic sac
2. Embryo
3. Uterine lining
4. Speculum
5. Vacurette
6. Attached to a suction pump

MVA, also known as "mini-suction" and "menstrual extraction", can be used in very early pregnancy, and does not require cervical dilation. Dilation and curettage (D&C), the second most common method of surgical abortion, is a standard gynecological procedure performed for a variety of reasons, including examination of the uterine lining for possible malignancy, investigation of abnormal bleeding, and abortion. Curettage refers to cleaning the walls of the uterus with a curette. The World Health Organization recommends this procedure, also called sharp curettage, only when MVA is unavailable.

From the 15th week of gestation until approximately the 26th, other techniques must be used. Dilation and evacuation (D&E) consists of opening the cervix of the uterus and emptying it using surgical instruments and suction. After the 16th week of gestation, abortions can also be induced by intact dilation and extraction (IDX) (also called intrauterine cranial decompression), which requires surgical decompression of the fetus's head before evacuation. IDX is sometimes called "partial-birth abortion", which has been federally banned in the United States.

In the third trimester of pregnancy, induced abortion may be performed surgically by intact dilation and extraction or by hysterotomy. Hysterotomy abortion is a procedure similar to a caesarean section and is performed under general anesthesia. It

requires a smaller incision than a caesarean section and is used during later stages of pregnancy. First-trimester procedures can generally be performed using local anesthesia, while second-trimester methods may require deep sedation or general anesthesia.

Abortion Debate

Induced abortion has long been the course of considerable debate.

Ethical, moral, philosophical, biological, religious and legal issues surrounding abortion are related to value systems. Opinions of abortion may be about fetal rights, governmental authority, and women's rights.

In both public and private debate, arguments presented in favor of or against abortion access focus on either the moral permissibility of an induced abortion, or justification of laws permitting or restricting abortion. The World Medical Association Declaration on Therapeutic Abortion notes, "circumstances bringing the interests of a mother into conflict with the interests of her unborn child create a dilemma and raise the question as to whether or not the pregnancy should be deliberately terminated." Abortion debates, especially pertaining to abortion laws, are often spearheaded by groups advocating one of these two positions. Anti-abortion groups who favor greater legal restrictions on abortion, including complete prohibition, most often describe themselves as "**pro-life**" while abortion rights groups who are against such legal restrictions describe themselves as "**pro-choice**". Generally, the former position argues that a human fetus is a human person with a right to live, making abortion morally the same as murder. The latter position argues that a woman has certain reproductive rights, especially the choice whether or not to carry a pregnancy to term.

Roe v. Wade

Roe v. Wade is a landmark decision issued in 1973 by the United States Supreme Court on the issue of the constitutionality of laws that criminalized or restricted access to abortions. The Court ruled 7–2 that a right to privacy under the Due Process Clause of the 14th Amendment extended to a woman's decision to have an abortion, but that this right must be balanced against the state's interests in regulating abortions: protecting women's health and protecting the potentiality of human life. Arguing that these state interests became stronger over the course of a pregnancy, the Court resolved this balancing test by tying state regulation of abortion to the third trimester of pregnancy.

Later, in *Planned Parenthood v. Casey* (1992), the Court rejected *Roe*'s trimester framework while affirming its central holding that a woman has a right to abortion until fetal viability. The *Roe* decision defined "viable" as "potentially able to live outside the mother's womb, albeit with artificial aid." Justices in *Casey* acknowledged that viability may occur at 23 or 24 weeks, or sometimes even earlier, in light of medical advances. In disallowing many state and federal restrictions on abortion in the United States, *Roe v. Wade* prompted a national debate that continues today about issues including whether, and to what extent, abortion should be legal, who should decide the legality of abortion, what methods the Supreme Court should use in constitutional adjudication, and what the role should be of religious and moral views in the political sphere. *Roe v. Wade* reshaped national politics, dividing much of the United States into pro-life and pro-choice camps, while activating grassroots movements on both sides.

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2.2.7: INFECTIOUS DISEASES AND SEXUALLY TRANSMITTED INFECTIONS

Most people on Earth experience at least one episode of an infectious disease every year. Although the majority recover, hundreds of millions suffer severe or long-term health effects as a direct result of an infection and around 10 million people – many of them children – lose their lives. In the 1960s, it was widely believed that advances in methods of prevention and treatment would overcome the threat to health from infectious diseases. Unfortunately these predictions have proved to be optimistic because of the rapidly increasing threat from 'emerging infectious diseases'.

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2.2.7.2: Sexually Transmitted Infections

2.2.7.3: STD/STI Treatments

2.2.7.4: STD/STI Prevention- How to Prevet STI's

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2.2.7.11: Immune Defenses Against Infectious Diseases

2.2.7.12: Risk Factors and Levels of Disease Prevention

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2.2.7.1: Levels of Disease Prevention

Prevention includes a wide range of activities — known as “interventions” — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviours that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)
- education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems. Examples include:

- regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- support groups that allow members to share strategies for living well
- vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

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2.2.7.2: Sexually Transmitted Infections

What are some types of sexually transmitted diseases or sexually transmitted infections (STDs/STIs)?

Approximately 20 different infections are known to be transmitted through sexual contact. Here are descriptions of some of the most common and well known:

- Chlamydia
- Gonorrhea
- Genital Herpes
- HIV/AIDS
- Human Papillomavirus (HPV)
- Syphilis
- Bacterial Vaginosis
- Trichomoniasis
- Viral Hepatitis

Chlamydia

Figure 2.2.7.2.1. Cervicitis and mucopurulent endocervical discharge in female chlamydial infection.

Chlamydia is a common STD/STI caused by the bacterium *Chlamydia trachomatis*. Chlamydia can be transmitted during vaginal, oral, or anal sexual contact with an infected partner. While many individuals will not experience symptoms, chlamydia can cause fever, abdominal pain, and unusual discharge of the penis or vagina.

In women, whether or not they are having symptoms and know about their infection, chlamydia can cause pelvic inflammatory disease (PID). In PID, the untreated STD/STI progresses and involves other parts of the woman's reproductive system, including the uterus and fallopian tubes. This progression can lead to permanent damage to the woman's reproductive organs. This damage may lead to ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

Additionally, if the woman is pregnant, her developing fetus is at risk, because chlamydia can be passed on during her pregnancy or delivery and could lead to eye infections or pneumonia in the infant. If chlamydia is detected early, it can be treated easily with an antibiotic taken by mouth.

Gonorrhea

Gonorrhea is caused by the bacterium Neisseria gonorrhoeae, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract. The most common symptoms of gonorrheal infection are a discharge from the vagina or penis and painful or difficult urination.

As with chlamydial infection, the most common and serious complications of gonorrhea occur in women and include pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and the potential spread to the developing fetus if acquired during pregnancy. Gonorrhea also can infect the mouth, throat, eyes, and rectum and can spread to the blood and joints, where it can become a life-threatening illness.

In addition, people with gonorrhea can more easily contract HIV, the virus that causes AIDS. HIV-infected people with gonorrhea are also more likely to transmit the virus to someone else.

Syphilis

Syphilis infections, caused by the bacterium Treponema pallidum, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres. Between 2001 and 2009, the Centers for Disease Control and Prevention (CDC) data show that the syphilis rate increased each year. Those people at highest risk for syphilis include men having sex with both men and women and people residing in the south. The first sign of syphilis is a chancre, a painless genital sore that most often appears on the penis or in and around the vagina. Beyond being the first sign of a syphilis infection, chancres make a person two to five times more likely to contract an HIV infection. If the person is already infected with HIV, chancres also increase the

likelihood that the virus will be passed on to a sexual partner. These sores typically resolve on their own, even without treatment. However, the body does not clear the infection on its own, and, over time, syphilis may involve other organs, including the skin, heart, blood vessels, liver, bones, and joints in secondary syphilis. If the illness is still not treated, tertiary syphilis can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.

Expectant mothers harboring the bacterium are at an increased risk of miscarriage and stillbirth, and they can pass the infection on to their fetuses during pregnancy and delivery. Infants that acquire congenital syphilis during pregnancy may suffer from skeletal deformity, difficulty with speech and motor development, seizure, anemia, liver disease, and neurologic problems.

STD/STI Data

CDC FACT SHEET

Reported STDs in the United States

2015 National Data for Chlamydia, Gonorrhea, and Syphilis

Many cases of chlamydia, gonorrhea, and syphilis continue to go undiagnosed and unreported, and data on several additional STDs — such as human papillomavirus, herpes simplex virus, and trichomoniasis — are not routinely reported to CDC. As a result, the annual surveillance report captures only a fraction of the true burden of STDs in America. However, it provides important insights into the scope, distribution, and trends in STD diagnoses in the country.

STDs are a substantial health challenge facing the United States. CDC estimates that nearly **20 million new sexually transmitted infections** occur every year in this country, half among young people aged 15–24, and account for almost $16 billion in health care costs. Each of these infections is a potential threat to an individual's immediate and long-term health and well-being. In addition to increasing a person's risk for acquiring and transmitting HIV infection, STDs can lead to chronic pain and severe reproductive health complications, such as infertility and ectopic pregnancy.

Figure 2.2.7.2.2. How STD's Affect Populations in the United States

Figure 2.2.7.2.3. Ages affected by chlamydia and gonorrhea infections

Genital Herpes

Genital herpes is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2. When symptomatic, HSV-1 usually appears as fever blisters or cold sores on the lips, but it can also infect the genital region through oral-genital or genital-genital contact. Symptomatic HSV-2 typically causes painful, watery skin blisters on or around the genitals or anus. However, substantial numbers of people who carry these viruses have no or only minimal signs or symptoms.

Neither HSV-1 nor HSV-2 can be cured, and even during times when an infected person has no symptoms, the virus can be found in the body's nerve cells. Periodically, some people will experience outbreaks in which new blisters form on the skin in the genital area; at those times, the virus is more likely to be passed on to other people.

Pregnant women, especially those who acquire genital herpes for the first time during pregnancy, may pass the infection to their newborns, causing life-threatening neonatal HSV, an infection affecting the infant's skin, brain, and other organs.

HIV/AIDS

HIV, or the human immunodeficiency virus, is the virus that causes AIDS (acquired immunodeficiency syndrome). HIV destroys the body's immune system by killing the blood cells that fight infection. Once HIV destroys a substantial proportion of these cells (CD4 cells), the body's ability to fight off and recover from infections is compromised. This advanced stage of HIV infection is known as AIDS.

The CD4 count is like a snapshot of how well your immune system is functioning. CD4 cells (also known as CD4+ T cells) are white blood cells that fight infection. The more you have, the better. These are the cells that the HIV virus kills. As HIV infection progresses, the number of these cells declines. When the CD4 count drops below 200 due to advanced HIV disease, a person is diagnosed with AIDS. A normal range for CD4 cells is about 500-1,500. Usually, when a person with low CD4 cells starts HIV

medicines, the CD4 cell count increases as the HIV virus is controlled. Most, but not all, people will experience an increase in CD4 cells with effective HIV treatment.

People whose HIV has progressed to AIDS are very susceptible to opportunistic infections that do not normally make people sick and to certain forms of cancer.

AIDS can be prevented by early initiation of antiretroviral therapy in those with HIV infection. Transmission of the virus primarily occurs during unprotected sexual activity and by sharing needles used to inject intravenous drugs, although the virus also can spread from mother to infant during pregnancy, delivery, and breastfeeding.

In 2013, NIH-supported researchers reported that a 2-year-old child who was born with HIV and was treated starting in the first few days of life has had her HIV infection go into remission. This appears to be the first case of functional cure of HIV.

Human Papillomavirus (HPV)

HPV is the most common STD/STI. More than 40 HPV types exist, and all of them can infect both men and women. The types of HPVs vary in their ability to cause genital warts; infect other regions of the body, including the mouth and throat; and cause cancers of the cervix, vulva, penis, and mouth.

Although no cure exists for HPV infection once it occurs, regular screening with a Pap smear test can prevent or detect at an early stage most cases of HPV-caused cervical cancer. (A Pap smear test involves a health care provider taking samples of cells from the cervix during a standard gynecologic exam; these cells are examined under a microscope for signs of developing cancer).

A newly available vaccine protects against most (but not all) HPV types that cause cervical cancer. The American Academy of Pediatrics recommends this vaccine for school-aged boys and girls.

Bacterial Vaginosis

Bacterial vaginosis is a common, possibly sexually transmitted, vaginal infection in women of reproductive age. While it is healthy and normal for a vagina to have bacteria, just like the skin, mouth, or gastrointestinal (GI) tract, sometimes changes in the balance of different types of bacteria can cause problems.

Bacterial vaginosis occurs when problematic bacteria that are normally present only in small amounts increase in number, replace normal vaginal lactobacilli bacteria, and upset the usual balance. This situation becomes more likely if a woman douches frequently or has new or multiple sexual partners. The most common sign of a bacterial vaginosis infection is a thin, milky discharge that is often described as having a “fishy” odor. However, some women will have no symptoms at all.

Regardless of symptoms, having bacterial vaginosis increases the risk of getting other STDs/STIs and is also associated with pelvic inflammatory disease (PID), an infection of the female reproductive organs, including the uterus and the fallopian tubes (which carry eggs to the uterus), and postoperative infections. Preterm labor and birth are also possibly more common in women with bacterial vaginosis.

Trichomoniasis

Trichomoniasis infection is caused by the single-celled protozoan parasite Trichomonas vaginalis and is common in young, sexually active women. The parasite also infects men, though less frequently. The parasite can be transmitted between men and women as well as between women whenever physical contact occurs between the genital areas.

Although *Trichomonas* infections do not always cause symptoms, they can cause frequent, painful, or burning urination in men and women as well as vaginal discharge, genital soreness, redness, or itching in women. Because the infection can occur without symptoms, a person may be unaware that he or she is infected and continue to re-infect a sexual partner who is having recurrent signs of infection. As with bacterial STDs/STIs, all sexual partners should be treated at the same time to avoid re-infection.

NICHD-sponsored research has shown that during pregnancy, Trichomonas infection is associated with an increased risk of premature birth and infants with low birth weight. Moreover, infants born to mothers with Trichomonas infection are more than twice as likely as infants born to uninfected women to be stillborn or to die as newborns.

Viral Hepatitis

Viral hepatitis is a serious liver disease that can be caused by several different viruses, which can be transmitted through sexual

contact.

- Hepatitis A virus (HAV) causes a short-term or self-limited liver infection that can be quite serious, although it does not result in chronic infection. While there are other ways the virus can be transmitted, HAV can be spread from person to person during sexual activity through oral-rectal contact. Vaccination can prevent HAV infection.
- Hepatitis B virus (HBV) causes a serious liver disease that can result in both immediate illness and lifelong infection leading to permanent liver scarring (cirrhosis), cancer, liver failure, and death. HBV spreads through both heterosexual and homosexual contact as well as through contact with other bodily fluids, such as blood, through shared contaminated needles used for injecting intravenous (IV) drugs, tattooing, and piercing. Pregnant women with HBV can transmit the virus to their infants during delivery. HBV infection is preventable through vaccination.
- Hepatitis C virus (HCV) can cause an immediate illness affecting the liver, but it more commonly becomes a silent, chronic infection that leads to liver scarring (cirrhosis), cancer, liver failure, and death. HCV is most commonly transmitted through sharing needles or exposure to infected blood. However, it can spread through sexual contact or from mother to fetus during pregnancy and delivery. There is no vaccine for HCV, and treatments are not always effective.

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2.2.7.3: STD/STI Treatments

Treatments for Specific Types of Sexually Transmitted Diseases and Sexually Transmitted Infections (STDs/STIs)

- Gonorrhea and Chlamydia
- Genital Herpes
- Human Papillomavirus (HPV)
- Syphilis
- Bacterial Vaginosis
- Trichomoniasis
- Viral Hepatitis
- HIV/AIDS
- During Pregnancy

Gonorrhea and Chlamydia

Gonorrhea and chlamydia are bacterial STDs/STIs that can be treated with antibiotics given either orally or by injection. Because the infections often occur together, people who have one infection are typically treated for both by their health care provider. Recent sexual partners should be treated at the same time.

Genital Herpes

Genital herpes outbreaks can be treated with antiviral drugs. Although this medication can limit the length and severity of outbreaks, it does not cure the infection. In addition, daily suppressive therapy (daily use of antiviral medication) for herpes can reduce the likelihood of transmission to partners. A pregnant woman known to have the infection must take additional care because she can pass the infection to her infant during delivery. Women who first acquire genital HSV during pregnancy are at highest risk of transmission to their infants. If a pregnant woman has an outbreak when she goes into labor, she may need to have a cesarean section (C-section) to prevent the infant from getting the virus during birth.

Human Papillomavirus (HPV)

A person who has an HPV infection cannot be cured. However, many HPV infections can be prevented with vaccination. Furthermore, a health care provider can treat genital warts caused by the virus as well as monitor and control a woman's risk of cervical cancer through frequent screening with Pap smear tests.

Syphilis

If recognized during the early stages, usually within the first year of infection, syphilis can be treated with a singular intramuscular injection of antibiotic. A person being treated for syphilis must avoid sexual contact until the chancre sores caused by the bacteria are completely healed to avoid infecting other people.

If a person does not recognize the infection early, or does not seek treatment immediately, longer treatment with antibiotics may be required. If left untreated, the infection can progress even further and potentially cause death. Although antibiotics can prevent the infection from getting worse, they cannot reverse damage that has already occurred.

Bacterial Vaginosis

Bacterial vaginosis can be treated with antibiotics, typically metronidazole or clindamycin. Generally, male sexual partners of women with bacterial vaginosis do not need to be treated because treatment of partners has not been shown to reduce the risk of recurrence. Treatment during pregnancy is recommended primarily for women at risk for preterm labor or having a low birthweight infant.

Trichomoniasis

Trichomoniasis can be treated with a single dose of an antibiotic, usually either metronidazole or tinidazole, taken by mouth. Often, *Trichomonas* infection recurs, so it is important to make sure that both you and your sexual partners are treated if you are diagnosed with this infection.

Viral Hepatitis

- Hepatitis A virus (HAV) infects the liver and may cause abdominal pain, nausea, and vomiting. Usually the infection gets better on its own without requiring treatment. In some cases, however, individuals may have lasting damage to their livers or may have such severe nausea and vomiting that they must be admitted to the hospital.
- Hepatitis B virus (HBV) can cause a lifelong infection but can be treated with antiviral medications. People with HBV infection will need to see a liver specialist with experience treating individuals with chronic liver disease. These individuals need to take special care not to pass on the virus to their sexual partners, and sexual partners should receive hepatitis B vaccine if not already immune.
- Hepatitis C virus can cause immediate illness affecting the liver or, more commonly, it can be a silent, chronic infection. As with hepatitis B, individuals with HCV may have a lifelong infection and will always be at risk of passing the virus on to their sexual partners. New treatments are available that can clear the infection in some individuals.

More information about hepatitis A, B, and C can be found on the Centers for Disease Control and Prevention website.

HIV/AIDS

There is no cure for HIV/AIDS. However, research into new treatments has improved outcomes for people living with the disease. A combination of antiretroviral drugs can be given in highly active antiretroviral therapy to control the virus, promote a healthy immune system, help people with the virus live longer lives, and reduce the risk of transmission.

During Pregnancy

Pregnant women who have certain types of STDs/STIs may pass them on to their infants during pregnancy or delivery. Therefore, it is important for women to be tested for such STDs/STIs as part of their early prenatal care to help ensure delivery of a healthy infant. The specific treatment will depend on which STD/STI is involved.

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2.2.7.4: STD/STI Prevention- How to Prevet STI's

Every year, there are an estimated 20 million new sexually transmitted infections in the United States. Anyone who is sexually active can get an STI. Some groups are disproportionately affected by STI's:

- Adolescents and Young Adults
- Gay, Bisexual, & other Men who have Sex with Men
- Some Racial and Ethnic Minorities

The Good News: STI's ARE preventable. There are steps you can take to keep yourself and your partner(s) healthy. Here's How You Can Avoid (or reduce the risk of) giving or getting an STI:

Practice Abstinence

The surest way to avoid STI's is to not have sex. This means not having vaginal, oral, or anal sex.

Use Condoms

Using a condom correctly every time you have sex can help you avoid STI's. Condoms lessen the risk of infection for all STI's. **You still can get certain STI's, like herpes or HPV, from contact with your partner's skin even when using a condom.**

Most people say they used a condom the first time they ever had sex, but when asked about the last 4 weeks, less than a quarter said they used a condom every time.

Step by step male condom instructions

Have Fewer Partners

Agree to only have sex with one person who agrees to only have sex with you. Make sure you both get tested to know for sure that neither of you has an STI. This is one of the most reliable ways to avoid STI's.

Get Vaccinated



Figure 2.2.7.4.1. Get Vaccinated!

The most common STI can be prevented by a vaccine. The HPV vaccine is safe, effective, and can help you avoid HPV-related health problems like genital warts and some cancers.

Who should get the HPV vaccine?

- Routine vaccination for boys & girls ages 11 to 12

Catch-up vaccination for:

- Young women ages 13 to 26 and young men ages 13 to 21
- Gay, Bisexual, & other Men who have sex with Men up to age 26
- Men with compromised immune systems up to age 26

Talk With Your Partner

Talk with your sex partner(s) about STI's and staying safe before having sex. It might be uncomfortable to start the conversation, but protecting your health is your responsibility.

Get Tested

Many STI's don't have symptoms, but they can still cause health problems.

- Talk with your health care provider
- Search for CDC recommended tests
- Find a location to get tested for STDs

The only way to know for sure if you have an STI is to get tested.

If You Test Positive...

If either you or your partner is infected with an STI that can be cured (remember, some STI's cannot be cured), both of you need to start treatment immediately to avoid getting re-infected.

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- 11.1C: Overview of the Immune System is licensed CC BY-SA 4.0.

2.2.7.5: What are infectious diseases?

Infectious diseases are distinguished from other illnesses and disorders because they can be transmitted from someone who is ill either directly or indirectly to other individuals, who then develop the same infectious disease and are also able to pass it on. A familiar example is the 'common cold' which almost everyone has experienced at some time in their lives (Figure 2.2.7.5.1). Non-human animals and plants also suffer from infectious diseases, which cause massive losses to food crops and livestock, but our focus in this course is on infection in humans.

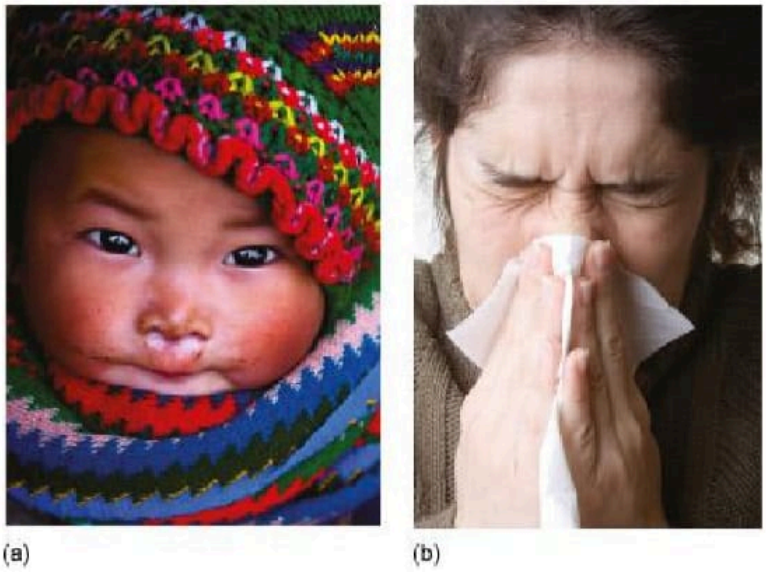


Figure 2.2.7.5.1. The common cold affects children and adults all over the world: (a) a child from Vietnam. (b) an adult in the United States

By contrast, health problems that cannot be transmitted between individuals, such as heart disease, diabetes, lung cancer, arthritis and depression, are known as non-communicable diseases (or NCDs). However, a few NCDs also have an infectious component, for example:

- in most cases of cervical cancer there is evidence of infection with a specific virus (the human papilloma virus, or HPV)
- hepatitis viruses cause liver disease and cancer of the liver
- a bacterium (Helicobacter pylori) causes stomach ulcers.

These examples illustrate the point that there is some overlap between some infectious and non-communicable diseases. For completeness, we should mention here that the third major category of diseases, disorders and disabilities is termed injuries, i.e. physical damage to the body caused by accidents or violence.

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2.2.7.6: Symptoms and signs of infection

Symptoms are sensations in the body that only the person who is unwell can experience; for example, a headache, pain in the abdomen, blurred vision and nausea are all symptoms, because no one but the sufferer can experience them. Lay people, including children, can usually describe their symptoms accurately or report them if asked the right questions, but symptoms are subjective experiences that others cannot observe or verify.

By contrast, the signs of a disease are indicators of illness that other people can observe (e.g. a runny nose and frequent sneezing). Considering the symptoms and signs together may give enough information for a trained health care worker to make a diagnosis, i.e. identify the underlying cause of the illness and give it a definite name.

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2.2.7.7: What causes infectious diseases?

Infectious diseases are transmitted between individuals by infectious agents, known as pathogens [path-oh-jens], from the Greek word *pathos* (to suffer) and *genès* (to produce). Pathogens produce a lot of human suffering and disability across the world, including in relatively wealthy nations like the United States. Most people have heard of at least some types of pathogen, for example bacteria or viruses.

The wider causes of infectious diseases range from insanitary living conditions in impoverished communities, to inadequate hygiene in the high-tech environments of modern hospitals (Figure 2.2.7.7.1). The impact of infectious diseases is therefore unequally distributed around the world, not only between countries, but also between individuals and groups within the same population.



Figure 2.2.7.7.1. Infectious diseases are a threat everywhere: (a) A shanty settlement without piped water or sanitation in Indonesia. (b) Testing for pathogens in a hospital laboratory in England.

Human biology is another factor to consider in explaining the cause of infectious diseases. Infancy and old age, inadequate nourishment, other illnesses and some types of medication can all create conditions in the body in which infection is more easily established. In addition, there are individual human behaviors, habits and traditional practices that contribute to the causes of infectious diseases by spreading pathogens from one person to another. These behaviors give some clues about the routes by which pathogens can be transmitted, as the next section describes.

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2.2.7.8: Direct person-to-person transmission of pathogens

A new infection begins when pathogens leave the body of their host – the infected individual in which the pathogens are multiplying – and enter a new host. They may be repelled by defense mechanisms (i.e. skin) in the new host, or they may survive and reproduce in sufficient numbers to cause an infectious disease.

Transmission of pathogens can occur directly between people, or indirectly in the air, water or food, or via other animals to humans, or from sources in the environment. In this section we explore direct transmission.

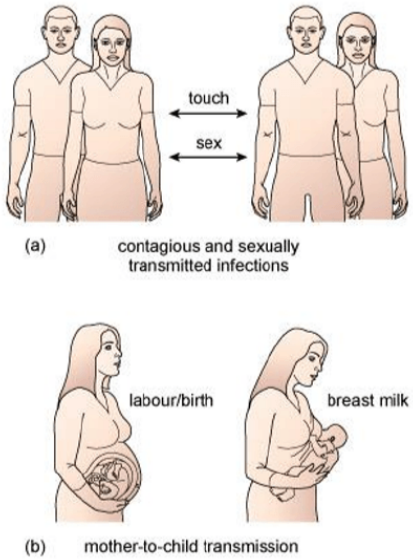


Figure 2.2.7.8.1. Direct person-to-person transmission of infection. (a) Contagion and sexual transmission. (b) Mother-to-child transmission.

Figure 2.2.7.8.1 represents the three ways in which pathogens can be transmitted by direct person-to-person contact. They are:

- Contagious infection, when touch, such as a handshake, transfers pathogens to a susceptible person; they may enter the new host through a cut or graze, or be transferred from hand to mouth.
- Sexually transmitted infection (or STI) involving infected semen, vaginal secretions, saliva or blood transmitting pathogens to the infected individual's partner during unprotected sex. This is the most common route for the worldwide spread of HIV (the human immunodeficiency virus), which causes AIDS (acquired immune deficiency syndrome). Sexual transmission is more likely if the partner's genitals, mouth or rectum are inflamed, for example, by another STI such as gonorrhea [gonn-or-ree-ah] or syphilis [siff-ill-iss].
- Mother-to-child transmission, when pathogens pass from mother to baby during labor and delivery, or via breast milk.

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2.2.7.9: Indirect person-to-person transmission of pathogens

Indirect person-to-person transmission occurs when the original host sheds pathogens into the air, water, food or objects in the environment, which then infect someone else (Figure 2.2.7.9.1).

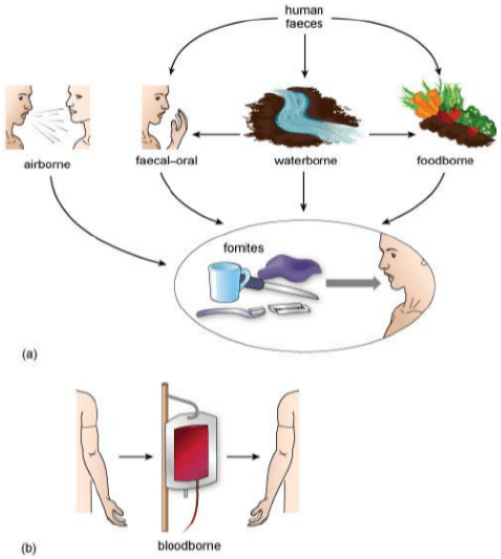


Figure 2.2.7.9.1. There are many routes for indirect person-to-person transmission of infection. Most airborne infections are transmitted when a cough or sneeze expels fine droplets of water (known as an aerosol) containing millions of bacteria or viruses. The aerosol droplets may be inhaled by a susceptible person, or settle on surfaces where the pathogens contaminate hands, utensils, clothing, water or food, which are then touched or consumed by someone else.



Figure 2.2.7.9.2. Coughs and sneezes spread diseases!

Waterborne infections are particularly common in parts of the world where large numbers of people don't have access to clean drinking water or safe disposal of sewage. Infected urine and feces from humans and animals can wash into lakes and streams, where the pathogens multiply and re-infect people when they drink or bathe in contaminated water. Some pathogens (including the bacteria that cause cholera, a serious diarrheal disease) live naturally in environmental water sources, so they will always pose a threat to health.

Fecal–oral infections (refer to solid waste, or excrement) occur when pathogens from feces enter the mouth and multiply in the

gut. Transmission occurs when unclean hands, dirty cooking utensils or food contaminated by feces enters the mouth. Flies can transfer pathogens from feces to food via their feet. Contact with feces is unavoidable when people are forced to defecate in the open because there is no sanitation. In these cases, people can get contaminated soil on their hands and the pathogens are easily transmitted from hand to mouth if there is no clean water or soap for hand washing.

Diarrheal diseases are often transmitted via the fecal–oral route, and some (e.g. cholera) are mainly waterborne. But they may also be due to foodborne infections caused by pathogens that originated in food components, for example, pathogenic bacteria in raw meat, eggs and on salad leaves.

Non-living objects in the environment, such as cups, spoons and door handles that people routinely touch, can also transmit infection and are known collectively as fomites [fohmytz]. Clothing can also act as a fomite, which is why hospital doctors rarely wear neckties that could drape across a patient during a medical examination and pick up infection that the next patient might acquire.

Medical procedures can also transmit bloodborne infections; for example, before the transmission of HIV was understood, thousands of infections occurred from HIVcontaminated blood transfusions. Bloodborne pathogens can also spread via shared needles and syringes among people who inject illegal drugs, such as heroin.

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2.2.7.10: Animal-to-human transmission of pathogens

Pathogens are often transmitted from animals to humans 'accidentally', for example via infected meat or water contaminated with animal feces. But there are two transmission routes in which the animal is an essential agent in the transfer of pathogens to humans. An example of zoonosis that may be familiar is influenza originating in pigs (swine flu) or poultry (bird flu). The influenza viruses that cause these diseases can sometimes be transmitted from animals to humans during the slaughter or handling of livestock. Some zoonotic influenza viruses pose a much greater health risk than the airborne seasonal influenza viruses that commonly circulate in human populations every winter.

Another route of transmission from animals to humans results in vector-borne infections. They differ from zoonoses in that they are transmitted by an invertebrate animal (without a backbone), mainly biting insects and ticks. The term 'vector' [vek-torr] comes from the Latin word for 'carrier', so in this context it means a carrier of an infectious disease. The pathogen must complete part of its life cycle in the vector, so transmission to humans may be prevented if the vectors can be killed. For example, Lyme disease is caused by a bacteria transmitted from birds or small mammals (such as deer) to humans by a type of tick.

There are many other vector-borne infections, including bubonic plague transmitted by rat fleas, typhus transmitted by ticks, and yellow fever transmitted by mosquitoes. In 2014, the World Health Organization– the branch of the United Nations responsible for coordinating and directing international policy and actions on health – devoted its annual 'World Health Day' to publicize the risk from vector-borne infections.

Emerging infectious diseases

Emerging infectious diseases (EIDs) is the collective term for a group of conditions that pose new threats to human health. EIDs can be distinguished into three types:

- New infectious diseases caused by previously unknown pathogens: Many of the diseases in this category are caused by zoonotic viruses, i.e. the viruses originated in other vertebrate animals, but at some point in the past they changed in ways that made them infectious to people. The best known 'new' infectious disease is AIDS but the virus that causes AIDS (HIV) may have originated in monkeys. Since HIV was identified in 1984, several other new infectious diseases caused by potentially fatal viruses have been identified. They include SARS (Severe Acute Respiratory Syndrome,), which may have originated in poultry, MERS (Middle East Respiratory Syndrome), which may have originated in camels, and zoonotic strains of influenza (swine flu and bird flu).
- Infectious diseases that have spread far outside their original range: One example is Ebola virus disease (EVD), a 'haemorrhagic' [hemm-orr-adj-ik] fever, which means it causes severe internal bleeding, among other symptoms. Cases have occurred from time to time in remote villages in West Africa, but the first urban cases were detected in the capital of Guinea in February 2014 and from there Ebola quickly spread to neighbouring Liberia and Sierra Leone. A few travellers or health workers caring for Ebola patients developed the disease in other countries, including Nigeria, Mali, Senegal and the USA. By October 2015, over 11 000 deaths had occurred from over 28 000 suspected, probable and confirmed cases (Centers for Disease Control and Prevention, 2015). Many of these cases have not been confirmed in a laboratory, so the 'case fatality rate' (the proportion of confirmed infected people who die) is unknown; however, it is likely to fall within the range of 30 to 60 per cent.

Previously declining infectious diseases that have resurged: Tuberculosis and some other infections caused by bacteria are a growing health concern because the causative pathogens are becoming increasingly resistant to antibiotics, which previously treated them successfully. So-called 'hospital super-bugs' are bacteria that have developed resistance to antibiotics in health care facilities, where antibiotics are heavily prescribed. An additional factor in countries where HIV/AIDS is common is that infection with HIV suppresses the body's immune defenses, so people with AIDS are more susceptible to other infections, including TB.

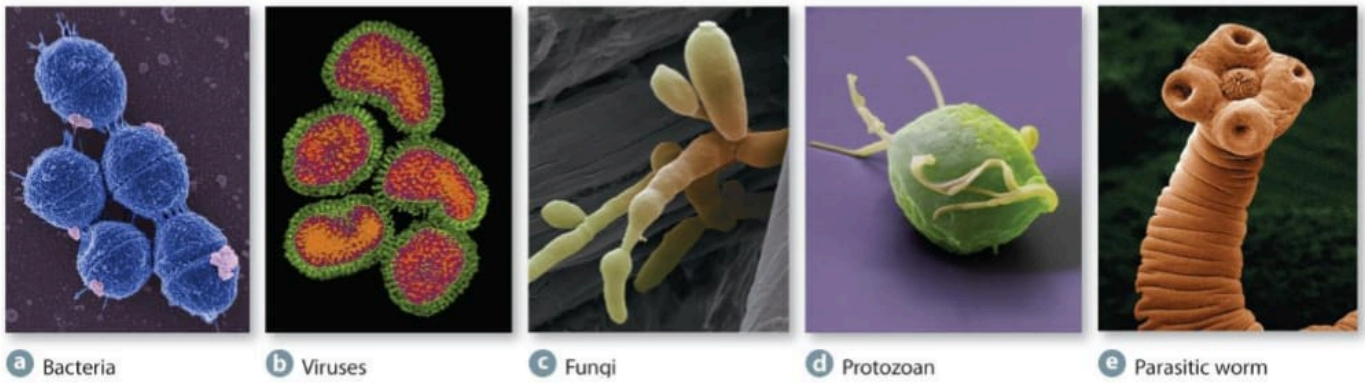


Figure 2.2.7.10.1. Examples of Five Major Types of Pathogens

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2.2.7.11: Immune Defenses Against Infectious Diseases

Natural barriers against pathogens

The physical and chemical barriers that prevent pathogens from getting into our body tissues in the first place are often overlooked. As Figure 6 shows, the most comprehensive barrier is the waterproof layer of skin that covers the body's surface. Human skin keeps most pathogens out as long as it remains intact. The speed with which a cut or graze can become infected is a reminder of the protection we normally get from our skin.

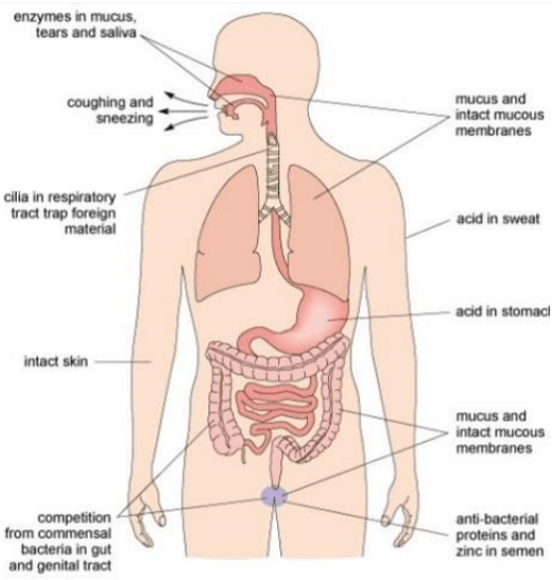


Figure 2.2.7.11.1. Physical and chemical barriers against infection

Vector-borne infections (e.g. malaria) are transmitted by biting invertebrates (e.g. mosquitoes) penetrating the skin when taking a blood meal. Humans are also vulnerable to invasion by pathogens in the air, food, water and soil, or during physical contact with infected people, some animals (e.g. pigs, dogs, poultry) or their feces. As Figure 2.2.7.11.1 illustrates, the inner surface of the respiratory system (nose, throat, airways and lungs), stomach, intestines, bladder and reproductive tract are lined with membranes that secrete jelly-like mucus, presenting a barrier against pathogens entering our tissues via these routes. Microscopic hairs called cilia [sill-ee-ah] line the respiratory system and 'beat' in unison to shunt mucus containing trapped pathogens towards the nose and mouth, where they can be expelled by coughing and sneezing, or swallowed into the stomach where acid destroys them.

Chemical barriers against infection include enzymes in tears, saliva and mucus that break down the surface of bacteria. The acid in sweat and in the stomach kills cellular pathogens and there are anti-bacterial proteins in semen (the fluid that contains male sperm). The more complex mechanisms of the immune system are only needed if pathogens breach these physical and chemical barriers.

The immune response to infection

The human immune system is an extremely complex network of interacting cells and biological molecules. The aim here is simply to give you an overview of how an immune response to infection develops, without going into too much detail. It occurs in three overlapping stages, the first of which is triggered when body cells are damaged. When tissues are injured, the damaged cells release chemicals that trigger the sequence of events described as inflammation. It occurs in response to any type of injury, such as a blow or a cut, an insect bite, or damage caused by pathogens multiplying in body tissues. Inflammation has four characteristic effects at the site of an injury, the first two of which are visible around the splinter shown in Figure 2.2.7.11.2:

- swelling

- redness
- heat
- pain



Figure 2.2.7.11.2. Inflammation of the tissues around a splinter

The inflamed area shows these signs because the local blood vessels dilate (get wider), increasing blood flow into the injury site, so it looks red as well as feeling warmer than the surrounding tissue. The walls of the blood vessels near the injury become leaky, allowing fluid, defensive proteins and immune system cells (described shortly) to flood into the area, which becomes swollen as a result. One of the proteins released during the inflammatory response also makes the area more sensitive to painful stimuli, so inflamed tissue is sore to touch.

Sites of tissue injury are vulnerable to invasion by pathogens so the benefits of inflammation generally outweigh the discomfort it causes. Flooding the area with fluid dilutes any pathogens that are already present, and the local concentration of immune system cells and defensive proteins enables an immune response to begin more quickly.

Leukocytes: the cells of the immune system

Once the barriers to infection have been breached and inflammation has begun, the active agents of the immune system, the *leukocytes* [loo-koh-sites], get to work. Leukocytes are often described as 'white blood cells' to distinguish them from the red blood cells that transport oxygen around the body; however, calling them 'blood' cells is misleading because leukocytes roam throughout the body tissues and only spend part of their lives in the bloodstream. In fact, they spend more time in the lymphatic system (Figure 2.2.7.11.3), the network of fine tubules that collect tissue fluid from all over the body and return it to the bloodstream.

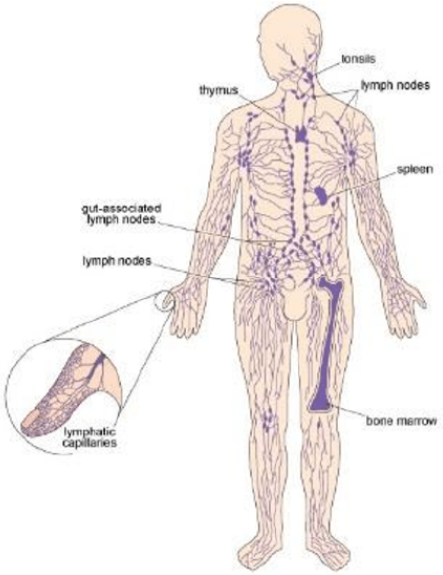


Figure 2.2.7.11.3. The human lymphatic system

The lymphatic system includes specialized organs and tissues where leukocytes develop. During an immune response to pathogens, we may become aware of swollen lymph nodes (popularly called 'glands') in the neck, armpits or groin, which enlarge

when the leukocytes they contain are multiplying near a site of infection.

Leukocytes can distinguish between 'self', the cells and proteins generated by the organism whose body they patrol, and 'non-self' (or 'foreign') material such as pathogens that originated outside the host's body. Leukocytes are *self-tolerant*, i.e. they do not normally attack the host's own cells or body proteins, but direct their actions only against non-self material that may pose a threat.

Although we have referred to 'the' immune response, as if it was just one thing, in fact, there are two types of immune response, distinguished as *innate* and *adaptive* immunity.

Innate immunity

All animals, even those with much simpler bodies than our own (e.g. parasitic worms) respond to tissue damage in ways that resemble inflammation in humans. They have cells similar to leukocytes and defensive proteins that flood into areas of tissue damage or infection. These leukocytes and proteins can defend the organism from pathogens because they recognize common patterns of molecules that occur in the structures of many different types of pathogens. These pathogen 'signature' molecules are known as PAMPs, or *pathogen-associated molecular patterns*.

The fact that PAMPs are commonly found in unrelated pathogens means that the leukocytes that recognize them cannot tell one type of pathogen from another. This *non-specific* immune response against pathogens is so widespread among animals that it is described as innate immunity ('innate' means 'inborn'). Some texts use the alternative term 'natural' immunity.

The leukocytes involved in innate immunity are of two general types, each with a different action against pathogens:

- Cytotoxic [sigh-toh-tox-ik] leukocytes, which simply means 'cell poisoning' (the prefix 'cyto' denotes a cell). These leukocytes have various methods of attaching to the outside of a pathogen and releasing destructive chemicals onto its surface. Worm larvae, bacteria and protists can all be killed this way.
- Phagocytic [fag-oh-sit-ik] leukocytes (the prefix 'phago' comes from a Greek word meaning 'to eat'), often abbreviated to phagocytes [fag-oh-sigh-tz]. These leukocytes engulf small pathogens such as bacteria, drawing them into the cytosol where destructive chemicals break them down. This action is termed phagocytosis [fag-ohsigh-toh-siss].

The anti-pathogen activities of certain specialized proteins are important contributors to the innate immune response. They include proteins that accelerate inflammation, target leukocytes onto pathogens or make host cells resistant to invasion by viruses. Their concentration increases rapidly in the bloodstream during an infection and this rise can be detected in blood tests as a diagnostic sign of infection.

In summary, all animals have innate immunity based on cells similar to human leukocytes and defensive proteins that defend the organism against pathogens 'in general' in a nonspecific way, i.e. these defenses cannot distinguish between one type of pathogen and another. Humans and other warm-blooded animals have an additional defensive capability called adaptive immunity, which differentiates specifically between pathogens, as the next section describes.

Adaptive Immunity

Adaptive immunity is due to the actions of two types of specialized leukocytes, known as T cells and B cells. (If you are interested, the letters denote 'thymus' and 'bone marrow', the tissues where each of these leukocytes mature.) We will describe their individual contributions to the adaptive immune response shortly, but first we focus on the most striking difference between innate and adaptive immunity. The clue lies in the word 'adaptive'.

T cells and B cells have recognition methods that distinguish between different pathogens (e.g. different species of bacteria), and they *adapt* during their first encounter with a particular pathogen. The second time they meet it in the body, the adaptive response begins earlier, lasts longer and is more effective than it was on the first occasion.

So, there is a much faster and increased response to a subsequent encounter with a pathogen and this demonstrates the adaptability of the immune system. This response is due to the production of long-lived memory cells that circulate in the body after the primary adaptive immune response subsides. These memory cells are specifically programmed to recognize the *same* pathogens that triggered the primary response if they ever get into the body again.

Antigens and the specific recognition of pathogens

Every type of pathogen has at least one (often many more) unique molecules known as antigens in their structure. In addition to

the PAMPs (pathogen-associated molecular patterns) shared by many different pathogens, each type of pathogen also has its own unique distinctive antigens. Each individual T cell and B cell (the leukocytes responsible for adaptive immunity) is programmed to recognize just one specific antigen, so it follows that each T or B cell can usually recognize only one type of pathogen, or at most two or three closely related pathogens that have very similar antigens. Recognition of an antigen by these adaptive leukocytes triggers an immune response against only those pathogens with that antigen in their structure. The political slogan 'One person, one vote' springs to mind as an analogy for 'One adaptive leukocyte, one target'!

Antibodies and B cells

Antibodies are very large proteins that contribute to adaptive immunity. A distinguishing feature of antibodies is that their structure includes at least two binding sites for antigens. B cells produce antibodies and also use them as their antigen receptors. The B cells carry antibodies embedded by the 'tail' in their outer cell membrane, with the binding sites facing outwards. This enables the B cell to bind to antigens that fit the binding sites in the antibodies it carries on its surface. This binding event is essential (but not sufficient on its own) to activate B cells into making a lot more antibody molecules that recognize the same antigen. These antibodies are released by the B cells and circulate in the bloodstream, tissue fluids and the lymphatic system. Antibodies are also abundant in the mucus membranes lining the respiratory system, the gut and the reproductive system, i.e. the sites in the body in contact with substances such as air, food, drinking water and sexual fluids that could contain pathogens.

Antibodies are often portrayed in the media as if they were 'magic bullets' that attack pathogens, but in fact they are more like 'waving flags' with a message that reads 'here is a pathogen – come and destroy it'. When antibodies bind to a pathogen, they simply label it for destruction by leukocytes with the innate ability to phagocytose (engulf) it, or cytotoxic (cell-killing) leukocytes and defensive proteins. You can think of them as recruiting the cells and defensive proteins of the innate immune system to join the attack. We conclude this tour of adaptive immunity by describing the T cells.

T cells in adaptive immunity

There are two types of T cells with different roles in adaptive immunity. The cytotoxic T cells release destructive chemicals onto their target's outer surface in much the same way as the cytotoxic leukocytes do in an innate immune response. But there is one crucial difference. Cytotoxic T cells are programmed to kill the body's *own* cells that have become infected by viruses or by the few types of bacteria and single-celled pathogens that can 'hide' inside the cells of their host (*Mycobacterium tuberculosis*, the bacteria that cause TB, can do this). Without the cytotoxic T cells, we woud be particularly susceptible to infectious diseases caused by these pathogens.

The other T cell type is called the **helper T cells**. They send activation signals to all the other leukocytes involved in inflammation, phagocytosis, cytotoxicity or production of antibodies by B cells. Recognition of a pathogen by binding to it is only the first step. The other leukocytes cannot take action against the pathogens they encounter without activation signals from the helper T cells.

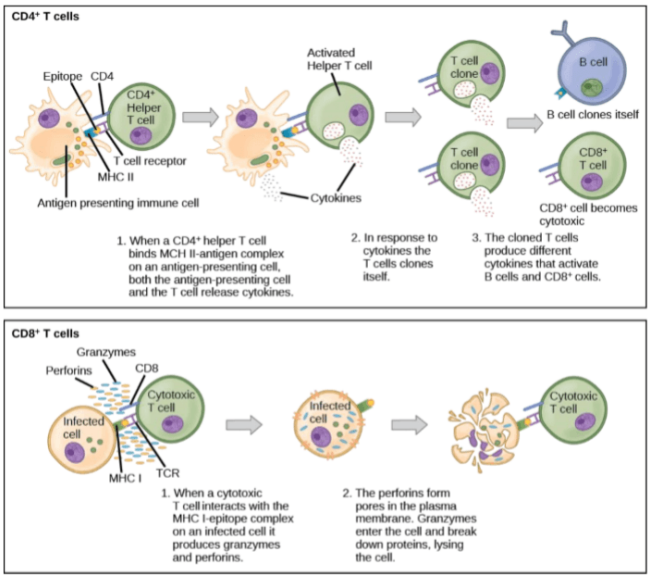


Figure 2.2.7.11.4. The Cell-Mediated Immune Response

Vaccination

Vaccination relies on the development of immunological memory for its protective effect. Vaccines contain killed pathogens, or extracts from pathogens, or modified strains of pathogens that are no longer harmful. For example, the MMR vaccine contains weakened (the technical term is 'attenuated') variants of the three viruses that cause measles, mumps and rubella (Figure 2.2.7.11.5).



Figure 2.2.7.11.5. The MMR vaccine contains live attenuated strains of measles, mumps and rubella viruses.

Note that each of the memory cells and the T cells and B cells generated in an adaptive immune response are specifically directed against just one type of pathogen or a very closely related strain. Vaccination with MMR vaccine is only protective against measles, mumps and rubella infection.

Despite decades of effort, medical science has so far been unable to produce effective vaccines against a number of important infectious diseases, including HIV/AIDS and other sexually transmitted infections (although trials of several candidate vaccines are underway). Vaccines against malaria have shown some potential, but they only protected about half the vaccinated children in large-scale African trials. There are no effective vaccines against infections caused by any other single-celled or multicellular parasites.

Some vaccines are effective only for a relatively short time, e.g. cholera vaccines give protection for only around six months. Others, such as the tetanus vaccine, need repeated booster doses. Annual influenza vaccinations are offered to vulnerable groups in the population because influenza viruses alter their antigens over time.

Opposition to vaccination

Another major challenge is parental opposition to vaccination because of concerns about vaccine safety. Some parents are understandably anxious about taking a healthy child to be given a vaccine derived from infectious agents. Most vaccines are injected, which can be a frightening and painful experience for a child. Of even greater concern is that some children experience a negative reaction to a vaccine, most often inflammation around the injection site and/or a mild fever lasting a day or two, but rare instances of more severe reactions such as convulsions sometimes occur.

Hesitancy about vaccinating a child is increased if parents have no experience of the disease the vaccine prevents, because it has become rare in communities with high vaccine coverage. Some parents conclude that vaccination is unnecessary and might expose their children to an avoidable risk.

Negative rumors about a vaccine are another deterrent. For example, the myth that vaccination is a Western plot to sterilize Muslim children has deterred parents in northern Nigeria, Pakistan and Afghanistan from allowing their children to be vaccinated against polio (Figure 2.2.7.11.6). Terrorist attacks have occurred against polio vaccination teams in all three countries – the only remaining locations where polio had not been eradicated by the WHO target of 2015.



Figure 2.2.7.11.6. Negative rumors about the oral polio vaccine did not deter this Nigerian child's parents from bringing her for vaccination.

An inevitable consequence of falling vaccination rates in a community is an increase in infections, sometimes with fatal outcomes. In 2014, the WHO warned that progress on eliminating measles had stalled and the number of deaths had begun to rise – from 122 000 in 2012 to 145 700 in 2013.

Countries urgently need to prioritize maintaining and improving immunization coverage. Failure to reverse this alarming trend could jeopardize the momentum generated by a decade of achievements in reducing measles mortality.

Even in countries where over 90% of children are fully vaccinated, uptake rates can plummet under pressure from negative rumors. For example, false claims in 1998 that the MMR vaccine caused autism led to a sustained fall in vaccinations in the United States and United Kingdom, followed by a significant rise in measles cases and, to a lesser extent, mumps. The largest outbreak of measles around Wales in 2012–13 caused more than 1200 cases and one death (Public Health Wales, 2013). Once parents saw the reality of measles infection and the misery and discomfort it causes, a rapid increase in uptake of the MMR vaccine followed the outbreak. The memory of infection fades in well-protected communities, until an outbreak reminds everyone of how devastating infectious diseases can be.

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2.2.7.12: Risk Factors and Levels of Disease Prevention

What is a Risk Factor?

Part of learning how to take charge of your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control. You may be born with them or exposed to them through no fault of your own.

Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some risk factors you can control include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs

In fact, it has been estimated that almost 35 percent of all U.S. premature deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (eating more fruits and vegetables and less red meat)
- Getting more physical activity

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

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2.2.8: SUBSTANCE USE AND ABUSE

Many people don't understand why or how other people become addicted to drugs. They may mistakenly think that those who use drugs lack moral principles or willpower and that they could stop their drug use simply by choosing to. In reality, drug addiction is a complex disease, and quitting usually takes more than good intentions or a strong will. Drugs change the brain in ways that make quitting hard, even for those who want to. Fortunately, researchers know more than ever about how drugs affect the brain and have found treatments that can help people recover from drug addiction and lead productive lives. Before further studying addiction and recovery, we must first gain an understanding of the different types of drugs and substances and their effects on the body.

2.2.8.1: Understanding Drug Use and Addiction

2.2.8.2: Types of Drugs

2.2.8.3: Prescription Drugs

2.2.8.4: Alcohol Abuse

2.2.8.5: Tobacco

2.2.8.6: Myths about Smoking and Cigarettes

2.2.8.7: Drug Addiction

2.2.8.8: Treatment Approaches for Drug Addiction

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2.2.8.1: Understanding Drug Use and Addiction

Many people don't understand why or how other people become addicted to drugs. They may mistakenly think that those who use drugs lack moral principles or willpower and that they could stop their drug use simply by choosing to. In reality, drug addiction is a complex disease, and quitting usually takes more than good intentions or a strong will. Drugs change the brain in ways that make quitting hard, even for those who want to. Fortunately, researchers know more than ever about how drugs affect the brain and have found treatments that can help people recover from drug addiction and lead productive lives. Before further studying addiction and recovery, we must first gain an understanding of the different types of drugs and substances and their effects on the body.

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2.2.8.2: Types of Drugs

Drug abuse is a serious public health problem that affects almost every community and family in some way. Each year drug abuse results in around 40 million serious illnesses or injuries among people in the United States. Abused drugs include:

- Club drugs
- Amphetamines
- Anabolic steroids
- Cocaine
- Heroin
- Inhalants
- Marijuana
- Prescription drugs

Drug abuse also plays a role in many major social problems, such as drugged driving, violence, stress, and child abuse. Drug abuse can lead to homelessness, crime and missed work or problems with keeping a job. There are different types of treatment for drug abuse. But the best is to prevent drug abuse in the first place.

Club Drugs

The term club drug refers to a wide variety of dangerous drugs. These drugs are often used by young adults at all-night dance parties, dance clubs and bars. They include

- Methylenedioxymethamphetamine (MDMA), also known as Ecstasy XTC, X, Adam, Clarity and Lover's Speed
- Gamma-hydroxybutyrate (GHB), also known as Grievous Bodily Harm, G, Liquid Ecstasy and Georgia Home Boy
- Ketamine, also known as Special K, K, Vitamin K, Cat Valium
- Rohypnol, also known as Roofies, Rophies, Roche, Forget-me Pill
- Methamphetamine, also known as Speed, Ice, Chalk, Meth, Crystal, Crank, Fire, Glass
- Lysergic Acid Diethylamide (LSD), also known as or Acid, Boomers, Yellow Sunshines

Club drugs have become more common in recent years. Sometimes people use them to commit sexual assaults. Club drugs can cause serious health problems and sometimes death. They are even more dangerous if you use them with alcohol.

What Type of Drugs are Club Drugs?

Club drugs are a pharmacologically heterogeneous group of psychoactive drugs that tend to be abused by teens and young adults at bars, nightclubs, concerts, and parties. Gamma hydroxybutyrate (GHB), Rohypnol, ketamine, as well as MDMA (ecstasy) and methamphetamine are some of the drugs included in this group.

- GHB (Xyrem) is a central nervous system (CNS) depressant that was approved by the Food and Drug Administration (FDA) in 2002 for use in the treatment of narcolepsy (a sleep disorder). This approval came with severe restrictions, including its use only for the treatment of narcolepsy, and the requirement for a patient registry monitored by the FDA. GHB is also a metabolite of the inhibitory neurotransmitter gamma-aminobutyric acid (GABA). It exists naturally in the brain, but at much lower concentrations than those found when GHB is abused.
- Rohypnol (flunitrazepam) use began gaining popularity in the United States in the early 1990s. It is a benzodiazepine (chemically similar to sedative-hypnotic drugs such as Valium or Xanax), but it is not approved for medical use in this country, and its importation is banned.
- Ketamine is a dissociative anesthetic, mostly used in veterinary practice.

How Are Club Drugs Abused?

GHB and Rohypnol are available in odorless, colorless, and tasteless forms that are frequently combined with alcohol and other beverages. Both drugs have been used to commit sexual assaults (also known as “date rape,” “drug rape,” “acquaintance rape,” or “drug-assisted” assault) due to their ability to sedate and incapacitate unsuspecting victims, preventing them from resisting sexual assault.

- GHB is usually ingested orally, either in liquid or powder form, while Rohypnol is typically taken orally in pill form. Recent reports, however, have shown that Rohypnol is being ground up and snorted.
- Both GHB and Rohypnol are also abused for their intoxicating effects, similar to other CNS depressants.
- GHB also has anabolic effects (it stimulates protein synthesis) and has been used by bodybuilders to aid in fat reduction and muscle building.
- Ketamine is usually snorted or injected intramuscularly.

How Do Club Drugs Affect the Brain?

- At high doses, GHB's sedative effects may result in sleep, coma, or death.
- Rohypnol can produce anterograde amnesia, in which individuals may not remember events they experienced while under the influence of the drug.
- Ketamine is a dissociative anesthetic, so called because it distorts perceptions of sight and sound and produces feelings of detachment from the environment and self. Low-dose intoxication results in impaired attention, learning ability, and memory. At higher doses, ketamine can cause dreamlike states and hallucinations; and at higher doses still, ketamine can cause delirium and amnesia.

Addictive Potential

Repeated use of GHB may lead to withdrawal effects, including insomnia, anxiety, tremors, and sweating. Severe withdrawal reactions have been reported among patients presenting from an overdose of GHB or related compounds, especially if other drugs or alcohol are involved.

- Like other benzodiazepines, chronic use of Rohypnol can produce tolerance, physical dependence, and addiction.
- There have been reports of people binging on ketamine, a behavior that is similar to that seen in some cocaine- or amphetamine-dependent individuals. Ketamine users can develop signs of tolerance and cravings for the drug.

What Other Adverse Effects Do Club Drugs Have on Health?

Uncertainties about the sources, chemicals, and possible contaminants used to manufacture many club drugs make it extremely difficult to determine toxicity and associated medical consequences. Nonetheless, we do know that:

- Coma and seizures can occur following use of GHB. Combined use with other drugs such as alcohol can result in nausea and breathing difficulties. GHB has been involved in poisonings, overdoses, date rapes, and deaths.
- Rohypnol may be lethal when mixed with alcohol and/or other CNS depressants.
- Ketamine, in high doses, can cause impaired motor function, high blood pressure, and potentially fatal respiratory problems.

Methamphetamine

Methamphetamine is a very addictive stimulant drug. It can be smoked, injected, inhaled or taken by mouth. It has many street names, such as speed, meth, and chalk.

Methamphetamine hydrochloride, the crystal form inhaled by smoking, is referred to as ice, crystal, glass and tina.

Methamphetamine affects the brain and can create feelings of pleasure, increase energy and elevate mood. Abusers may become addicted quickly, needing higher doses more often. Adverse health effects include irregular heartbeat, increased blood pressure and a variety of psychological problems. Long-term effects may include severe mental disorders, memory loss and severe dental problems.

What Type of Drug is Methamphetamine?

Methamphetamine is a central nervous system stimulant drug that is similar in structure to amphetamine. Due to its high potential for abuse, methamphetamine is classified as a Schedule II drug and is available only through a prescription that cannot be refilled. Although methamphetamine can be prescribed by a doctor, its medical uses are limited, and the doses that are prescribed are much lower than those typically abused. Most of the methamphetamine abused in this country comes from foreign or domestic superlabs, although it can also be made in small, illegal laboratories, where its production endangers the people in the labs, neighbors, and the environment.

How Is Methamphetamine Abused?

Methamphetamine is a white, odorless, bitter-tasting crystalline powder that easily dissolves in water or alcohol and is taken orally, intranasally (snorting the powder), by needle injection, or by smoking.

How Does Methamphetamine Affect the Brain?

Methamphetamine increases the release and blocks the reuptake of the brain chemical (or neurotransmitter) dopamine, leading to high levels of the chemical in the brain—a common mechanism of action for most drugs of abuse. Dopamine is involved in reward, motivation, the experience of pleasure, and motor function. Methamphetamine's ability to release dopamine rapidly in reward regions of the brain produces the intense euphoria, or "rush," that many users feel after snorting, smoking, or injecting the drug.

Chronic methamphetamine abuse significantly changes how the brain functions. Noninvasive human brain imaging studies have shown alterations in the activity of the dopamine system that are associated with reduced motor skills and impaired verbal learning. Recent studies in chronic methamphetamine abusers have also revealed severe structural and functional changes in areas of the brain associated with emotion and memory, which may account for many of the emotional and cognitive problems observed in chronic methamphetamine abusers.

Repeated methamphetamine abuse can also lead to addiction—a chronic, relapsing disease characterized by compulsive drug seeking and use, which is accompanied by chemical and molecular changes in the brain. Some of these changes persist long after methamphetamine abuse is stopped. Reversal of some of the changes, however, may be observed after sustained periods of abstinence (e.g., more than 1 year).

What Other Adverse Effects Does Methamphetamine Have on Health?

Taking even small amounts of methamphetamine can result in many of the same physical effects as those of other stimulants, such as cocaine or amphetamines, including increased wakefulness, increased physical activity, decreased appetite, increased respiration, rapid heart rate, irregular heartbeat, increased blood pressure, and hyperthermia.

Long-term methamphetamine abuse has many negative health consequences, including extreme weight loss, severe dental problems ("meth mouth"), anxiety, confusion, insomnia, mood disturbances, and violent behavior. Chronic methamphetamine abusers can also display a number of psychotic features, including paranoia, visual and auditory hallucinations, and delusions (for example, the sensation of insects crawling under the skin).

Transmission of HIV and hepatitis B and C can be consequences of methamphetamine abuse. The intoxicating effects of methamphetamine, regardless of how it is taken, can also alter judgment and inhibition and can lead people to engage in unsafe behaviors, including risky sexual behavior. Among abusers who inject the drug, HIV/AIDS and other infectious diseases can be spread through contaminated needles, syringes, and other injection equipment that is used by more than one person. Methamphetamine abuse may also worsen the progression of HIV/AIDS and its consequences. Studies of methamphetamine abusers who are HIV-positive indicate that HIV causes greater neuronal injury and cognitive impairment for individuals in this group compared with HIV-positive people who do not use the drug.

Anabolic Steroids

Anabolic-androgenic steroids (AAS) are synthetically produced variants of the naturally occurring male sex hormone testosterone. "Anabolic" refers to muscle-building, and "androgenic" refers to increased male sexual characteristics. "Steroids" refers to the class of drugs. These drugs can be legally prescribed to treat conditions resulting from steroid hormone deficiency, such as delayed puberty, as well as diseases that result in loss of lean muscle mass, such as cancer and AIDS.

How Are AAS Abused?

Some people, both athletes and non-athletes, abuse AAS in an attempt to enhance performance and/or improve physical appearance. AAS are taken orally or injected, typically in cycles rather than continuously. "Cycling" refers to a pattern of use in which steroids are taken for periods of weeks or months, after which use is stopped for a period of time and then restarted. In addition, users often combine several different types of steroids in an attempt to maximize their effectiveness, a practice referred to as "stacking."

How Do AAS Affect the Brain?

The acute effects of AAS in the brain are substantially different from those of other drugs of abuse. The most important difference

is that AAS are not euphorigenic, meaning they do not trigger rapid increases in the neurotransmitter dopamine, which is responsible for the “high” that often drives substance abuse behaviors. However, long-term use of AAS can eventually have an impact on some of the same brain pathways and chemicals—such as dopamine, serotonin, and opioid systems—that are affected by other drugs of abuse.Considering the combined effect of their complex direct and indirect actions, it is not surprising that AAS can affect mood and behavior in significant ways.

AAS and Mental Health

Preclinical, clinical, and anecdotal reports suggest that steroids may contribute to psychiatric dysfunction. Research shows that abuse of anabolic steroids may lead to aggression and other adverse effects. For example, although many users report feeling good about themselves while on anabolic steroids, extreme mood swings can also occur, including manic-like symptoms that could lead to violence. Researchers have also observed that users may suffer from paranoid jealousy, extreme irritability, delusions, and impaired judgment stemming from feelings of invincibility.

Addictive Potential

Animal studies have shown that AAS are reinforcing—that is, animals will self-administer AAS when given the opportunity, just as they do with other addictive drugs. This property is more difficult to demonstrate in humans, but the potential for AAS abusers to become addicted is consistent with their continued abuse despite physical problems and negative effects on social relations. Also, steroid abusers typically spend large amounts of time and money obtaining the drug: this is another indication of addiction. Individuals who abuse steroids can experience withdrawal symptoms when they stop taking AAS—these include mood swings, fatigue, restlessness, loss of appetite, insomnia, reduced sex drive, and steroid cravings, all of which may contribute to continued abuse. One of the most dangerous withdrawal symptoms is depression— when persistent, it can sometimes lead to suicide attempts.

Research also indicates that some users might turn to other drugs to alleviate some of the negative effects of AAS. For example, a study of 227 men admitted in 1999 to a private treatment center for dependence on heroin or other opioids found that 9.3 percent had abused AAS before trying any other illicit drug. Of these, 86 percent first used opioids to counteract insomnia and irritability resulting from the steroids.

What Other Adverse Effects Do AAS Have on Health?

Steroid abuse can lead to serious, even irreversible health problems. Some of the most dangerous among these include liver damage; jaundice (yellowish pigmentation of skin, tissues, and body fluids); fluid retention; high blood pressure; increases in LDL (“bad” cholesterol); and decreases in HDL (“good” cholesterol). Other reported effects include renal failure, severe acne, and trembling. In addition, there are some gender- and agespecific adverse effects:

- For men—shrinking of the testicles, reduced sperm count, infertility, baldness, development of breasts, increased risk for prostate cancer
- For women—growth of facial hair, male-pattern baldness, changes in or cessation of the menstrual cycle, enlargement of the clitoris, deepened voice
- For adolescents—stunted growth due to premature skeletal maturation and accelerated puberty changes; risk of not reaching expected height if AAS is taken before the typical adolescent growth spurt

In addition, people who inject AAS run the added risk of contracting or transmitting HIV/AIDS or hepatitis, which causes serious damage to the liver.

Cocaine

Cocaine is a powerful drug that stimulates the brain. People who use it can form a strong addiction. They may have to use more and more of the drug to get high. It's sold on the street as a fine, white powder. There are two forms of cocaine: hydrochloride salt and freebase. The salt dissolves in water. People can take it in a vein or in the nose. The freebase form can be smoked. Crack is the street name of a smokable form of cocaine. No matter how cocaine is taken, it is dangerous. Some of the most common serious problems include

- Heart problems, including heart attacks
- Respiratory effects, including respiratory failure
- Nervous system problems, including strokes

- Digestive problems

Any of these can be fatal. Using cocaine with alcohol is a common cause of drug-related death.

What Type of Drug is Cocaine?

Cocaine is a powerfully addictive stimulant drug. The powdered hydrochloride salt form of cocaine can be snorted or dissolved in water and then injected. Crack is the street name given to the form of cocaine that has been processed to make a rock crystal, which, when heated, produces vapors that are smoked. The term “crack” refers to the crackling sound produced by the rock as it is heated.

How Is Cocaine Abused?

Three routes of administration are commonly used for cocaine: snorting, injecting, and smoking. Snorting is the process of inhaling cocaine powder through the nose, where it is absorbed into the bloodstream through the nasal tissues. Injecting is the use of a needle to insert the drug directly into the bloodstream. Smoking involves inhaling cocaine vapor or smoke into the lungs, where absorption into the bloodstream is as rapid as it is by injection. All three methods of cocaine abuse can lead to addiction and other severe health problems, including increasing the risk of contracting HIV/AIDS and other infectious diseases.

The intensity and duration of cocaine’s effects—which include increased energy, reduced fatigue, and mental alertness—depend on the route of drug administration. The faster cocaine is absorbed into the bloodstream and delivered to the brain, the more intense the high. Injecting or smoking cocaine produces a quicker, stronger high than snorting. On the other hand, faster absorption usually means shorter duration of action: the high from snorting cocaine may last 15 to 30 minutes, but the high from smoking may last only 5 to 10 minutes. In order to sustain the high, a cocaine abuser has to administer the drug again.

For this reason, cocaine is sometimes abused in binges—taken repeatedly within a relatively short period of time, at increasingly higher doses.

How Does Cocaine Affect the Brain?

Cocaine is a strong central nervous system stimulant that increases levels of dopamine, a brain chemical (or neurotransmitter) associated with pleasure and movement, in the brain’s reward circuit. Certain brain cells, or neurons, use dopamine to communicate. Normally, dopamine is released by a neuron in response to a pleasurable signal (e.g., the smell of good food), and then recycled back into the cell that released it, thus shutting off the signal between neurons.

Cocaine acts by preventing the dopamine from being recycled, causing excessive amounts of the neurotransmitter to build up, amplifying the message to and response of the receiving neuron, and ultimately disrupting normal communication. It is this excess of dopamine that is responsible for cocaine’s euphoric effects. With repeated use, cocaine can cause long-term changes in the brain’s reward system and in other brain systems as well, which may eventually lead to addiction. With repeated use, tolerance to the cocaine high also often develops. Many cocaine abusers report that they seek but fail to achieve as much pleasure as they did from their first exposure. Some users will increase their dose in an attempt to intensify and prolong the euphoria, but this can also increase the risk of adverse psychological or physiological effects.

What Adverse Effects Does Cocaine Have on Health?

Abusing cocaine has a variety of adverse effects on the body. For example, cocaine constricts blood vessels, dilates pupils, and increases body temperature, heart rate, and blood pressure. It can also cause headaches and gastrointestinal complications such as abdominal pain and nausea. Because cocaine tends to decrease appetite, chronic users can become malnourished as well.

Different methods of taking cocaine can produce different adverse effects. Regular intranasal use (snorting) of cocaine, for example, can lead to loss of the sense of smell; nosebleeds; problems with swallowing; hoarseness; and a chronically runny nose. Ingesting cocaine can cause severe bowel gangrene as a result of reduced blood flow. Injecting cocaine can bring about severe allergic reactions and increased risk for contracting HIV/AIDS and other blood-borne diseases. Binge-patterned cocaine use may lead to irritability, restlessness, and anxiety. Cocaine abusers can also experience severe paranoia—a temporary state of full-blown paranoid psychosis—in which they lose touch with reality and experience auditory hallucinations.

Regardless of the route or frequency of use, cocaine abusers can experience acute cardiovascular or cerebrovascular emergencies, such as a heart attack or stroke, which may cause sudden death. Cocaine-related deaths are often a result of cardiac arrest or seizure followed by respiratory arrest.

Heroin

Heroin is a drug made from morphine, a natural substance in the seedpod of the Asian poppy plant. Heroin usually appears as a white or brown powder. Heroin can be injected, smoked or snorted. Heroin abuse is a serious problem in the United States. Major health problems from heroin include miscarriages, heart infections and death from overdose.

People who inject the drug also risk infectious diseases, including HIV/AIDS and hepatitis. Regular use of heroin can lead to tolerance. This means users need more and more drug to have the same effect. At higher doses over time, the body becomes dependent on heroin. If dependent users stop heroin, they have withdrawal symptoms. These symptoms include restlessness, muscle and bone pain, diarrhea, vomiting and cold flashes.

Heroin is an opiate drug that is synthesized from morphine, a naturally occurring substance extracted from the seed pod of the Asian opium poppy plant. Heroin usually appears as a white or brown powder or as a black sticky substance, known as “black tar heroin.”

How Is Heroin Abused?

Heroin can be injected, snorted/sniffed, or smoked—routes of administration that rapidly deliver the drug to the brain. Injecting is the use of a needle to administer the drug directly into the bloodstream. Snorting is the process of inhaling heroin powder through the nose, where it is absorbed into the bloodstream through the nasal tissues. Smoking involves inhaling heroin smoke into the lungs. All three methods of administering heroin can lead to addiction and other severe health problems.

How Does Heroin Affect the Brain?

Heroin enters the brain, where it is converted to morphine and binds to receptors known as opioid receptors. These receptors are located in many areas of the brain (and in the body), especially those involved in the perception of pain and in reward. Opioid receptors are also located in the brain stem—important for automatic processes critical for life, such as breathing (respiration), blood pressure, and arousal. Heroin overdoses frequently involve a suppression of respiration.

After an intravenous injection of heroin, users report feeling a surge of euphoria (“rush”) accompanied by dry mouth, a warm flushing of the skin, heaviness of the extremities, and clouded mental functioning. Following this initial euphoria, the user goes “on the nod,” an alternately wakeful and drowsy state. Users who do not inject the drug may not experience the initial rush, but other effects are the same.

With regular heroin use, tolerance develops, in which the user’s physiological (and psychological) response to the drug decreases, and more heroin is needed to achieve the same intensity of effect. Heroin users are at high risk for addiction—it is estimated that about 23 percent of individuals who use heroin become dependent on it.

What Other Adverse Effects Does Heroin Have on Health?

Heroin abuse is associated with serious health conditions, including fatal overdose, spontaneous abortion, and—particularly in users who inject the drug—infectious diseases, including HIV/AIDS and hepatitis. Chronic users may develop collapsed veins, infection of the heart lining and valves, abscesses, and liver or kidney disease. Pulmonary complications, including various types of pneumonia, may result from the poor health of the abuser as well as from heroin’s depressing effects on respiration. In addition to the effects of the drug itself, street heroin often contains toxic contaminants or additives that can clog blood vessels leading to the lungs, liver, kidneys, or brain, causing permanent damage to vital organs.

Chronic use of heroin leads to physical dependence, a state in which the body has adapted to the presence of the drug. If a dependent user reduces or stops use of the drug abruptly, he or she may experience severe symptoms of withdrawal. These symptoms—which can begin as early as a few hours after the last drug administration—can include restlessness, muscle and bone pain, insomnia, diarrhea and vomiting, cold flashes with goose bumps (“cold turkey”), and kicking movements (“kicking the habit”). Users also experience severe craving for the drug during withdrawal, which can precipitate continued abuse and/or relapse.

Major withdrawal symptoms peak between 48 and 72 hours after the last dose of the drug and typically subside after about 1 week. Some individuals, however, may show persistent withdrawal symptoms for months. Although heroin withdrawal is considered less dangerous than alcohol or barbiturate withdrawal, sudden withdrawal by heavily dependent users who are in poor health is occasionally fatal. In addition, heroin craving can persist years after drug cessation, particularly upon exposure to triggers such as stress or people, places, and things associated with drug use.

Heroin abuse during pregnancy, together with related factors like poor nutrition and inadequate prenatal care, has been associated with adverse consequences including low birthweight, an important risk factor for later developmental delay. If the mother is regularly abusing the drug, the infant may be born physically dependent on heroin and could suffer from serious medical complications requiring hospitalization.

Marijuana

Marijuana is the most commonly abused illicit drug in the United States. It is a dry, shredded green and brown mix of flowers, stems, seeds, and leaves derived from the hemp plant Cannabis sativa. The main active chemical in marijuana is delta-9-tetrahydrocannabinol, or THC for short.

How is Marijuana Abused?

Marijuana is usually smoked as a cigarette (joint) or in a pipe. It is also smoked in blunts, which are cigars that have been emptied of tobacco and refilled with a mixture of marijuana and tobacco. This mode of delivery combines marijuana's active ingredients with nicotine and other harmful chemicals. Marijuana can also be mixed in food or brewed as a tea. As a more concentrated, resinous form, it is called hashish; and as a sticky black liquid, hash oil. Marijuana smoke has a pungent and distinctive, usually sweet-and-sour odor.

How Does Marijuana Affect the Brain?

Scientists have learned a great deal about how THC acts in the brain to produce its many effects. When someone smokes marijuana, THC rapidly passes from the lungs into the bloodstream, which carries the chemical to the brain and other organs throughout the body.

THC acts upon specific sites in the brain, called cannabinoid receptors, kicking off a series of cellular reactions that ultimately lead to the "high" that users experience when they smoke marijuana. Some brain areas have many cannabinoid receptors; others have few or none. The highest density of cannabinoid receptors are found in parts of the brain that influence pleasure, memory, thinking, concentrating, sensory and time perception, and coordinated movement.

Not surprisingly, marijuana intoxication can cause distorted perceptions, impaired coordination, difficulty with thinking and problem solving, and problems with learning and memory. Research has shown that, in chronic users, marijuana's adverse impact on learning and memory can last for days or weeks after the acute effects of the drug wear off. As a result, someone who smokes marijuana every day may be functioning at a suboptimal intellectual level all of the time.

Research into the effects of long-term cannabis use on the structure of the brain has yielded inconsistent results. It may be that the effects are too subtle for reliable detection by current techniques. A similar challenge arises in studies of the effects of chronic marijuana use on brain function. Brain imaging studies in chronic users tend to show some consistent alterations, but their connection to impaired cognitive functioning is far from clear. This uncertainty may stem from confounding factors such as other drug use, residual drug effects, or withdrawal symptoms in long-term chronic users.

What Other Adverse Effect Does Marijuana Have on Health?

1. Effects on the Heart: Marijuana increases heart rate by 20-100 percent shortly after smoking; this effect can last up to 3 hours. In one study, it was estimated that marijuana users have a 4.8-fold increase in the risk of heart attack in the first hour after smoking the drug. This may be due to increased heart rate as well as the effects of marijuana on heart rhythms, causing palpitations and arrhythmias. This risk may be greater in aging populations or in those with cardiac vulnerabilities.
2. Effects on the Lungs: Numerous studies have shown marijuana smoke to contain carcinogens and to be an irritant to the lungs. In fact, marijuana smoke contains 50-70 percent more carcinogenic hydrocarbons than tobacco smoke. Marijuana users usually inhale more deeply and hold their breath longer than tobacco smokers do, which further increase the lungs' exposure to carcinogenic smoke. Marijuana smokers show dysregulated growth of epithelial cells in their lung tissue, which could lead to cancer; however, a recent case-controlled study found no positive associations between marijuana use and lung, upper respiratory, or upper digestive tract cancers. Thus, the link between marijuana smoking and these cancers remains unsubstantiated at this time.

Nonetheless, marijuana smokers can have many of the same respiratory problems as tobacco smokers, such as daily cough and phlegm production, more frequent acute chest illness, and a heightened risk of lung infections. A study of 450 individuals found that people who smoke marijuana frequently but do not smoke tobacco have more health problems and miss more days of work

than nonsmokers. Many of the extra sick days among the marijuana smokers in the study were for respiratory illnesses.

How Widespread is Marijuana Abuse?

Source: National Survey on Drug Use and Health (NSDUH)

According to the National Survey on Drug Use and Health, in 2009, 16.7 million Americans aged 12 or older used marijuana at least once in the month prior to being surveyed, an increase over the rates reported in all years between 2002 and 2008. There was also a significant increase among youth aged 12-17, with current use up from 6.7 percent in 2008 to 7.3 percent in 2009, although this rate is lower than what was reported in 2002 (8.2 percent). Past-month use also increased among those 18-25, from 16.5 percent in 2008 to 18.1 percent in 2009.

Is Marijuana Medicine?

The potential medicinal properties of marijuana have been the subject of substantive research and heated debate. Scientists have confirmed that the cannabis plant contains active ingredients with therapeutic potential for relieving pain, controlling nausea, stimulating appetite, and decreasing ocular pressure. Cannabinoid-based medications include synthetic compounds, such as dronabinol (Marinol®) and nabilone (Cesamet®), which are FDA approved, and a new, chemically pure mixture of plant-derived THC and cannabidiol called Sativex®, formulated as a mouth spray and approved in Canada and parts of Europe for the relief of cancer-associated pain and spasticity and neuropathic pain in multiple sclerosis.

Scientists continue to investigate the medicinal properties of THC and other cannabinoids to better evaluate and harness their ability to help patients suffering from a broad range of conditions, while avoiding the adverse effects of smoked marijuana.

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2.2.8.3: Prescription Drugs

Most people take medicines only for the reasons their doctors prescribe them. But an estimated 20 percent of people in the United States have used prescription drugs for nonmedical reasons. This is prescription drug abuse. It is a serious and growing problem.

Abusing some prescription drugs can lead to addiction. You can develop an addiction to:

- Narcotic painkillers
- Sedatives and tranquilizers
- Stimulants

Experts don't know exactly why this type of drug abuse is increasing. The availability of drugs is probably one reason. Doctors are prescribing more drugs for more health problems than ever before. Online pharmacies make it easy to get prescription drugs without a prescription, even for younger people.

Commonly Abused Prescription Drugs

Medications can be effective when they are used properly, but some can be addictive and dangerous when abused. Some prescribed medications that - when used in ways or by people other than prescribed - have the potential for adverse medical consequences, including addiction.

In 2010, approximately 16 million Americans reported using a prescription drug for nonmedical reasons in the past year; 7 million in the past month. After marijuana, prescription and over-the-counter medications account for most of the commonly abused drugs.

What types of prescription drugs are abused?

Three types of drugs are abused most often:

- Opioids—prescribed for pain relief
- CNS depressants—barbiturates and benzodiazepines prescribed for anxiety or sleep problems (often referred to as sedatives or tranquilizers)
- Stimulants—prescribed for attention-deficit hyperactivity disorder (ADHD), the sleep disorder narcolepsy, or obesity.

How can you help prevent prescription drug abuse?

- Ask your doctor or pharmacist about your medication, especially if you are unsure about its effects.
- Keep your doctor informed about all medications you are taking, including over-thecounter medications.
- Read the information your pharmacist provides before starting to take medications.
- Take your medication(s) as prescribed.
- Keep all prescription medications secured at all times and properly dispose of any unused medications.

Prescription Drug Advertising

Your healthcare provider is the best source of information about the right medicines for you. The Food and Drug Administration (FDA) protects public health by assuring the safety, effectiveness, and security of a wide range of products, including human prescription drugs. We also advance public health by helping people get the accurate, science-based information they need to use medicines appropriately and improve their health. Prescription drug advertisements can provide useful information for consumers to work with their health care providers to make wise decisions about treatment.

FDA Authority Over Advertising

The FDA serves the public health and welfare in many ways. One way is overseeing the approval and marketing of prescription drugs. It's authority is based on a number of federal laws, including the Federal Food, Drug, and Cosmetic Act. Among other

areas, this law specifically addresses prescription drug advertising. This law requires that advertisements for prescription drugs be accurate and not misleading.

Direct-to-consumer (DTC) advertising is a relatively new area of prescription drug promotion. No federal law has ever banned DTC advertising. Until the mid-1980s, drug companies gave information about prescription drugs only to doctors and pharmacists. When these professionals thought it appropriate, they gave that information to their patients. However, during the 1980s, some drug companies started to give the general public more direct access to this information through DTC ads.

The law requires that product claim ads give a "fair balance" of information about drug risks as compared with information about drug benefits. This means that the content and presentation of a drug's most important risks must be reasonably similar to the content and presentation of its benefits.

This does not mean that equal space must be given to risks and benefits in print ads, or equal time to risks and benefits in broadcast ads. The amount of time or space needed to present risk information will depend on the drug's risks and the way that both the benefits and risks are presented.

Think about the following questions when you see an ad for a prescription drug. Also, think about asking these questions when you talk to your doctor or pharmacist about a drug.

- What condition does this drug treat?
- Why do I think that I might have this condition?
- If I have the condition, am I part of the population the drug is approved to treat?
- Should I take this drug if I have a certain condition?
- Should I take this drug if I am taking certain other drugs?
- Which of the drug's possible side effects am I concerned about?
- How will this drug affect other drugs I am taking?
- Will foods, beverages (alcoholic or non-alcoholic), vitamins, or other supplements affect how this drug works?
- Are there other drugs that treat my condition?
- Is there a less costly drug I could use to treat my condition?
- What else can I do to help deal with my condition? For example, should I exercise or change my diet?
- Do other drugs for my condition have different side effects?
- How can I learn more about this condition and this drug?

Harmful Interactions: Mixing Alcohol with Medicines

You've probably seen this warning on medicines you've taken. The danger is real. Mixing alcohol with certain medications can cause nausea and vomiting, headaches, drowsiness, fainting, or loss of coordination. It also can put you at risk for internal bleeding, heart problems, and difficulties in breathing. In addition to these dangers, alcohol can make a medication less effective or even useless, or it may make the medication harmful or toxic to your body. Some medicines that you might never have suspected can react with alcohol, including many medications which can be purchased "over-the-counter"—that is, without a prescription. Even some herbal remedies can have harmful effects when combined with alcohol.

Medications are safe and effective when used appropriately. Your pharmacist or other health care provider can help you determine which medications interact harmfully with alcohol.

Did You Know...

Mixing alcohol and medicines can be harmful. Alcohol, like some medicines, can make you sleepy, drowsy, or lightheaded. Drinking alcohol while taking medicines can intensify these effects. You may have trouble concentrating or performing mechanical skills. Small amounts of alcohol can make it dangerous to drive, and when you mix alcohol with certain medicines you put yourself at even greater risk. Combining alcohol with some medicines can lead to falls and serious injuries, especially among older people.

Medicines may have many ingredients

Some medications—including many popular painkillers and cough, cold, and allergy remedies—contain more than one ingredient that can react with alcohol. Read the label on the medication bottle to find out exactly what ingredients a medicine contains. Ask your pharmacist if you have any questions about how alcohol might interact with a drug you are taking.

Some medicines contain alcohol

Certain medicines contain up to 10 percent alcohol. Cough syrup and laxatives may have some of the highest alcohol concentrations.

Alcohol affects women differently

Women, in general, have a higher risk for problems than men. When a woman drinks, the alcohol in her bloodstream typically reaches a higher level than a man's even if both are drinking the same amount. This is because women's bodies generally have less water than men's bodies. Because alcohol mixes with body water, a given amount of alcohol is more concentrated in a woman's body than in a man's. As a result, women are more susceptible to alcohol-related damage to organs such as the liver.

Older people face greater risk

Older people are at particularly high risk for harmful alcohol– medication interactions. Aging slows the body's ability to break down alcohol, so alcohol remains in a person's system longer. Older people also are more likely to take a medication that interacts with alcohol—in fact, they often need to take more than one of these medications.

Timing is important

Alcohol and medicines can interact harmfully even if they are not taken at the same time.

Remember...

Mixing alcohol and medicines puts you at risk for dangerous reactions. Protect yourself by avoiding alcohol if you are taking a medication and don't know its effect. To learn more about a medicine and whether it will interact with alcohol, talk to your pharmacist or other health care provider.

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2.2.8.4: Alcohol Abuse

If you are like many Americans, you drink alcohol at least occasionally. For many people, moderate drinking is probably safe. It may even have health benefits, including reducing your risk of certain heart problems. Moderate drinking is one drink a day for women or anyone over 65, and two drinks a day for men under 65.

Some people should not drink at all, including alcoholics, children, pregnant women, people on certain medicines and people with some medical conditions.

Anything more than moderate drinking can be risky. Binge drinking - drinking five or more drinks at one time - can damage your health and increase your risk for accidents, injuries and assault. Years of heavy drinking can lead to liver disease, heart disease, cancer and pancreatitis. It can also cause problems at home, at work and with friends.

Quick Quiz

1. How many drinks for males within a short period of time is considered binge drinking? How many drinks for females within a short period of time is considered binge drinking?
2. True or False: Binge drinking is a risk factor for sexual assault, especially among young women in college settings. Each year, about 1 in 20 college women are sexually assaulted. Binge drinking also increases the chances of car crashes, violence against others, unintended pregnancies, and the spread of HIV and sexually transmitted diseases.
3. What is the most commonly used and abused substance among youth in the United States, more than tobacco and illicit drugs?
4. True or False: Teens and young adults who do not get enough sleep are at risk for automobile crashes, poor grades and performance in school, depressed moods, and problems with peer and adult relationships.

Answers available at the end of this section.

Beyond Hangovers

A brightly colored cosmopolitan is the drink of choice for the glamorous characters in Sex and the City. James Bond depends on his famous martini—shaken, not stirred—to unwind with after confounding a villain. And what wedding concludes without a champagne toast? Alcohol is part of our culture—it helps us celebrate and socialize, and it enhances our religious ceremonies. But drinking too much—on a single occasion or over time—can have serious consequences for our health. Most Americans recognize that drinking too much can lead to accidents and dependence. But that's only part of the story. In addition to these serious problems, alcohol abuse can damage organs, weaken the immune system, and contribute to cancers. Plus, much like smoking, alcohol affects different people differently. Genes, environment, and even diet can play a role in whether you develop an alcohol-related disease.

On the flip side, some people actually may benefit from drinking alcohol in small quantities. Sound complicated? It sure can be. To stay healthy, and to decide what role alcohol should play in your life, you need accurate, up-to-date information. This chapter is designed to offer you guidance based on the latest research on alcohol's effect on your health.

Moderate or "low-risk" drinking

Research shows that people who drink moderately may be less likely to experience an alcohol use disorder (AUD). These drinking levels, which differ for men and women, are:

For men:

- No more than 4 drinks on any single day AND no more than 14 drinks per week

For women:

- No more than 3 drinks on any single day AND no more than 7 drinks per week

To stay low risk for AUDs, you must keep within both the single-day and weekly limits. Even within these limits, you can have problems if you drink too quickly or have other health issues. To keep your risk for problems low, make sure you:

- Drink slowly
- Eat enough while drinking

Certain people should avoid alcohol completely, including those who:

- Plan to drive a vehicle or operate machinery
- Take medications that interact with alcohol
- Have a medical condition that alcohol can aggravate
- Are pregnant or trying to become pregnant

Heavy or "at-risk" drinking

For healthy adults in general, heavy drinking means consuming more than the single-day or the weekly amounts listed above. About 1 in 4 people who drink above these levels already has alcohol dependence or alcohol abuse problems.

Binge drinking

Binge drinking means drinking so much within about 2 hours that blood alcohol concentration (BAC) levels reach 0.08g/dL. For women, this usually occurs after about 4 drinks, and for men, after about 5.

Drinking this way can pose health and safety risks, including car crashes and injuries. Over the long term, binge drinking can damage the liver and other organs.

A Little Goes a Long Way: Know the Amounts

Knowing how much alcohol constitutes a "standard" drink can help you determine how much you are drinking and understand the risks. One standard drink contains about 0.6 fluid ounces or 14 grams of pure alcohol. In more familiar terms, the following amounts constitute one standard drink:

- 12 fluid ounces of beer (about 5% alcohol)
- 8 to 9 fluid ounces of malt liquor (about 7% alcohol)
- 5 fluid ounces of table wine (about 12% alcohol)
- 1.5 fluid ounces of hard liquor (about 40% alcohol)

You're chatting with friends at a party and a waitress comes around with glasses of champagne. You drink one, then another, maybe even a few more. Before you realize it, you are laughing more loudly than usual and swaying as you walk. By the end of the evening, you are too slow to move out of the way of a waiter with a dessert tray and have trouble speaking clearly. The next morning, you wake up feeling dizzy and your head hurts. You may have a hard time remembering everything you did the night before.

These reactions illustrate how quickly and dramatically alcohol affects the brain. The brain is an intricate maze of connections that keeps our physical and psychological processes running smoothly. Disruption of any of these connections can affect how the brain works. Alcohol also can have longer-lasting consequences for the brain—changing the way it looks and works and resulting in a range of problems.

Most people do not realize how extensively alcohol can affect the brain. But recognizing these potential consequences will help you make better decisions about what amount of alcohol is appropriate for you.

What happens inside the brain?

The brain's structure is complex. It includes multiple systems that interact to support all of your body's functions—from thinking to breathing to moving.

These multiple brain systems communicate with each other through about a trillion tiny nerve cells called neurons. Neurons in the brain translate information into electrical and chemical signals the brain can understand. They also send messages from the brain to the rest of the body.

Chemicals called *neurotransmitters* carry messages between the neurons.

Neurotransmitters can be very powerful. Depending on the type and the amount of neurotransmitter, these chemicals can either intensify or minimize your body's responses, your feelings, and your mood. The brain works to balance the neurotransmitters that speed things up with the ones that slow things down to keep your body operating at the right pace.

Alcohol can slow the pace of communication between neurotransmitters in the brain.

Fetal Alcohol Syndrome

Alcohol can affect the brain at any stage of development—even before birth. Fetal alcohol spectrum disorders are the full range of physical, learning, and behavioral problems, and other birth defects that result from prenatal alcohol exposure. The most serious of these disorders, *fetal alcohol syndrome* (FAS), is characterized by abnormal facial features and is usually associated with severe reductions in brain function and overall growth. FAS is the leading preventable birth defect associated with mental and behavioral impairment in the United States today.

The brains of children with FAS are smaller than normal and contain fewer cells, including neurons. These deficiencies result in life-long learning and behavioral problems. Current research is investigating whether the brain function of children and adults with FAS can be improved with complex rehabilitative training, dietary supplements, or medications.

Alcohol and Heart Disease

Americans know how prevalent heart disease is—about 1 in 12 of us suffer from it. What we don't always recognize are the connections heart disease shares with alcohol. On the one hand, researchers have known for centuries that excessive alcohol consumption can damage the heart. Drinking a lot over a long period of time or drinking too much on a single occasion can put your heart—and your life—at risk. On the other hand, researchers now understand that drinking moderate amounts of alcohol can protect the hearts of some people from the risks of coronary artery disease.

Deciding how much, if any, alcohol is right for you can be complicated. To make the best decision for yourself, you need to know the facts and then consult your physician.

Know the Benefits

Research shows that healthy people who drink moderate amounts of alcohol may have a lower risk of developing coronary heart disease than nondrinkers. Moderate drinking is usually defined as no more than two drinks in a given day for men and one drink per day for women who are not pregnant or trying to conceive.

A variety of factors, including diet, genetics, high blood pressure, and age, can cause fat to build up in your arteries, resulting in coronary heart disease. An excess of fat narrows the coronary arteries, which are the blood vessels that supply blood directly to the heart. Clogged arteries reduce blood supply to the heart muscle, and make it easier for blood clots to form. Blood clots can lead to both heart attacks and strokes.

According to recent studies, drinking moderately can protect your heart from these conditions. Moderate drinking helps inhibit and reduce the build-up of fat in the arteries. It can raise the levels of HDL—or "good" cholesterol—in the blood, which wards off heart disease. It can help guard against heart attack and stroke by preventing blood clots from forming and by dissolving blood clots that do develop. Drinking moderately also may help keep blood pressure levels in check.

These benefits may not apply to people with existing medical conditions, or who regularly take certain medications. In addition, researchers discourage people from beginning to drink just for the health benefits. Rather, you can use this research to help you spark a conversation with your medical professional about the best path for you.

Cancer Risk

Genetics, environment, and lifestyle habits can all heighten your risk of getting cancer. We can't do anything to change our genes, and we often can't do much to change our environment. But lifestyle habits are a different story.

Drinking too much alcohol is one lifestyle habit that can increase your risk of developing certain cancers. This does not mean that anyone who drinks too much will develop cancer. But numerous studies do show the more you drink, the more you increase your chances of developing certain types of cancer.

For example, a group of Italy-based scientists reviewed more than 200 studies examining alcohol's impact on cancer risk. The collective results of these studies clearly demonstrate that the more you drink, the higher your risk for developing a variety of cancers. The National Cancer Institute identifies alcohol as a risk factor for the following types of cancer:

- Mouth
- Esophagus
- Pharynx
- Larynx
- Liver
- Breast

At least 7 out of 10 people with mouth cancer drink heavily. Drinking five or more drinks per day can also increase your risk of developing other types of cancers, including colon or rectal cancer. In fact, summary estimates from the recent World Cancer Research Fund report indicate that women who drink five standard alcohol drinks each day have about 1.2 times the risk of developing colon or rectal cancer than women who do not drink at all. People who drink are also more likely to smoke, and the combination increases the risk significantly. Smoking alone is a known risk factor for some cancers. But smoking and drinking together intensifies the cancer-causing properties of each substance. The overall effect poses an even greater risk.

The risk of throat and mouth cancers is especially high because alcohol and tobacco both come in direct contact with those areas. Overall, people who drink and smoke are 15 times more likely to develop cancers of the mouth and throat than nondrinkers and nonsmokers. In addition, recent studies estimate that alcohol and tobacco together are responsible for:

- 80 percent of *throat and mouth cancer* in men
- 65 percent of *throat and mouth cancer* in women
- 80 percent of *esophageal squamous cell carcinoma*, a type of esophagus cancer
- 25 to 30 percent of all liver cancers

Answers

Quick Quiz

1. M ales - 5 or more within a short period of time, Females - 4 or more within a short period of time
2. T rue
3. Alcohol
4. True

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2.2.8.5: Tobacco

The 30th tobacco-related Surgeon General's report issued since 1964 describes in detail the specific pathways by which tobacco smoke damages the human body. The scientific evidence supports the following conclusions:

There is no safe level of exposure to tobacco smoke.

- Any exposure to tobacco smoke – even an occasional cigarette or exposure to secondhand smoke – is harmful.
- You don't have to be a heavy smoker or a long-time smoker to get a smoking-related disease or have a heart attack or asthma attack that is triggered by tobacco smoke.
- Low levels of smoke exposure, including exposures to secondhand tobacco smoke, lead to a rapid and sharp increase in dysfunction and inflammation of the lining of the blood vessels, which are implicated in heart attacks and stroke.
- Cigarette smoke contains more than 7,000 chemicals and compounds. Hundreds are toxic and at least 69 cause cancer. Tobacco smoke itself is a known human carcinogen.
- Chemicals in tobacco smoke interfere with the functioning of fallopian tubes, increasing risk for adverse pregnancy outcomes such as ectopic pregnancy, miscarriage, and low birth weight. They also damage the DNA in sperm which might reduce fertility and harm fetal development.

Damage from tobacco smoke is immediate.

- The chemicals in tobacco smoke reach your lungs quickly every time you inhale. Your blood then carries the toxins to every organ in your body.
- The chemicals and toxicants in tobacco smoke damage DNA, which can lead to cancer. Nearly one-third of all cancer deaths every year are directly linked to smoking. Smoking causes about 85% of lung cancers in the U.S.
- Exposure to tobacco smoke quickly damages blood vessels throughout the body and makes blood more likely to clot. This damage can cause heart attacks, strokes, and even sudden death.
- The chemicals in tobacco smoke inflame the delicate lining of the lungs and can cause permanent damage that reduces the ability of the lungs to exchange air efficiently and leads to chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis.

Smoking longer means more damage.

- Both the risk and the severity of many diseases caused by smoking are directly related to how long the smoker has smoked and the number of cigarettes smoked per day.
- Chemicals in tobacco smoke cause inflammation and cell damage, and can weaken the immune system. The body makes white blood cells to respond to injuries, infections, and cancers. White blood cell counts stay high while smoking continues, meaning the body is constantly fighting against the damage caused by smoking which can lead to disease in almost any part of the body.
- Smoking can cause cancer and weaken your body's ability to fight cancer. With any cancer – even those not related to tobacco use – smoking can decrease the benefits of chemotherapy and other cancer treatments. Exposure to tobacco smoke can help tumors grow.
- The chemicals in tobacco smoke complicate the regulation of blood sugar levels, exacerbating the health issues resulting from diabetes. Smokers with diabetes have a higher risk of heart and kidney disease, amputation, eye disease causing blindness, nerve damage and poor circulation.

Cigarettes are designed for addiction.

- The design and contents of tobacco products make them more attractive and addictive than ever before. Cigarettes today deliver nicotine more quickly from the lungs to the heart and brain.
- The powerful addicting elements of tobacco products affect multiple types of nicotine receptors in the brain.
- Evidence suggests that psychosocial, biologic, and genetic factors may also play a role in nicotine addiction.

There is no safe cigarette.

- The evidence indicates that changing cigarette designs over the last five decades, including filtered, low-tar, and "light" variations, have NOT reduced overall disease risk among smokers and may have hindered prevention and cessation efforts.

- The overall health of the public could be harmed if the introduction of novel tobacco products encourages tobacco use among people who would otherwise be unlikely to use a tobacco product or delays cessation among persons who would otherwise quit using tobacco altogether.

Quitting

The only proven strategy for reducing the risk of tobacco-related disease and death is to never smoke, and if you do smoke to quit.

Quitting at any age and at any time is beneficial. It's never too late to quit, but the sooner the better. Quitting gives your body a chance to heal the damage caused by smoking. When smokers quit, the risk for a heart attack drops sharply after just 1 year; stroke risk can fall to about the same as a nonsmoker's after 2-5 years; risks for cancer of the mouth, throat, esophagus, and bladder are cut in half after 5 years; and the risk for dying of lung cancer drops by half after 10 years. Smokers often make several attempts before they are able to quit, but new strategies for cessation, including nicotine replacement and non-nicotine medications, can make it easier.

Tobacco smoke is a toxic mix of more than 7,000 chemicals. Many are poisons. When these chemicals get deep into your body's tissues, they cause damage. Your body must fight to heal the damage each time you smoke. Over time, the damage can lead to disease.

The chemicals in tobacco smoke reach your lungs quickly when you inhale. What this new report shows is that *these same poisonous chemicals reach every organ in your body*. They go quickly from your lungs into your blood. Then the blood flows through your arteries. It carries the chemicals to tissues in all parts of your body. Your lungs, blood vessels, and other delicate tissues become inflamed and damaged when you smoke.

Smoking Keeps Your Body under Attack

If you spilled drain cleaner on your skin, it would hurt and become inflamed. If you did this many times a day, your skin would not have a chance to heal. It would stay red, irritated, and inflamed. The organs in your body also have a lining of cells similar to skin. Chemicals in tobacco smoke cause inflammation and damage to these cells. When you keep smoking, the damage cannot heal.

Smoking makes your immune system work overtime. Your body makes white blood cells to respond to injuries, infections, and even cancers. Blood tests show that your white blood cell numbers stay high when you smoke. High numbers mean that your body is constantly fighting against the damage caused by tobacco smoke. This constant stress disrupts how your body works. New research shows that stress can lead to disease in almost any part of your body.

Damage is Immediate.

The poisons in smoke pose a danger right away. Sudden blood clots, heart attacks, and strokes can be triggered by tobacco smoke. Poisons in tobacco smoke disrupt the way your body heals itself. Even smoking a cigarette now and then is enough to hurt you. Sitting in a smoky bar raises your odds of a heart attack.

The more years you smoke, the more you hurt your body. Scientists now know that your disease risk surges even higher after you have smoked for about 20 years. But research shows that if you quit by age 30, your health could become almost as good as a nonsmoker's. At any age, the sooner you quit, the sooner your body can begin to heal.

Nicotine is powerfully addictive.

Addiction to nicotine changes the chemical balance in your brain. Addiction keeps people smoking even when they want to quit. Breaking addiction is harder for some people than others. Many people need more than one try in order to quit.

Scientists now know more about why the brain craves nicotine. Like heroin or cocaine, nicotine changes the way your brain works and causes you to crave more and more nicotine. These powerful cravings make it hard for you to think about anything else. Smoking can cause both physical and mental addiction.

Cigarettes are designed for addiction.

Cigarette makers have long known that nicotine addiction helps sell their products.

Cigarettes today deliver more nicotine and deliver it quicker than ever before. The additives and chemicals that tobacco

companies put in cigarettes may have helped make them.

You might have thought that “filtered,” “low-tar,” or “light” cigarettes were less dangerous than others. But research shows that these cigarettes are every bit as addictive and are no safer than other cigarettes. Misleading labels are no longer allowed.

Many teens who try cigarettes don’t know how easy it is to become addicted. Nicotine addiction is so powerful that every day about 1,000 teens become daily smokers. Why is this important? Because most current smokers became addicted as teenagers.

You can beat addiction to tobacco.

Smokers who quit go through withdrawal. The first days are the most uncomfortable. The physical symptoms of nicotine addiction end about 3 weeks after you quit smoking. But you may still have an urge to smoke when you wake up, drink coffee, or are out with friends. It takes longer to break these patterns. But you can beat it.

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2.2.8.6: Myths about Smoking and Cigarettes

Smoking is just a choice.

The first time? Yes. After just a few cigarettes? No. Addiction to nicotine can happen quickly. It changes the chemical balance in your brain. Smoking may seem like it's just a choice or a habit. In fact, most people who use tobacco are addicted. Breaking nicotine addiction is harder for some people than others. Quitting can take several tries. But don't give up. If you need help to quit, ask your doctor about nicotine replacement, medicines, or coaching.

Filters make cigarettes safer.

Filters do not protect you. They are designed to make smoke particles smaller. That makes nicotine easier to absorb. This increases addiction. Cigarettes have been engineered to speed up nicotine's path to your brain. Their design feeds addiction. Light or low-tar cigarettes may sound less dangerous. They aren't. These misleading labels are no longer allowed. No cigarette is safe. Tobacco smoke contains more than 7,000 chemicals. At least 250 are toxic.

An occasional cigarette is no big deal.

Smoking doesn't just cause diseases for heavy smokers or longtime smokers. The 2010 Surgeon General's Report shows how breathing tobacco smoke can cause immediate harm. Tobacco smoke can trigger sudden heart attacks and death, even in nonsmokers. Each cigarette you smoke hurts your lungs, your blood vessels, and cells throughout your body. Smoking a few cigarettes a week can cause a heart attack. Cutting back is not enough to protect you. You have to quit entirely.

It's too late to quit—the damage is already done.

It's true that the longer you use tobacco, the more you hurt your body. But at any age, the sooner you quit, the sooner your health can improve. The 2010 Surgeon General's Report shows how using tobacco causes disease almost everywhere in your body. Within 20 minutes after quitting, your body starts to heal. After 2 to 5 years, your risk for stroke is similar to that of a nonsmoker. In 10 years, your lung cancer risk is cut in half.

Secondhand smoke may bother people, but it isn't dangerous.

Tens of thousands of nonsmokers die every year from breathing others' secondhand smoke. Breathing the chemicals in tobacco smoke changes your blood's chemistry almost immediately. Deadly clots can form and block arteries to your heart or brain. When you smoke at work, home, or at a restaurant, everyone there breathes poisons. If you smoke in your car, rolling down a window does not protect your passengers. It is not healthy to breathe any amount of tobacco smoke.

The little bit of smoke that my kids get doesn't hurt them.

Don't smoke or let others smoke around your children. They can get bronchitis, pneumonia, and ear infections from smoke. Even if you only smoke by an open window, some of the smoke stays in your house and poisons the air your children breathe. Children with asthma can have a serious, even deadly, asthma attack from breathing secondhand smoke. The best way to protect children is to quit smoking. If you or someone else in your household are not ready to quit, be sure to make your home and car 100% smoke-free.

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2.2.8.7: Drug Addiction

More than three decades of research supported by the National Institute on Drug Abuse (NIDA) has proven that addiction is a complex brain disease characterized by compulsive, at times uncontrollable, drug craving, seeking, and use that persist despite potentially devastating consequences. Addiction is also a developmental disease; that is, it usually starts in adolescence or even childhood and can last a lifetime if untreated. Disagreements about the nature of addiction remain: namely, whether it reflects voluntary or involuntary behavior and whether it should be punished or treated as a health issue. Even though the first time a person takes a drug, it is often by choice—to achieve a pleasurable sensation or desired emotional state—we now know from a large body of research that this ability to choose can be affected by drugs. And when addiction takes hold in the brain, it disrupts a person's ability to exert control over behavior— reflecting the compulsive nature of this disease.

The human brain is an extraordinarily complex and fine-tuned communications network made up of billions of cells that govern our thoughts, emotions, perceptions, and drives. Our brains reward certain behaviors such as eating or procreating—registering these as pleasurable activities that we want to repeat. Drug addiction taps into these vital mechanisms geared for our survival. And although not a life necessity, to an addicted person, drugs become life itself, driving the compulsive use of drugs—even in the face of dire life consequences—*that is the essence of addiction*.

How Does Addiction Take Hold in the Brain?

The rewarding effects of drugs of abuse come from large and rapid upsurges in dopamine, a neurochemical critical to stimulating feelings of pleasure and to motivating behavior. The rapid dopamine "rush" from drugs of abuse mimics but greatly exceeds in intensity and duration the feelings that occur in response to such pleasurable stimuli as the sight or smell of food, for example. Repeated exposure to large, drug-induced dopamine surges has the insidious consequence of ultimately blunting the response of the dopamine system to everyday stimuli. Thus the drug disturbs a person's normal hierarchy of needs and desires and substitutes new priorities concerned with procuring and using the drug.

Drug abuse also disrupts the brain circuits involved in memory and control over behavior. Memories of the drug experience can trigger craving as can exposure to people, places, or things associated with former drug use. Stress is also a powerful trigger for craving. Control over behavior is compromised because the affected frontal brain regions are what a person needs to exert inhibitory control over desires and emotions.

That is why addiction is a brain disease. As a person's reward circuitry becomes increasingly dulled and desensitized by drugs, nothing else can compete with them—food, family, and friends lose their relative value, while the ability to curb the need to seek and use drugs evaporates. Ironically and cruelly, eventually even the drug loses its ability to reward, but the compromised brain leads addicted people to pursue it, anyway; the memory of the drug has become more powerful than the drug itself.

When does drug abuse become drug addiction? It rarely happens with the first use of a drug. Drug abuse and drug addiction can be thought of as points along a continuum. Any use of a mind-altering drug or the inappropriate use of medication (either prescription or over-the-counter drugs) is **drug abuse**, but the point when drug abuse becomes drug addiction is less clear. Different people may reach the point of addiction at different stages. Scientists continue to investigate the factors that contribute to the transition to drug addiction.

Drug addiction is defined as the continued compulsive use of drugs despite adverse health or social consequences. Drug-addicted people have lost control of their drug use. Individuals who are addicted to drugs often become isolated from family or friends, have difficulty at work or school, may commit crimes, and become involved with the criminal justice system. For a person addicted to drugs, continuing to take them becomes the primary focus in life.

Certain drugs, including opioids and alcohol, cause strong physical reactions in the body when drug use stops. When a person addicted to heroin stops taking heroin, he or she can experience a variety of symptoms ranging from watery eyes and a runny nose to irritability and loss of appetite and then diarrhea, shivering, sweating, abdominal cramps, increased sensitivity to pain, and sleep problems. In general, withdrawal from heroin makes people feel miserable. Withdrawal from alcohol can cause serious effects such as seizures and even death. Withdrawal from other drugs, such as cocaine and amphetamines, does not lead to strong physical reactions, but it may make the person feel depressed or lethargic. For most drugs, physical withdrawal symptoms can usually be controlled effectively with medications. Even though withdrawal from some drugs does not cause the person abusing them to have physical reactions, stopping drug use is difficult because of the changes the drugs have caused in the brain. Once the drugs stop, the person will have cravings, or intense desire for the drugs. Craving arises from the brain's need to maintain a

state of homeostasis that now relies on the presence of the drug. A person may experience cravings at any stage of drug abuse or addiction, even early in the experimentation phase of drug abuse. Cravings have a physical basis in the brain. Using PET imaging, scientists have shown that just seeing images of drug paraphernalia can stimulate the amygdala (part of the brain involved in emotional memory) in an addicted person.

Drugs of addiction do not merely cause short-term changes in an individual's cognitive skill and behavior. A drug "high" lasts a short time, ranging from less than an hour to 12 hours, depending on the drug, dose, and route of administration. The changes in the brain that result from continued drug use, however, can last a long time. Scientists believe that some of these changes disappear when drug use stops; some disappear within a short time after drug use stops, and other changes are potentially permanent.

One of the first changes in the brain that may occur in response to repeated drug abuse is tolerance. **Tolerance** develops when a person needs increasing doses of a drug to achieve the same high or "rush" that previously resulted from a lower dose of the drug. Two primary mechanisms underlie the development of tolerance. First, the body may become more efficient at metabolizing the drug, thereby reducing the amount that enters the brain. Second, the cells of the body and brain may become more resistant to the effect of the drug. For example, after continued cocaine use, neurons decrease the number of dopamine receptors, which results in decreasing cocaine's stimulatory effect. Opioids, on the other hand, do not cause a change in the number of receptors. Instead the opioid receptors become less efficient in activating associated cellular processes, thus reducing the effects of the opioids.

In addition to the functional and anatomical changes in the brain, drug abuse puts people at higher risk for other health problems. For example, inhalant abuse can lead to disruption of heart rhythms, and snorting cocaine can lead to ulcerations in the mucous membranes of the nose. In addition, injection drug users (IDUs) are at higher risk of contracting HIV through the sharing of potentially contaminated needles. Similarly, hepatitis B and hepatitis C are much more common among drug addicts than the general population. Tuberculosis is another concern. Drug abuse and addiction also are contributing factors in motor vehicle accidents.

Why Do Some People Become Addicted While Others Do Not?

No single factor can predict whether a person will become addicted to drugs. Risk for addiction is influenced by a combination of factors that include individual biology, social environment, and age or stage of development. The more risk factors an individual has, the greater the chance that taking drugs can lead to addiction.

For example:

Biology. The genes that people are born with––in combination with environmental influences––account for about half of their addiction vulnerability. Additionally, gender, ethnicity, and the presence of other mental disorders may influence risk for drug abuse and addiction.

Environment. A person's environment includes many different influences, from family and friends to socioeconomic status and quality of life in general. Factors such as peer pressure, physical and sexual abuse, stress, and quality of parenting can greatly influence the occurrence of drug abuse and the escalation to addiction in a person's life.

Development. Genetic and environmental factors interact with critical developmental stages in a person's life to affect addiction vulnerability. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it will progress to more serious abuse, which poses a special challenge to adolescents. Because their brains are still developing in the areas that govern decisionmaking, judgment, and self-control, adolescents may be especially prone to risk-taking behaviors, including trying drugs of abuse.

Prevention Is the Key

Drug addiction is a preventable disease. Results from NIDA-funded research have shown that prevention programs involving families, schools, communities, and the media are effective in reducing drug abuse. Although many events and cultural factors affect drug abuse trends, when youths perceive drug abuse as harmful, they reduce their drug taking. Thus, education and outreach are key in helping youth and the general public understand the risks of drug abuse. Teachers, parents, medical and public health professionals must keep sending the message that drug addiction can be prevented if one never abuses drugs.

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2.2.8.8: Treatment Approaches for Drug Addiction

Can drug addiction be treated?

Yes, but it's not simple. Because addiction is a chronic disease, people can't simply stop using drugs for a few days and be cured. Most patients need long-term or repeated care to stop using completely and recover their lives.

Addiction treatment must help the person do the following:

- stop using drugs
- stay drug-free
- be productive in the family, at work, and in society

Principles of Effective Treatment

Based on scientific research since the mid-1970s, the following key principles should form the basis of any effective treatment program:

- Addiction is a complex but treatable disease that affects brain function and behavior.
- No single treatment is right for everyone.
- People need to have quick access to treatment.
- Effective treatment addresses all of the patient's needs, not just his or her drug use.
- Staying in treatment long enough is critical.
- Counseling and other behavioral therapies are the most commonly used forms of treatment.
- Medications are often an important part of treatment, especially when combined with behavioral therapies.
- Treatment plans must be reviewed often and modified to fit the patient's changing needs.
- Treatment should address other possible mental disorders.
- Medically assisted detoxification is only the first stage of treatment.
- Treatment doesn't need to be voluntary to be effective.
- Drug use during treatment must be monitored continuously.
- Treatment programs should test patients for HIV/AIDS, hepatitis B and C, tuberculosis, and other infectious diseases as well as teach them about steps they can take to reduce their risk of these illnesses.

How is drug addiction treated?

Successful treatment has several steps:

- detoxification (the process by which the body rids itself of a drug)
- behavioral counseling
- medication (for opioid, tobacco, or alcohol addiction)
- evaluation and treatment for co-occurring mental health issues such as depression and anxiety
- long-term follow-up to prevent relapse

A range of care with a tailored treatment program and follow-up options can be crucial to success. Treatment should include both medical and mental health services as needed. Follow-up care may include community- or family-based recovery support systems.

How are medications used in drug addiction treatment?

Medications can be used to manage withdrawal symptoms, prevent relapse, and treat cooccurring conditions.

Withdrawal: Medications help suppress withdrawal symptoms during detoxification. Detoxification is not in itself "treatment," but only the first step in the process. Patients who do not receive any further treatment after detoxification usually resume their drug

use. One study of treatment facilities found that medications were used in almost 80 percent of detoxifications (SAMHSA, 2014).

Relapse prevention: Patients can use medications to help re-establish normal brain function and decrease cravings. Medications are available for treatment of opioid (heroin, prescription pain relievers), tobacco (nicotine), and alcohol addiction. Scientists are developing other medications to treat stimulant (cocaine, methamphetamine) and cannabis (marijuana) addiction. People who use more than one drug, which is very common, need treatment for all of the substances they use.

- **Opioids:** Methadone (Dolophine®, Methadose®), buprenorphine (Suboxone®, Subutex®, Probuphine®), and naltrexone (Vivitrol®) are used to treat opioid addiction. Acting on the same targets in the brain as heroin and morphine, methadone and buprenorphine suppress withdrawal symptoms and relieve cravings. Naltrexone blocks the effects of opioids at their receptor sites in the brain and should be used only in patients who have already been detoxified. All medications help patients reduce drug seeking and related criminal behavior and help them become more open to behavioral treatments.
- **Tobacco:** Nicotine replacement therapies have several forms, including the patch, spray, gum, and lozenges. These products are available over the counter. The U.S. Food and Drug Administration (FDA) has approved two prescription medications for nicotine addiction: bupropion (Zyban®) and varenicline (Chantix®). They work differently in the brain, but both help prevent relapse in people trying to quit. The medications are more effective when combined with behavioral treatments, such as group and individual therapy as well as telephone quitlines.
- **Alcohol:** Three medications have been FDA-approved for treating alcohol addiction and a fourth, topiramate, has shown promise in clinical trials (large-scale studies with people). The three approved medications are as follows:
  - **Naltrexone** blocks opioid receptors that are involved in the rewarding effects of drinking and in the craving for alcohol. It reduces relapse to heavy drinking and is highly effective in some patients. Genetic differences may affect how well the drug works in certain patients.
  - **Acamprosate (Campral®)** may reduce symptoms of long-lasting withdrawal, such as insomnia, anxiety, restlessness, and dysphoria (generally feeling unwell or unhappy). It may be more effective in patients with severe addiction.
  - **Disulfiram (Antabuse®)** interferes with the breakdown of alcohol. Acetaldehyde builds up in the body, leading to unpleasant reactions that include flushing (warmth and redness in the face), nausea, and irregular heartbeat if the patient drinks alcohol. Compliance (taking the drug as prescribed) can be a problem, but it may help patients who are highly motivated to quit drinking.
- *Co-occuring conditions:* Other medications are available to treat possible mental health conditions, such as depression or anxiety, that may be contributing to the person's addiction.

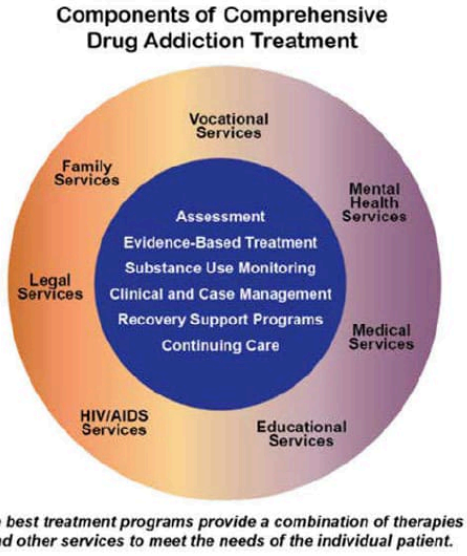


Figure 2.2.8.8.1. Wheel of drug addiction treatments

How are behavioral therapies used to treat drug addiction?

Behavioral therapies help patients:

- modify their attitudes and behaviors related to drug use

- increase healthy life skills
- persist with other forms of treatment, such as medication

Patients can receive treatment in many different settings with various approaches.

Outpatient behavioral treatment includes a wide variety of programs for patients who visit a behavioral health counselor on a regular schedule. Most of the programs involve individual or group drug counseling, or both. These programs typically offer forms of behavioral therapy such as:

- *cognitive-behavioral therapy,* which helps patients recognize, avoid, and cope with the situations in which they are most likely to use drugs
- *multidimensional family therapy*—developed for adolescents with drug abuse problems as well as their families—which addresses a range of influences on their drug abuse patterns and is designed to improve overall family functioning
- *motivational interviewing*, which makes the most of people's readiness to change their behavior and enter treatment
- *motivational incentive*s (contingency management), which uses positive reinforcement to encourage abstinence from drugs

Treatment is sometimes intensive at first, where patients attend multiple outpatient sessions each week. After completing intensive treatment, patients transition to regular outpatient treatment, which meets less often and for fewer hours per week to help sustain their recovery.

Inpatient or residential treatment can also be very effective, especially for those with more severe problems (including co-occurring disorders). Licensed residential treatment facilities offer 24-hour structured and intensive care, including safe housing and medical attention. Residential treatment facilities may use a variety of therapeutic approaches, and they are generally aimed at helping the patient live a drug-free, crime-free lifestyle after treatment.

Points To Remember

Drug addiction can be treated, but it's not simple. Addiction treatment must help the person do the following:

- stop using drugs
- stay drug-free
- be productive in the family, at work, and in society

Successful treatment has several steps:

- detoxification
- behavioral counseling
- medication (for opioid, tobacco, or alcohol addiction)
- evaluation and treatment for co-occurring mental health issues such as depression and anxiety
- long-term follow-up to prevent relapse

Medications can be used to manage withdrawal symptoms, prevent relapse, and treat cooccurring conditions.

- Behavioral therapies help patients:
- modify their attitudes and behaviors related to drug use
- increase healthy life skills
- persist with other forms of treatment, such as medication
- People within the criminal justice system may need additional treatment services to treat drug use disorders effectively. However, many offenders don't have access to the types of services they need.

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2.2.9: WEIGHT MANAGEMENT

2.2.9.1: Weight Management intro

2.2.9.2: Assessing Body Weight and Body Composition

2.2.9.3: Factors Contributing to Overweight and Obesity

2.2.9.4: Balancing Calories and Eating Healthfully

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2.2.9.6.1: Prevalence of Overweight and Obesity

2.2.9.6.2: Balancing Calories

2.2.9.6.3: Measuring Obesity

2.2.9.6.4: Health Effects of Overweight and Obesity

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2.2.9.1: Weight Management intro

Achieving and sustaining appropriate body weight across the lifespan is vital to maintaining good health and quality of life. Many behavioral, environmental, and genetic factors have been shown to affect a person's body weight. Calorie balance over time is the key to weight management. Calorie balance refers to the relationship between calories consumed from foods and beverages and calories expended in normal body functions (i.e., metabolic processes) and through physical activity. People cannot control the calories expended in metabolic processes, but they can control what they eat and drink, as well as how many calories they use in physical activity.

Calories consumed must equal calories expended for a person to maintain the same body weight. Consuming more calories than expended will result in weight gain. Conversely, consuming fewer calories than expended will result in weight loss. This can be achieved over time by eating fewer calories, being more physically active, or, best of all, a combination of the two.

Maintaining a healthy body weight and preventing excess weight gain throughout the lifespan are highly preferable to losing weight after weight gain. Once a person becomes obese, reducing body weight back to a healthy range requires significant effort over a span of time, even years. People who are most successful at losing weight and keeping it off do so through continued attention to calorie balance.

The current high rates of overweight and obesity among virtually all subgroups of the population in the United States demonstrate that many Americans are in calorie imbalance—that is, they consume more calories than they expend. To curb the obesity epidemic and improve their health, Americans need to make significant efforts to decrease the total number of calories they consume from foods and beverages and increase calorie expenditure through physical activity. Achieving these goals will require Americans to select a healthy eating pattern that includes nutrient-dense foods and beverages they enjoy, meets nutrient requirements, and stays within calorie needs. In addition, Americans can choose from a variety of strategies to increase physical activity.

Key Recommendations

- Prevent and/or reduce overweight and obesity through improved eating and physical activity behaviors.
- Control total calorie intake to manage body weight. For people who are overweight or obese, this will mean consuming fewer calories from foods and beverages.
- Increase physical activity and reduce time spent in sedentary behaviors.
- Maintain appropriate calorie balance during each stage of life—childhood, adolescence, adulthood, pregnancy and breastfeeding, and older age.

An Epidemic of Overweight and Obesity

The prevalence of overweight and obesity in the United States is dramatically higher now than it was a few decades ago. This is true for all age groups, including children, adolescents, and adults. One of the largest changes has been an increase in the number of Americans in the obese category. As shown in the maps below, the prevalence of obesity has doubled and in some cases tripled between the 1990s and 2011.

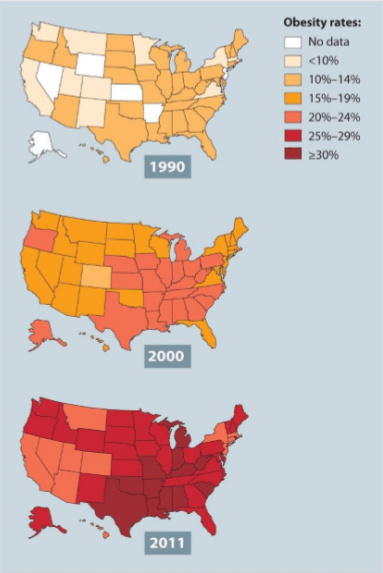


Figure 2.2.9.1.1. Obesity Rates

The high prevalence of overweight and obesity across the population is of concern because individuals who are overweight obese, compared to those with a normal or healthy weight, are at increased risk for many serious diseases and health conditions, including the following:

- All-causes of death (mortality)
- High blood pressure (Hypertension)
- High LDL cholesterol, low HDL cholesterol, or high levels of triglycerides (Dyslipidemia)
- Type 2 diabetes
- Coronary heart disease
- Stroke
- Gallbladder disease
- Osteoarthritis (a breakdown of cartilage and bone within a joint)
- Sleep apnea and breathing problems
- Some cancers (endometrial, breast, colon, kidney, gallbladder, and liver)
- Low quality of life
- Mental illness such as clinical depression, anxiety, and other mental disorders
- Body pain and difficulty with physical functioning

Ultimately, obesity can increase the risk of premature death. These increased health risks are not limited to adults. Weight-associated diseases and conditions that were once diagnosed primarily in adults are now observed in children and adolescents with excess body fat. For example, cardiovascular disease risk factors, such as high blood cholesterol and hypertension, and type 2 diabetes are now increasing in children and adolescents. The adverse effects also tend to persist through the lifespan, as children and adolescents who are overweight and obese are at substantially increased risk of being overweight and obese as adults and developing weight-related chronic diseases later in life. Primary prevention of obesity, especially in childhood, is an important strategy for combating and reversing the obesity epidemic.

All Americans—children, adolescents, adults, and older adults—are encouraged to strive to achieve and maintain a healthy body weight. Adults who are obese should make changes in their eating and physical activity behaviors to prevent additional weight gain and promote weight loss. Adults who are overweight should not gain additional weight, and most, particularly those with cardiovascular disease risk factors, should make changes to their eating and physical activity behaviors to lose weight. Children and adolescents are encouraged to maintain calorie balance to support normal growth and development without promoting excess weight gain. Children and adolescents who are overweight or obese should change their eating and physical activity behaviors so that their BMI-for-age percentile does not increase over time. Further, a health care provider should be consulted to determine appropriate weight management for the child or adolescent. Families, schools, and communities play important roles in supporting changes in eating and physical activity behaviors for children and adolescents.

Maintaining a healthy weight also is important for certain subgroups of the population, including women who are capable of

becoming pregnant, pregnant women, and older adults.

- Women are encouraged to achieve and maintain a healthy weight before becoming pregnant. This may reduce a woman's risk of complications during pregnancy, increase the chances of a healthy infant birth weight, and improve the long-term health of both mother and infant.
- Pregnant women are encouraged to gain weight within the 2009 Institute of Medicine (IOM) gestational weight gain guidelines. Maternal weight gain during pregnancy outside the recommended range is associated with increased risks for maternal and child health.
- Adults ages 65 years and older who are overweight are encouraged to not gain additional weight. Among older adults who are obese, particularly those with cardiovascular disease risk factors, intentional weight loss can be beneficial and result in improved quality of life and reduced risk of chronic diseases and associated disabilities.

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2.2.9.2: Assessing Body Weight and Body Composition

Body Mass Index (BMI) is a number calculated from a person's weight and height. BMI is a fairly reliable indicator of body fatness for most people. BMI does not measure body fat directly, but research has shown that BMI correlates to direct measures of body fat, such as underwater weighing and dual energy x-ray absorptiometry (DXA). BMI can be considered an alternative for direct measures of body fat. Additionally, BMI is an inexpensive and easy-to-perform method of screening for weight categories that may lead to health problems.

How is BMI used?

BMI is used as a screening tool to identify possible weight problems for adults. However, BMI is not a diagnostic tool. For example, a person may have a high BMI. However, to determine if excess weight is a health risk, a healthcare provider would need to perform further assessments. These assessments might include skinfold thickness measurements, evaluations of diet, physical activity, family history, and other appropriate health screenings.

Calculating BMI is one of the best methods for population assessment of overweight and obesity. Because calculation requires only height and weight, it is inexpensive and easy to use for clinicians and for the general public. The use of BMI allows people to compare their own weight status to that of the general population.

Other methods for Assessing Body Composition

Other methods to measure body fatness include skinfold thickness measurements (with calipers), underwater weighing, bioelectrical impedance, and dual-energy x-ray absorptiometry (DEXA). However, these methods are not always readily available, and they are either expensive or need highly trained personnel. Furthermore, many of these methods can be difficult to standardize across observers or machines, complicating comparisons across studies and time periods.



Figure 2.2.9.2.1.Other methods for Assessing Body Composition

Calculating BMI

BMI is calculated the same way for both adults and children. The calculation is based on the following formulas:

Measurement Units	Formula and Calculation

Kilograms and meters/ centimeters	Formula: weight (kg) / [height (m)]^2 With the metric system, the formula for BMI is weight in kilograms divided by height in meters squared. Since height is commonly measured in centimeters, divide height in centimeters by 100 to obtain height in meters. Example: Weight = 68 kg, Height = 165 cm (1.65 m) Calculation: 68 ÷ (1.65)^2 = 24.98
Pounds and Inches	Formula: weight (lb) / [height (in)]^2 x 703 Calculate BMI by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703. Example: Weight = 150 lbs, Height = 5'5" (65") Calculation: [150 ÷ (65)^2] x 703 = 24.96

Interpreting BMI for adults

For adults 20 years old and older, BMI is interpreted using standard weight status categories that are the same for all ages and for both men and women. For children and teens, on the other hand, the interpretation of BMI is both age- and sex-specific. The standard weight status categories associated with BMI ranges for adults are shown in the following table.

BMI	Weight Status
Below 18.5	Underweight
18.5 - 24.9	Normal
25.0 - 29.9	Overweight
30.0 and above	Obese

The following link can be used as a quick reference guide to determine BMI:

https://www.nhlbi.nih.gov/health/edu...MI/bmi_tbl.htm

Reliability of BMI an Indicator of Body Fatness

The correlation between the BMI number and body fatness is fairly strong; however the correlation varies by sex, race, and age. These variations include the following examples:

- At the same BMI, women tend to have more body fat than men.
- At the same BMI, older people, on average, tend to have more body fat than younger adults.
- Highly trained athletes may have a high BMI because of increased muscularity rather than increased body fatness.

It is also important to remember that BMI is only one factor related to risk for disease. For assessing someone's likelihood of developing overweight- or obesity-related diseases, the National Heart, Lung, and Blood Institute guidelines recommend looking at two other predictors:

- The individual's waist circumference (because abdominal fat is a predictor of risk for obesity-related diseases).
- Other risk factors the individual has for diseases and conditions associated with obesity (for example, high blood pressure or physical inactivity).

Measuring Waist Circumference

Measuring waist circumference helps screen for possible health risks that come with overweight and obesity. If most of your fat is around your waist rather than at your hips, you're at a higher risk for heart disease and type 2 diabetes. This risk goes up with a waist size that is greater than 35 inches for women or greater than 40 inches for men. To correctly measure your waist, stand and place a tape measure around your middle, just above your hipbones. Measure your waist just after you breathe out.

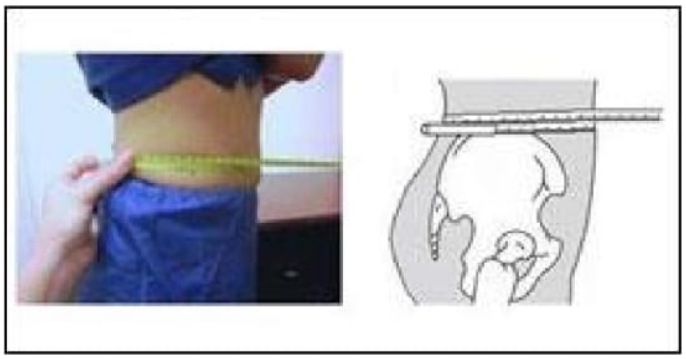


Figure 2.2.9.2.2. Measuring Waist Circumference

Interpreting BMI for Teens and Children

Although the BMI number is calculated the same way for children and adults, the criteria used to interpret the meaning of the BMI number for children and teens are different from those used for adults. For children and teens, BMI age- and sex-specific percentiles are used for two reasons:

- The amount of body fat changes with age.
- The amount of body fat differs between girls and boys.

Because of these factors, the interpretation of BMI is both age- and sex-specific for children and teens. The CDC BMI-for-age growth charts take into account these differences and allow translation of a BMI number into a percentile for a child's sex and age.

For adults, on the other hand, BMI is interpreted through categories that are not dependent on sex or age.

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2.2.9.3: Factors Contributing to Overweight and Obesity

Environmental Factors

The overall environment in which many Americans now live, work, learn, and play has contributed to the obesity epidemic. Ultimately, individuals choose the type and amount of food they eat and how physically active they are. However, choices are often limited by what is available in a person's environment, including stores, restaurants, schools, and worksites. Environment affects both sides of the calorie balance equation—it can promote over-consumption of calories and discourage physical activity and calorie expenditure. The food supply has changed dramatically over the past 40 years. Foods available for consumption increased in all major food categories from 1970 to 2008. Average daily calories available per person in the marketplace increased approximately 600 calories, with the greatest increases in the availability of added fats and oils, grains, milk and milk products, and caloric sweeteners. Many portion sizes offered for sale also have increased. Research has shown that when larger portion sizes are served, people tend to consume more calories. In addition, strong evidence shows that portion size is associated with body weight, such that being served and consuming smaller portions is associated with weight loss.

Studies examining the relationship between the food environment and BMI have found that communities with a larger number of fast food or quick-service restaurants tend to have higher BMIs. Since the 1970s, the number of fast food restaurants has more than doubled. Further, the proportion of daily calorie intake from foods eaten away from home has increased, and evidence shows that children, adolescents, and adults who eat out, particularly at fast food restaurants, are at increased risk of weight gain, overweight, and obesity. The strongest association between fast food consumption and obesity is when one or more fast food meals are consumed per week. As a result of the changing food environment, individuals need to deliberately make food choices, both at home and away from home, that are nutrient dense, low in calories, and appropriate in portion size.

On the other side of the calorie balance equation, many Americans spend most of their waking hours engaged in sedentary behaviors, making it difficult for them to expend enough calories to maintain calorie balance. Many home, school, work, and community environments do not facilitate a physically active lifestyle. For example, the lack of sidewalks or parks and concerns for safety when outdoors can reduce the ability of individuals to be physically active.

Also, over the past several decades, transportation and technological advances have meant that people now expend fewer calories to perform tasks of everyday life. Consequently, many people today need to make a special effort to be physically active during leisure time to meet physical activity needs. Unfortunately, levels of leisure-time physical activity are low. Approximately one-third of American adults report that they participate in leisure-time physical activity on a regular basis, one-third participate in some leisure-time physical activity, and one-third are considered inactive. Participation in physical activity also declines with age. For example, in national surveys using physical activity monitors, 42 percent of children ages 6 to 11 years participate in 60 minutes of physical activity each day, whereas only 8 percent of adolescents achieve this goal. Less than 5 percent of adults participate in 30 minutes of physical activity each day, with slightly more meeting the recommended weekly goal of at least 150 minutes.

Genetic Influences

Obesity is a complex multifactorial chronic disease developing from interactive influences of numerous factors—social, behavioral, physiological, metabolic, cellular, and molecular.

Genetic influences are difficult to explain and identification of the genes is not easily achieved through studies. Furthermore, whatever the influence the genotype has on the etiology of obesity, it is generally attenuated or exacerbated by nongenetic factors. A large number of twin, adoption, and family studies have explored the level of heritability of obesity; that is, the fraction of the population variation in a trait (e.g., BMI) that can be explained by genetic transmission. Recent studies of individuals with a wide range of BMIs, together with information obtained on their parents, siblings, and spouses, suggest that about 25 to 40 percent of the individual differences in body mass or body fat may depend on genetic factors. However, studies with identical twins reared apart suggest that the genetic contribution to BMI may be higher, i.e., about 70 percent.

Hormonal Influences

From the research currently available, several genes seem to have the capacity to cause obesity or to increase the likelihood of becoming obese. Leptin and ghrelin are two hormones that have been recognized to have a major influence on energy balance.

Leptin is a mediator of long-term regulation of energy balance, suppressing food intake and thereby inducing weight loss. Ghrelin on the other hand is a fast-acting hormone, seemingly playing a role in meal initiation. As a growing number of people suffer from obesity, understanding the mechanisms by which various hormones and neurotransmitters have influence on energy balance has been a subject of intensive research. In obese subjects the circulating level of the anorexigenic hormone leptin is increased, whereas surprisingly, the level of the orexigenic hormone ghrelin is decreased. It is now established that obese patients are leptin-resistant. However, the manner in which both the leptin and ghrelin systems contribute to the development or maintenance of obesity is as of yet not clear.

Metabolic Rates

Numerous aspects of your metabolism play a role in determining whether you lose, gain, or maintain your weight. We all have a distinctive ability to burn energy called basal metabolic rate (BMR). BMR is the minimal rate of energy expenditure the body uses in order to survive and main vital functions in the body. *Resting metabolic rate (RMR)* takes into account BMR and any additional energy used during activities of daily living such as eating, digestion, sitting, or standing. *Exercise metabolic rate (EMR)* refers to the energy that is expended during exercise/physical activity. A person's metabolic rates can change throughout one's lifespan and can be affected by puberty, hormonal changes, age, physical activity. Unfortunately, our metabolism naturally slows down as we age making it much more difficult to lose weight at middle age. A slower metabolism, combined with age related muscle loss known as sarcopenia, family obligations, and long work hours all contribute to gradual weight gain in middle-aged adults.

Current Dietary Intake

The current dietary intake of Americans has contributed to the obesity epidemic. Many children and adults have a usual calorie intake that exceeds their daily needs, and they are not physically active enough to compensate for these intakes. The combination sets them on a track to gain weight. On the basis of national survey data, the average calorie intake among women and men older than age 19 years are estimated to be 1,785 and 2,640 calories per day, respectively. While these estimates do not appear to be excessive, the numbers are difficult to interpret because survey respondents, especially individuals who are overweight or obese, often underreport dietary intake. Well-controlled studies suggest that the actual number of calories consumed may be higher than these estimates.

Sources of Calories

The Table below provides the top sources of calories among Americans ages 2 years and older. The table reveals some expected differences in intake between younger (ages 2 to 18 years) and adult (ages 19 years and older) Americans. For example, alcoholic beverages are a major calorie source for adults, while fluid milk provides a greater contribution to calorie intake for children and adolescents. Further, while not shown in the table, there is additional variability in calorie sources among children, adolescents, and adults of different ages. For example, sugar-sweetened beverages and pizza are greater calorie contributors for those ages 9 to 18 years than for younger children. Also, dairy desserts and ready-to-eat cereals provide a greater contribution to calorie intake for those ages 71 years and older than they do among younger adults.

Although some of the top calorie sources by category are important sources of essential nutrients, others provide calories with few essential nutrients. Many of the foods and beverages most often consumed within these top categories are in forms high in solid fats and/or added sugars, thereby contributing excess calories to the diet. For example, many grain-based desserts are high in added sugars and solid fats, while many chicken dishes are both breaded and fried, which adds a substantial number of calories to the chicken.

Table 2.2.9.3.1 *Top 25 Sources of Calories Among Americans Ages 2 Years and Older, NHANES 2005-2006* [a.]

rank	overall, ages 2+ yrs (Mean kcal/d; total daily calories = 2,157)	children and adolescents, ages 2–18 yrs (Mean kcal/d; total daily calories = 2,027)	adults and older adults, ages 19+ yrs (Mean kcal/d; total daily calories = 2,199)
1	Grain-based desserts[b] (138 kcal)	Grain-based desserts[b] (138 kcal)	Grain-based desserts[b] (138 kcal)
2	Yeast breads[c] (129 kcal)	Pizza (136 kcal)	Yeast breads[c] (134 kcal)

3	Chicken and chicken mixed dishes[d] (121 kcal)	Soda/energy/sports drinks (118 kcal)[e]	Chicken and chicken mixed dishes[d] (123 kcal)
4	Soda/energy/sports drinks[e] (114 kcal)	Yeast breads[c] (114 kcal)	Soda/energy/sports drinks[e] (112 kcal)
5	Pizza (98 kcal)	Chicken and chicken mixed dishes (113 kcal)	Alcoholic beverages (106 kcal)
6	Alcoholic beverages (82 kcal)	Pasta and pasta dishes[f] (91 kcal)	Pizza (86 kcal)
7	Pasta and pasta dishes[f] (81 kcal)	Reduced fat milk (86 kcal)	Tortillas, burritos, tacos[g] (85 kcal)
8	Tortillas, burritos, tacos[g] (80 kcal)	Dairy desserts[i] (76 kcal)	Pasta and pasta dishes[f] (78 kcal)
9	Beef and beef mixed dishes[h] (64 kcal)	Potato/corn/other chips (70 kcal)	Beef and beef mixed dishes[h] (71 kcal)
10	Dairy desserts[i] (62 kcal)	Ready-to eat cereals (65 kcal)	Dairy desserts[i] (58 kcal)
11	Potato/corn/other chips (56 kcal)	Tortillas, burritos, tacos[g] (63 kcal)	Burgers (53 kcal)
12	Burgers (53 kcal)	Whole milk (60 kcal)	Regular cheese (51 kcal)
13	Reduced fat milk (51 kcal)	Candy (56 kcal)	Potato/corn/other chips (51 kcal)
14	Regular cheese (49 kcal)	Fruit drinks[m] (55 kcal)	Sausage, franks, bacon, and ribs (49 kcal)
15	Ready-to-eat cereals (49 kcals)	Burgers (55 kcal)	Nuts/seeds and nut/seed mixed dishes[j](47 kcal)
16	Sausage, franks, bacon, and ribs (49 kcal)	Fried white potatoes (52 kcal)	Fried white potatoes (46 kcal)
17	Fried white potatoes (48 kcal)	Sausage, franks, bacon, and ribs (47 kcal)	Ready-to-eat cereals (44 kcal)
18	Candy (47 kcal)	Regular cheese (43 kcal)	Candy (44 kcal)
19	Nuts/seeds and nut/seed mixed dishes[j] (42 kcal)	Beef and beef mixed dishes[h] (43 kcal)	Eggs and egg mixed dishes[k] (42 kcal)
20	Eggs and egg mixed dishes[k] (39 kcal)	100% fruit juice, not orange/grapefruit (35 kcal)	Rice and rice mixed dishes[l] (41 kcal)
21	Rice and rice mixed dishes[l] (36 kcal)	Eggs and egg mixed dishes[k] (30 kcal)	Reduced fat milk (39 kcal)
22	Fruit drink[m] (36 kcal)	Pancakes, waffles, and French Toast (29 kcal)	Quickbreads[n] (36 kcal)
23	Whole milk (33 kcal)	Crackers (28 kcal)	Other fish and fish mixed dishes[o] (30 kcal)
24	Quickbreads[n] (32 kcal)	Nuts/seeds and nut/seed mixed dishes[j](27 kcal)	Fruit drinks[m] (29 kcal)
25	Cold cuts (27 kcal)	Cold cuts (24 kcal)	Salad dressing (29 kcal)

a. Data are drawn from analyses of usual dietary intakes conducted by the National Cancer Institute. Foods and beverages consumed were divided into 97 categories and ranked according to calorie contribution to the diet. Table shows each food category and its mean calorie contribution for each age group. Additional information on calorie contribution by age, gender, and race/ethnicity is available at http://riskfactor.cancer.gov/diet/foodsources/.
b. Includes cake, cookies, pie, cobbler, sweet rolls, pastries, and donuts.
c. Includes white bread or rolls, mixed-grain bread, flavored bread, whole- wheat bread, and bagels.
d. Includes fried or baked chicken parts and chicken strips/patties, chicken stir-fries, chicken casseroles, chicken sandwiches, chicken salads, stewed chicken, and other chicken mixed dishes.

e. Sodas, energy drinks, sports drinks, and sweetened bottled water including vitamin water.
f. Includes macaroni and cheese, spaghetti, other pasta with or without sauces, filled pasta (e.g., lasagna and ravioli), and noodles.
g. Also includes nachos, Quesadilla, and other Mexican mixed dishes.
h. Includes steak, meatloaf, beef with noodles, and beef stew.
i. Includes ice cream, frozen yogurt, sherbet, milk shakes, and pudding.
j. Includes peanut butter, peanuts, and mixed nuts.
k. Includes scrambled eggs, omelets, fried eggs, egg breakfast sandwiches/ biscuits, boiled and poached eggs, egg salad, deviled eggs, quiche, and egg substitutes.
l. Includes white rice, Spanish rice, and fried rice.
m. Includes fruitflavored drinks, fruit juice drinks, and fruit punch.
n. Includes muffins, biscuits, and cornbread.
o. Fish other than tuna or shrimp.

Source: National Cancer Institute. Food sources of energy among U.S. population, 2005-2006. Risk Factor Monitoring and Methods. Control and Population Sciences. National Cancer Institute; 2010. riskfactor. cancer.gov/diet/foodso urces/. Updated May 21, 2010. Accessed May 21, 2010.

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2.2.9.4: Balancing Calories and Eating Healthfully

Calorie Balance: Food and Beverage Intake

Controlling calorie intake from foods and beverages is fundamental to achieving and attaining calorie balance. Understanding calorie needs, knowing food sources of calories, and recognizing associations between foods and beverages and higher or lower body weight are all important concepts when building an eating pattern that promotes calorie balance and weight management. Many Americans are unaware of how many calories they need each day or the calorie content of foods and beverages.

Understanding Calories Needs

The total number of calories a person needs each day varies depending on a number of factors, including the person's age, gender, height, weight, and level of physical activity. In addition, a desire to lose, maintain, or gain weight affects how many calories should be consumed. Estimates range from 1,600 to 2,400 calories per day for adult women and 2,000 to 3,000 calories per day for adult men, depending on age and physical activity level.

Within each age and gender category, the low end of the range is for sedentary individuals; the high end of the range is for active individuals. Due to reductions in basal metabolic rate that occurs with aging, calorie needs generally decrease for adults as they age. Estimated needs for young children range from 1,000 to 2,000 calories per day, and the range for older children and adolescents varies substantially from 1,400 to 3,200 calories per day, with boys generally having higher calorie needs than girls. These are only estimates, and more accurate calorie needs may be determined using the Harris Benedict Equation shown below:

Step 1 – Calculating the Harris–Benedict BMR

The original Harris–Benedict equations published in 1918 and 1919.

BMR calculation for men	BMR = 66 + (6.2 x weight in pounds) + (12.7 x height in inches) – (6.76 x age in years)
BMR calculations for women	BMR = 655 + (4.35 x weight in pounds) + (4.7 x height in inches) - (4.7 x age in years)

Step 2 – Determine Recommended Intake

The following table enables calculation of an individual's recommended daily kilocalorie intake to maintain current weight.

Little to no exercise	Daily kilocalories needed =BMR x 1.2
Light exercise (1–3 days per week)	Daily kilocalories needed = BMR x 1.375
Moderate exercise (3–5 days per week)	Daily kilocalories needed = BMR x 1.55
Heavy exercise (6–7 days per week)	Daily kilocalories needed = BMR x 1.725
Very heavy exercise (twice per day, extra heavy workouts)	Daily kilocalories needed = BMR x 1.9

Knowing one's daily calorie needs may be a useful reference point for determining whether the calories that a person eats and drinks are appropriate in relation to the number of calories needed each day. The best way for people to assess whether they are eating the appropriate number of calories is to monitor body weight and adjust calorie intake and participation in physical activity based on changes in weight over time. A calorie deficit of 500 calories or more per day is a common initial goal for weight loss for adults. However, maintaining a smaller deficit can have a meaningful influence on body weight over time. The effect of a calorie deficit on weight does not depend on how the deficit is produced—by reducing calorie intake, increasing expenditure, or both. Yet, in research studies, a greater proportion of the calorie deficit is often due to decreasing calorie intake with a relatively smaller fraction due to increased physical activity.

Table 2.2.9.4.1. Estimated Calorie Needs Per Day By Age, Gender, and Physical Activity Level*

Estimated amounts of calories needed to maintain calorie balance for various gender and age groups at three different levels of physical activity. The estimates are rounded to the nearest 200 calories. An individual's calorie needs may be higher or lower than these average estimates.

gender	age (years)	Physical activity level: sedentary	Physical activity level: moderately active	Physical activity level: active
child (female and male)	2-3	1000-1200	1000-1400	1000-1400
female	4-8	1200-1400	1400-1600	1400-1800
	9-13	1400-1600	1600-2000	1800-2200
	14-18	1800	2000	2400
	19-30	1800-2000	2000-2200	2400
	31-50	1800	2000	2200
	51+	1600	1800	2000-2200
male	4-8	1200-1400	1400-1600	1600-2000
	9-13	1600-2000	1800-2200	2000-2600
	14-18	2000-2400	2400-2800	2800-3200
	19-30	2400-2600	2600-2800	3000
	31-50	2200-2400	2400-2600	2800-3000
	51+	2000-2200	2200-2400	2400-2800

- Based on Estimated Energy Requirements (EER) equations, using reference heights (average) and reference weights (healthy) for each age/gender group. For children and adolescents, reference height and weight vary. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. EER equations are from the Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.
- Sedentary means a lifestyle that includes only the light physical activity associated with typical day-to-day life. Moderately active means a lifestyle that includes physical activity equivalent to walking about 1.5 to 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life. Active means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.
- The calorie ranges shown are to accommodate needs of different ages within the group. For children and adolescents, more calories are needed at older ages. For adults, fewer calories are needed at older ages. d. Estimates for females do not include women who are pregnant or breastfeeding.

Macronutrient Proportions

The Institute of Medicine has established ranges for the percentage of calories in the diet that should come from carbohydrate, protein, and fat. These Acceptable Macronutrient Distribution Ranges (AMDR) take into account both chronic disease risk reduction and intake of essential nutrients.

To manage body weight, Americans should consume a diet that has an appropriate total number of calories and that is within the AMDR. Strong evidence shows that there is no optimal proportion of macronutrients that can facilitate weight loss or assist with maintaining weight loss. Although diets with a wide range of macronutrient proportions have been documented to promote weight loss and prevent weight regain after loss, evidence shows that the critical issue is not the relative proportion of macronutrients in the diet, but whether or not the eating pattern is reduced in calories and the individual is able to maintain a reduced-calorie intake

over time. The total number of calories consumed is the essential dietary factor relevant to body weight. In adults, moderate evidence suggests that diets that are less than 45 percent of total calories as carbohydrate or more than 35 percent of total calories as protein are generally no more effective than other calorie-controlled diets for long-term weight loss and weight maintenance. Therefore, individuals who wish to lose weight or maintain weight loss can select eating patterns that maintain appropriate calorie intake and have macronutrient proportions that are within the AMDR ranges recommended in the Dietary Reference Intakes.

Individual Foods and Beverages and Body Weight

For calorie balance, the focus should be on total calorie intake, but intake of some foods and beverages that are widely over- or under consumed has been associated with effects on body weight. In studies that have held total calorie intake constant, there is little evidence that any individual food groups or beverages have a unique impact on body weight.

Although total calorie intake is ultimately what affects calorie balance, some foods and beverages can be easily over- consumed, which results in a higher total calorie intake. As individuals vary a great deal in their dietary intake, the best advice is to monitor dietary intake and replace foods higher in calories with nutrient-dense foods and beverages relatively low in calories. The following guidance may help individuals control their total calorie intake and manage body weight:

- increase intake of whole grains, vegetables, and fruits: Moderate evidence shows that adults who eat more whole grains, particularly those higher in dietary fiber, have a lower body weight compared to adults who eat fewer whole grains. Moderate evidence in adults and limited evidence in children and adolescents suggests that increased intake of vegetables and/or fruits may protect against weight gain.
- reduce intake of sugar-sweetened beverages: This can be accomplished by drinking fewer sugar-sweetened beverages and/or consuming smaller portions. Strong evidence shows that children and adolescents who consume more sugar-sweetened beverages have higher body weight compared to those who drink less, and moderate evidence also supports this relationship in adults. Sugar-sweetened beverages provide excess calories and few essential nutrients to the diet and should only be consumed when nutrient needs have been met and without exceeding daily calorie limits.
- Monitor intake of 100% fruit juice for children and adolescents, especially those who are over- weight or obese: For most children and adolescents, intake of 100% fruit juice is not associated with body weight. However, limited evidence suggests that increased intake of 100% juice has been associated with higher body weight in children and adolescents who are overweight or obese.
- Monitor calorie intake from alcoholic beverages for adults: Moderate evidence suggests that moderate drinking of alcoholic beverages is not associated with weight gain. However, heavier than moderate consumption of alcohol over time is associated with weight gain. Because alcohol is often consumed in mixtures with other beverages, the calorie content of accompanying mixers should be considered when calculating the calorie content of alcoholic beverages. Reducing alcohol intake is a strategy that can be used by adults to consume fewer calories.

Strong evidence in adults and moderate evidence in children and adolescents demonstrates that consumption of milk and milk products does not play a special role in weight management. Evidence also suggests that there is no independent relationship between the intake of meat and poultry or beans and peas, including soy, with body weight. Although not independently related to body weight, these foods are important sources of nutrients in healthy eating patterns.

Table 2.2.9.4.2. Recommended Macronutrient Proportions by Age

	Carbohydrate	Protein	fat
Young children (1-3 years)	45-65%	5-20%	30-40%
Other children and adolescents (4-18 years)	45-65%	10-30%	25-35%
Adults (19 years and older)	45-65%	10-30%	20-35%

Source: Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.

Developing Healthy Eating Patterns

Because people consume a variety of foods and beverages throughout the day as meals and snacks, a growing body of research

has begun to describe overall eating patterns that help promote calorie balance and weight management. One aspect of these patterns that has been researched is the concept of calorie density, or the amount of calories provided per unit of food weight. Foods high in water and/or dietary fiber typically have fewer calories per gram and are lower in calorie density, while foods higher in fat are generally higher in calorie density. A dietary pattern low in calorie density is characterized by a relatively high intake of vegetables, fruit, and dietary fiber and a relatively low intake of total fat, saturated fat, and added sugars. Strong evidence shows that eating patterns that are low in calorie density improve weight loss and weight maintenance, and also may be associated with a lower risk of type 2 diabetes in adults.

Although total calories consumed is important for calorie balance and weight management, it is important to consider the nutrients and other healthful properties of food and beverages, as well as their calories, when selecting an eating pattern for optimal health. When choosing carbohydrates, Americans should emphasize naturally occurring carbohydrates, such as those found in whole grains, beans and peas, vegetables, and fruits, especially those high in dietary fiber, while limiting refined grains and intake of foods with added sugars. Glycemic index and glycemic load have been developed as measures of the effects of carbohydrate-containing foods and beverages on blood sugar levels. Strong evidence shows that glycemic index and/or glycemic load are not associated with body weight; thus, it is not necessary to consider these measures when selecting carbohydrate foods and beverages for weight management. For protein, plant-based sources and/or animal-based sources can be incorporated into a healthy eating pattern. However, some protein products, particularly some animal-based sources, are high in saturated fat, so nonfat, low-fat, or lean choices should be selected. Fat intake should emphasize monounsaturated and polyunsaturated fats, such as those found in seafood, nuts, seeds, and oils.

Americans should move toward more healthful eating patterns. Overall, as long as foods and beverages consumed meet nutrient needs and calorie intake is appropriate, individuals can select an eating pattern that they enjoy and can maintain over time. Individuals should consider the calories from all foods and beverages they consume, regardless of when and where they eat or drink.

Calorie Balance: Physical Activity

Physical activity is the other side of the calorie balance equation and should be considered when addressing weight management. In 2008, the U.S. Department of Health and Human Services released a comprehensive set of physical activity recommendations for Americans ages 6 years and older. Weight management along with health outcomes, including premature (early) death, diseases (such as coronary heart disease, type 2 diabetes, and osteoporosis), and risk factors for disease (such as high blood pressure and high blood cholesterol) were among the outcomes considered in developing the Physical Activity Guidelines for Americans. Getting adequate amounts of physical activity conveys many health benefits independent of body weight.

Strong evidence supports that regular participation in physical activity also helps people maintain a healthy weight and prevent excess weight gain. Further, physical activity, particularly when combined with reduced calorie intake, may aid weight loss and maintenance of weight loss. Decreasing time spent in sedentary behaviors also is important as well. Strong evidence shows that more screen time, particularly television viewing, is associated with overweight and obesity in children, adolescents, and adults. Substituting active pursuits for sedentary time can help people manage their weight and provides other health benefits.

The Physical Activity Guidelines for Americans provides guidance to help Americans improve their health, including weight management, through appropriate physical activity. The amount of physical activity necessary to successfully maintain a healthy body weight depends on calorie intake and varies considerably among adults, including older adults. To achieve and maintain a healthy body weight, adults should do the equivalent of 150 minutes of moderate-intensity aerobic activity each week. If necessary, adults should increase their weekly minutes of aerobic physical activity gradually over time and decrease calorie intake to a point where they can achieve calorie balance and a healthy weight. Some adults will need a higher level of physical activity than others to achieve and maintain a healthy body weight. Some may need more than the equivalent of 300 minutes per week of moderate-intensity activity.

For children and adolescents ages 6 years and older, 60 minutes or more of physical activity per day is recommended. Although the Physical Activity Guidelines do not include a specific quantitative recommendation for children ages 2 to 5 years, young children should play actively several times each day. Children and adolescents are often active in short bursts of time rather than for sustained periods of time, and these short bursts can add up to meet physical activity needs. Physical activities for children and adolescents of all ages should be developmentally appropriate and enjoyable, and should offer variety.

Principles for Promoting Calorie Balance and Weight Management

To address the current calorie imbalance in the United States, individuals are encouraged to become more conscious of what they eat and what they do. This means increasing awareness of what, when, why, and how much they eat, deliberately making better choices regarding what and how much they consume, and seeking ways to be more physically active. Several behaviors and practices have been shown to help people manage their food and beverage intake and calorie expenditure and ultimately manage body weight. The behaviors with the strongest evidence related to body weight include:

- Focus on the total number of calories consumed. Maintaining a healthy eating pattern at an appropriate calorie level within the AMDR is advisable for weight management. Consuming an eating pattern low in calorie density may help to reduce calorie intake and improve body weight outcomes and overall health.
- Monitor food intake. Monitoring intake has been shown to help individuals become more aware of what and how much they eat and drink. The Nutrition Facts label found on food packaging provides calorie information for each serving of food or beverage and can assist consumers in monitoring their intake. Also, monitoring body weight and physical activity can help prevent weight gain and improve outcomes when actively losing weight or maintaining body weight following weight loss.
- When eating out, choose smaller portions or lower-calorie options. When possible, order a small-sized option, share a meal, or take home part of the meal. Review the calorie content of foods and beverages offered and choose lower-calorie options. Calorie information may be available on menus, in a pamphlet, on food wrappers, or online. Or, instead of eating out, cook and eat more meals at home.
- Prepare, serve, and consume smaller portions of foods and beverages, especially those high in calories. Individuals eat and drink more when provided larger portions. Serving and consuming smaller portions is associated with weight loss and weight maintenance over time.
- Eat a nutrient-dense breakfast. Not eating breakfast has been associated with excess body weight, especially among children and adolescents. Consuming breakfast also has been associated with weight loss and weight loss maintenance, as well as improved nutrient intake.
- Limit screen time. In children, adolescents, and adults, screen time, especially television viewing, is directly associated with increased overweight and obesity. Children and adolescents are encouraged to spend no more than 1 to 2 hours each day watching television, playing electronic games, or using the computer (other than for homework). Also, avoid eating while watching television, which can result in overeating.

Research has investigated additional principles that may promote calorie balance and weight management. However, the evidence for these behaviors is not as strong. Some evidence indicates that beverages are less filling than solid foods, such that the calories from beverages may not be offset by reduced intake of solid foods, which can lead to higher total calorie intake. In contrast, soup, particularly broth or water-based soups, may lead to decreased calorie intake and body weight over time. Further, replacing added sugars with non-caloric sweeteners may reduce calorie intake in the short-term, yet questions remain about their effectiveness as a weight management strategy. Other behaviors have been studied, such as snacking and frequency of eating, but there is currently not enough evidence to support a specific recommendation for these behaviors to help manage body weight.

Although obesity is related to many chronic health conditions, it is not the only lifestyle-related public health problem confronting the Nation. Eating patterns that are high in calories, but low in nutrients can leave a person overweight but malnourished.

Nutritionally unbalanced diets can negatively affect a person's health regardless of weight status. Such diets are related to many of the most common and costly health problems in the United States, particularly heart disease and its risk factors and type 2 diabetes.

Similarly, a sedentary lifestyle increases risk of these diseases. Improved eating patterns and increased physical activity have numerous health benefits beyond maintaining a healthy weight. Improved nutrition, appropriate eating behaviors, and increased physical activity have tremendous potential to decrease the prevalence of overweight and obesity, enhance the public's health, reduce morbidity and premature mortality, and reduce health care costs.

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2.2.9.5: Body Image

One of the greatest difficulties we have as a society is achieving and maintaining a healthy weight, while also maintaining a healthy body image. Body image is how you see yourself when you look in the mirror or when you picture yourself in your mind. It encompasses:

- What you believe about your own appearance (including your memories, assumptions, and generalizations).
- How you feel about your body, including your height, shape, and weight.
- How you sense and control your body as you move. How you feel in your body, not just about your body.

Below are examples of negative and positive body image:

Negative Body Image

- A distorted perception of your shape--you perceive parts of your body unlike they really are.
- You are convinced that only other people are attractive and that your body size or shape is a sign of personal failure.
- You feel ashamed, self-conscious, and anxious about your body.
- You feel uncomfortable and awkward in your body.

Positive Body Image

- A clear, true perception of your shape--you see the various parts of your body as they really are.
- You celebrate and appreciate your natural body shape and you understand that a person's physical appearance says very little about their character and value as a person.
- You feel proud and accepting of your unique body and refuse to spend an unreasonable amount of time worrying about food, weight, and calories.
- You feel comfortable and confident in your body.

We all may have our days when we feel awkward or uncomfortable in our bodies, but the key to developing positive body image is to recognize and respect our natural shape and learn to overpower those negative thoughts and feelings with positive, affirming, and accepting ones. For more information you can visit the website for the National Eating Disorder Association. Their message is simple: **Accept yourself. Accept your body.**

Eating Disorders

People with negative body image have a greater likelihood of developing an eating disorder and are more likely to suffer from feelings of depression, isolation, low self-esteem, and obsessions with weight loss.

Anorexia Nervosa

Anorexia nervosa, or anorexia, is a type of eating disorder that mainly affects adolescent girls and young women, but can also affect men. A person with this disease has an intense fear of gaining weight and severely limits food intake. Individual may:

- Have a low body weight
- Refuse to keep a normal body weight
- Be extremely afraid of becoming fat
- Believe they are fat even if they are very thin
- Women may miss three (menstrual) periods in a row (for girls/women who have started having their periods)

Anorexia affects your health because it can damage many parts of your body. A person with anorexia will have many of these signs:

- Loses a lot of weight
- Talks about weight and food all the time
- Moves food around the plate; doesn't eat it
- Weighs food and counts calories

- Follows a strict diet
- Won't eat in front of others
- Ignores/denies hunger
- Uses extreme measures to lose weight (self-induced vomiting, laxative abuse, diuretic abuse, diet pills, fasting, excessive exercise)
- Thinks she's fat when she's too thin
- Gets sick a lot
- Weighs self several times a day
- Feels depressed
- Feels irritable
- Doesn't socialize
- Wears baggy clothes to hide appearance

A health care team of doctors, nutritionists, and therapists will help the patient get better. They will:

- Help bring the person back to a normal weight
- Treat any psychological issues related to anorexia
- Help the person get rid of any actions or thoughts that cause the eating disorder

Some research suggests that the use of medicines — such as antidepressants, antipsychotics, or mood stabilizers — may sometimes work for anorexic patients. It is thought that these medicines help the mood and anxiety symptoms that often co-exist with anorexia. Other recent studies, however, suggest that antidepressants may not stop some patients with anorexia from relapsing. Also, no medicine has shown to work 100 percent of the time during the important first step of restoring a patient to healthy weight. So, it is not clear if and how medications can help anorexic patients get better, but research is still in progress.

Some forms of psychotherapy can help make the psychological reasons for anorexia better. Psychotherapy is sometimes known as "talk therapy." It uses different ways of communicating to change a patient's thoughts or behavior. This kind of therapy can be useful for treating eating disorders in young patients who have not had anorexia for a long time.

Individual counseling can help someone with anorexia. If the patient is young, counseling may involve the whole family. Support groups may also be a part of treatment. In support groups, patients, and families meet and share what they've been through.

Some researchers point out that prescribing medicines and using psychotherapy designed just for anorexic patients works better at treating anorexia than just psychotherapy alone. Whether or not a treatment works, though, depends on the person involved and his or her situation. Unfortunately, no one kind of psychotherapy always works for treating adults with anorexia.

Bulimia Nervosa

Bulimia nervosa, or bulimia, is a type of eating disorder. Someone with bulimia eats a lot of food in a short amount of time (bingeing) and then tries to get rid of the calories by purging. Purging might be done in these ways:

- Making oneself throw up
- Taking laxatives (pills or liquids that increase how fast food moves through your body and leads to a bowel movement)

A person with bulimia may also use these ways to prevent weight gain:

- Exercising a lot (more than normal)
- Restricting her eating or not eating at all (like going without food for a day)
- Taking diuretics (pills that make you urinate)

Bulimia is more than just a problem with food. It's a way of using food to feel in control of other feelings that may seem overwhelming. Purging and other behaviors to prevent weight gain are ways for people with bulimia to feel more in control of their lives and to ease stress and anxiety.

Unlike anorexia, when people are severely underweight, people with bulimia may be underweight, overweight, or have a normal weight. This makes it harder to know if someone has this disease. However, someone with bulimia may have these signs:

- Thinks about food a lot
- Binges (normally in secret)
- Throws up after bingeing

- Uses laxatives, diet pills, or diuretics to control weight
- Is depressed
- Is unhappy and/or thinks a lot about her body shape and weight
- Eats large amounts of food quickly
- Goes to the bathroom all the time after she eats (to throw up)
- Exercises a lot, even during bad weather, fatigue, illness, or injury
- Unusual swelling of the cheeks or jaw area
- Cuts and calluses on the back of the hands and knuckles from making herself throw up
- White enamel of teeth wears away making teeth look clear
- Doesn't see friends or participate in activities as much. Has rules about food — has "good" foods and "bad" foods

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2.2.9.6: WEIGHT MANAGEMENT

2.2.9.6.1: Prevalence of Overweight and Obesity

2.2.9.6.2: Balancing Calories

2.2.9.6.3: Measuring Obesity

2.2.9.6.4: Health Effects of Overweight and Obesity

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2.2.9.6.1: Prevalence of Overweight and Obesity

Overweight and Obesity in the United States

According to data from the National Health and Nutrition Examination Survey (NHANES):

- About 1 in 3 adults were considered to be overweight.
- More than 2 in 3 adults were considered to be overweight or have obesity.
- More than 1 in 3 adults were considered to have obesity.
- About 1 in 13 adults were considered to have extreme obesity.
- About 1 in 6 children and adolescents ages 2 to 19 were considered to have obesity.

YouTube Video

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You Tube Video: The Obesity Epidemic (https://www.youtube.com/watch?time_continue=1&v=vCORDl4bqDE)

Worldwide Obesity Statistics from the World Health Organization

- Worldwide obesity has nearly tripled since 1975.
- In 2016, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 650 million were obese.
- 39% of adults aged 18 years and over were overweight in 2016, and 13% were obese.
- Most of the world's population live in countries where overweight and obesity kills more people than underweight.
- 41 million children under the age of 5 were overweight or obese in 2016.
- Obesity is preventable.

Causes and Health Consequences of Overweight and Obesity

Factors that may contribute to weight gain among adults and youth include genes, eating habits, physical inactivity, TV, computer, phone, and other screen time, sleep habits, medical conditions or medications, and where and how people live, including their access to healthy foods and safe places to be active.

Overweight and obesity are risk factors for many health problems such as type 2 diabetes, high blood pressure, joint problems, and gallstones, among other conditions.
For more information on the causes and health consequences of overweight and obesity, please visit NIDDK's webpages on Understanding Adult Overweight and Obesity.

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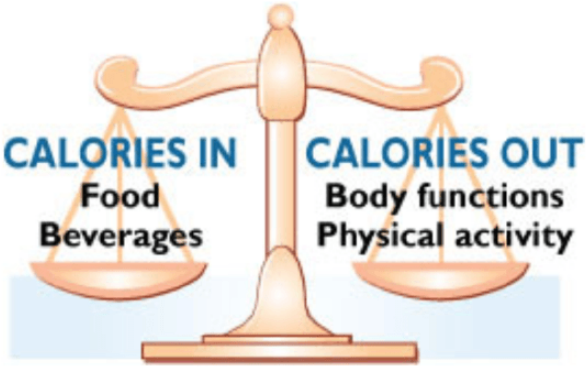
2.2.9.6.2: Balancing Calories

More than one third of U.S. adults are obese. Weight gain occurs when you consume more calories than your body uses. Reaching and maintaining a healthy weight will help you prevent and control many diseases and conditions. The key is “Finding a Balance” in your lifestyle that includes healthy eating and regular physical activity.

The Caloric Balance Equation

When it comes to maintaining a healthy weight for a lifetime, the bottom line is – calories count! Weight management is all about balance—balancing the number of calories you consume with the number of calories your body uses or “burns off.”

- A calorie is defined as a unit of energy supplied by food. A calorie is a calorie regardless of its source. Whether you’re eating carbohydrates, fats, sugars, or proteins, all of them contain calories.
- Caloric balance is like a scale. To remain in balance and maintain your body weight, the calories consumed (from foods) must be balanced by the calories used (in normal body functions, daily activities, and exercise).



If you are...	Your caloric balance status is...
Maintaining your weight	“in balance.” You are eating roughly the same number of calories that your body is using. Your weight will remain stable.
Gaining weight	“in caloric excess.” You are eating more calories than your body is using. You will store these extra calories as fat and you’ll gain weight.
Losing weight	“in caloric deficit.” You are eating fewer calories than you are using. Your body is pulling from its fat storage cells for energy, so your weight is decreasing.

Am I in Caloric Balance?



If you are maintaining your current body weight, you are in caloric balance. If you need to gain weight or to lose weight, you'll need to tip the balance scale in one direction or another to achieve your goal.

If you need to tip the balance scale in the direction of losing weight, keep in mind that it takes approximately 3,500 calories below your calorie needs to lose a pound of body fat. To lose about 1 to 2 pounds per week, you'll need to reduce your caloric intake by 500—1000 calories per day.

To learn how many calories you are currently eating, begin writing down the foods you eat and the beverages you drink each day. By writing down what you eat and drink, you become more aware of everything you are putting in your mouth. Also, begin writing down the physical activity you do each day and the length of time you do it. Here are simple paper and pencil tools to assist you:

- Food Diary[PDF-3KB]
- Physical Activity Diary[PDF-42KB]

Want to try an interactive approach evaluate your food intake and physical activity? Go to the SuperTracker. The site will give you a detailed assessment and analysis of your current eating and physical activity habits.

Physical activities (both daily activities and exercise) help tip the balance scale by increasing the calories you expend each day. For examples, go to How Many Calories Does Physical Activity Burn?

Find out how many calories your body needs to maintain, lose, or gain weight by clicking here.

The bottom line is... each person's body is unique and may have different caloric needs. A healthy lifestyle requires balance, in the foods you eat, in the beverages you consume, in the way you carry out your daily activities, and in the amount of physical activity or exercise you include in your daily routine. While counting calories is not necessary, it may help you in the beginning to gain an awareness of your eating habits as you strive to achieve energy balance. The ultimate test of balance is whether or not you are gaining, maintaining, or losing weight.

Research suggests that safe weight loss involves combining a reduced-calorie diet with physical activity to lose 1/2 to 2 pounds a week (after the first few weeks of weight loss). Make healthy food choices. Eat small portions. Build exercise into your daily life. Combined, these habits may be a healthy way to lose weight and keep it off. These habits may also lower your chances of developing heart disease, high blood pressure, and type 2 diabetes.

To review these key concepts, watch the video below:

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2.2.9.6.3: Measuring Obesity

Body Mass Index (BMI)

What is BMI?

BMI is a person's weight in kilograms divided by the square of height in meters. BMI does not measure body fat directly, but research has shown that BMI is moderately correlated with more direct measures of body fat obtained from skinfold thickness measurements, bioelectrical impedance, densitometry (underwater weighing), dual energy x-ray absorptiometry (DXA) and other methods. Furthermore, BMI appears to be as strongly correlated with various metabolic and disease outcome as are these more direct measures of body fatness. In general, BMI is an inexpensive and easy-to-perform method of screening for weight category, for example underweight, normal or healthy weight, overweight, and obesity.

Adult BMI Calculator

How is BMI used?

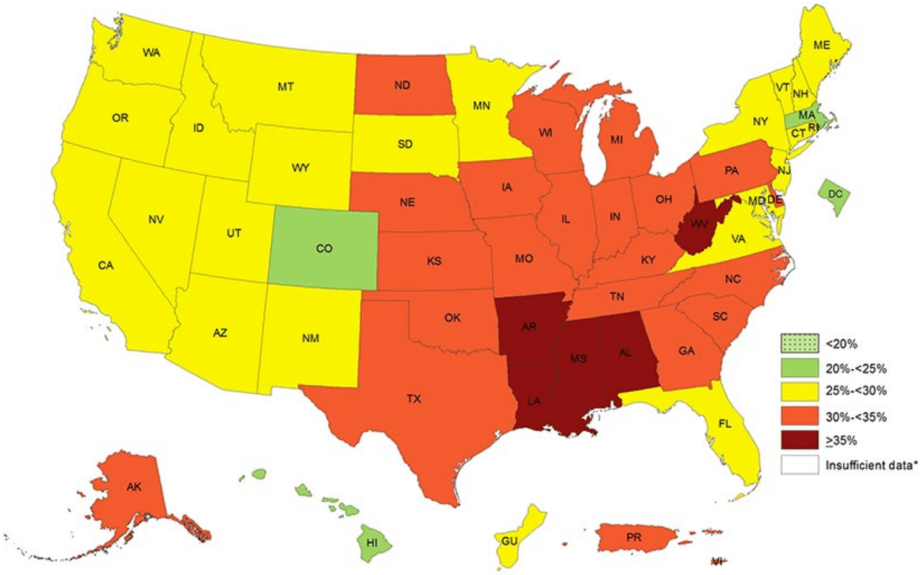
A high BMI can be an indicator of high body fatness. BMI can be used as a screening tool but is not diagnostic of the body fatness or health of an individual.

To determine if a high BMI is a health risk, a healthcare provider would need to perform further assessments. These assessments might include skinfold thickness measurements, evaluations of diet, physical activity, family history, and other appropriate health screenings.

What are the BMI trends for adults in the United States?

The prevalence of adult BMI greater than or equal to 30 kg/m2 (obese status) has greatly increased since the 1970s. Recently, however, this trend has leveled off, except for older women. Obesity has continued to increase in adult women who are age 60 years and older.

Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2016



Why is BMI used to measure overweight and obesity?

BMI can be used for population assessment of overweight and obesity. Because calculation requires only height and weight, it is inexpensive and easy to use for clinicians and for the general public. BMI can be used as a screening tool for body fatness but is not diagnostic.

To see the formula based on either kilograms and meters or pounds and inches, visit How is BMI calculated?

What are some of the other ways to assess excess body fatness besides BMI?

Other methods to measure body fatness include skinfold thickness measurements (with calipers), underwater weighing, bioelectrical impedance, dual-energy x-ray absorptiometry (DXA), and isotope dilution 1,2,3. However, these methods are not always readily available, and they are either expensive or need to be conducted by highly trained personnel. Furthermore, many of these methods can be difficult to standardize across observers or machines, complicating comparisons across studies and time periods.

How is BMI interpreted for adults?

For adults 20 years old and older, BMI is interpreted using standard weight status categories. These categories are the same for men and women of all body types and ages.

The standard weight status categories associated with BMI ranges for adults are shown in the following table.

BMI	Weight Status
Below 18.5	Underweight
18.5 – 24.9	Normal or Healthy Weight
25.0 – 29.9	Overweight
30.0 and Above	Obese

For example, here are the weight ranges, the corresponding BMI ranges, and the weight status categories for a person who is 5′ 9″.

Height	Weight Range	BMI	Weight Status
5′ 9″	124 lbs or less	Below 18.5	Underweight
	125 lbs to 168 lbs	18.5 to 24.9	Normal or Healthy Weight
	169 lbs to 202 lbs	25.0 to 29.9	Overweight
	203 lbs or more	30 or higher	Obese

For children and teens, the interpretation of BMI depends upon age and sex.

For adults, the interpretation of BMI does not depend on sex or age.

How good is BMI as an indicator of body fatness?

The correlation between the BMI and body fatness is fairly strong, but even if 2 people have the same BMI, their level of body fatness may differ.

In general:

- At the same BMI, women tend to have more body fat than men.
- At the same BMI, Blacks have less body fat than do Whites, and Asians have more body fat than do Whites
- At the same BMI, older people, on average, tend to have more body fat than younger adults.

- At the same BMI, athletes have less body fat than do non-athletes.

The accuracy of BMI as an indicator of body fatness also appears to be higher in persons with higher levels of BMI and body fatness. While, a person with a very high BMI (e.g., 35 kg/m2) is very likely to have high body fat, a relatively high BMI can be the results of either high body fat or high lean body mass (muscle and bone). A trained healthcare provider should perform appropriate health assessments in order to evaluate an individual's health status and risks.

If an athlete or other person with a lot of muscle has a BMI over 25, is that person still considered to be overweight?

According to the BMI weight status categories, anyone with a BMI between 25 and 29.9 would be classified as overweight and anyone with a BMI over 30 would be classified as obese.

However, athletes may have a high BMI because of increased muscularity rather than increased body fatness. In general, a person who has a high BMI is likely to have body fatness and would be considered to be overweight or obese, but this may not apply to athletes. A trained healthcare provider should perform appropriate health assessments in order to evaluate an individual's health status and risks.

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2.2.9.6.4: Health Effects of Overweight and Obesity

People who are overweight or obese, compared to those with a normal or healthy weight, are at increased risk for many serious diseases and health conditions. The more body fat that you have and the more you weigh, the more likely you are to develop:

- All causes of death (mortality)
- High blood pressure (Hypertension)
- High LDL cholesterol, low HDL cholesterol, or high levels of triglycerides (Dyslipidemia)
- Type 2 diabetes
- Coronary heart disease
- Stroke
- Gallbladder disease
- Osteoarthritis (a breakdown of cartilage and bone within a joint)
- Sleep apnea and breathing problems
- Some cancers (endometrial, breast, colon, kidney, gallbladder, and liver)
- Low quality of life
- Mental illness such as clinical depression, anxiety, and other mental disorders
- Body pain and difficulty with physical functioning

Your weight is the result of many factors. These factors include environment, family history and genetics, metabolism (the way your body changes food and oxygen into energy), behavior or habits, and more.

You can't change some factors, such as family history. However, you can change other factors, such as your lifestyle habits.

For example, follow a healthy eating plan and keep your calorie needs in mind. Be physically active and try to limit the amount of time that you're inactive.

As shown in the video below, it is important to remember that obesity happens one pound at a time, and even relatively small weight gains can negatively affect one's health and well-being.

YouTube Video

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2.2.10: PHYSICAL FITNESS

Being physically active is one of the most important steps that Americans of all ages can take to improve their health. The benefits of physical activity occur in generally healthy people, in people at risk of developing chronic diseases, and in people with current chronic conditions or disabilities. Studies have examined the role of physical activity in many groups—men and women, children, teens, adults, older adults, people with disabilities, and women during pregnancy and the postpartum period. These studies have focused on the role that physical activity plays in many health outcomes.

2.2.10.1: Physical Fitness

2.2.10.2: Health Benefits Associated with Regular Physical Activity

2.2.10.3: Health Related Components of Physical Fitness

2.2.10.4: Adding Physical Activity to Your Life

2.2.10.5: Implementing Your Fitness Plan

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2.2.10.1: Physical Fitness

Being physically active is one of the most important steps that Americans of all ages can take to improve their health. The benefits of physical activity occur in generally healthy people, in people at risk of developing chronic diseases, and in people with current chronic conditions or disabilities. Studies have examined the role of physical activity in many groups—men and women, children, teens, adults, older adults, people with disabilities, and women during pregnancy and the postpartum period. These studies have focused on the role that physical activity plays in many health outcomes, including:

- Premature (early) death;
- Diseases such as coronary heart disease, stroke, some cancers, type 2 diabetes, osteoporosis, and depression;
- Risk factors for disease, such as high blood pressure and high blood cholesterol;
- Physical fitness, such as aerobic capacity, and muscle strength and endurance
- Functional capacity (the ability to engage in activities needed for daily living);
- Mental health, such as depression and cognitive function;
- Injuries or sudden heart attacks.

There have also been additional studies by the Advisory Committee of the U.S. Department of Health and Human Services. The Advisory Committee rated the evidence of health benefits of physical activity as strong, moderate, or weak. To do so, the Committee considered the type, number, and quality of studies available, as well as consistency of findings across studies that addressed each outcome.

The Committee also considered evidence for causality and dose response in assigning the strength-of-evidence rating.

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2.2.10.2: Health Benefits Associated with Regular Physical Activity

Table 2.2.10.2.1: Health Benefits Associated with Regular Physical Activity in Children and Adolescents

Strong Evidence	Moderate Evidence
• Improved cardiorespiratory and muscular fitness • Improved bone health • Improved cardiovascular and metabolic health biomarkers • Favorable body composition	• Reduced symptoms of depression

Table 2.2.10.2.2: Health Benefits Associated with Regular Physical Activity in Adults and Older Adults

Strong Evidence	Moderate to Strong Evidence	Moderate Evidence
• Lower risk of early death • Lower risk of coronary heart disease • Lower risk of stroke • Lower risk of high blood pressure • Lower risk of adverse blood lipid profile • Lower risk of type 2 diabetes • Lower risk of metabolic syndrome • Lower risk of colon cancer • Lower risk of breast cancer • Prevention of weight gain • Weight loss, particularly when combined with reduced calorie intake • Improved cardiorespiratory and muscular fitness • Prevention of falls • Reduced depression • Better cognitive function (for older adults)	• Better functional health (for older adults) • Reduced abdominal obesity	• Lower risk of hip fracture • Lower risk of lung cancer • Lower risk of endometrial cancer • Weight maintenance after weight loss • Increased bone density • Improved sleep quality

These studies have also prompted questions as to what type and how much physical activity is needed for various health benefits. That led to the development of The Physical Activity Guidelines for Americans, which gives guidance on the amount of physical activity that will provide health benefits for all Americans. Although some health benefits seem to begin with as little as 60 minutes (1 hour) a week, research shows that a total amount of 150 minutes (2 hours and 30 minutes) a week of moderate-intensity aerobic activity, such as brisk walking, consistently reduces the risk of many chronic diseases and other adverse health outcomes. For more details on the Physical Activity Guidelines for Americans please see the table below:

Table 2.2.10.2.3*For Important Health Benefits Adults Need at Least*

2 hours and 30 minutes (150 minutes) of moderate aerobic activity every week (i.e., brisk walking) every week OR 1 hour and 15 minutes (75 minutes) of vigorous intensity aerobic activity (i.e., jogging or running) every week; OR An equivalent mix of moderate-and-vigorous intensity aerobic activity	AND	Muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs hips, back, abdomen, chest, shoulders, and arms)

Although the Guidelines focus on the health benefits of physical activity, these benefits are not the only reason why people are active. Physical activity gives people a chance to have fun, be with friends and family, enjoy the outdoors, improve their personal appearance, and improve their fitness so that they can participate in more intensive physical activity or sporting events. Some people are active because they feel it gives them certain health benefits (such as feeling more energetic) that aren't yet conclusively proven for the general population. The Guidelines encourage people to be physically active for any and all reasons that are meaningful for them. Nothing in the Guidelines is intended to mean that health benefits are the only reason to do physical activity.

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2.2.10.3: Health Related Components of Physical Fitness

In many studies related to physical fitness and health, researchers have focused on **exercise,** as well as on the more broadly defined concept of **physical activity**. Physical activity is defined by the World Health Organization as any bodily movement produced by skeletal muscles that requires energy expenditure, while exercise is a form of physical activity that is planned, structured, repetitive, and performed with the goal of improving health or fitness. So, although all exercise is physical activity, not all physical activity is exercise. Although physical activity and exercise are defined concepts, the ultimate focus of the health related components of physical fitness is to provide a framework for components that are necessary for good health. They are cardiorespiratory (CR) endurance (also called aerobic endurance), flexibility, muscular strength, muscular endurance, and body composition.

Cardiorespiratory Endurance

- ***Aerobic endurance:*** The ability of the heart, blood vessels, and lungs to work together to accomplish three goals:
  1. deliver oxygen to body tissues
  2. deliver nutrients
  3. remove waste products.
- CR endurance exercises involve large muscle groups in prolonged, dynamic movement (ex. running, swimming, etc)

Table 2.2.10.3.1

Examples of Different Aerobic Physical Activities and Intensities	
Moderate Intensity	Vigorous Intensity
• Walking briskly (3 miles per hour or faster, but not race-walking) • Water aerobics • Bicycling slower than 10 miles per hour • Tennis (doubles) • Ballroom dancing • General gardening	• Racewalking, jogging, or running • Swimming laps • Tennis (singles) • Aerobic dancing • Bicycling 10 miles per hour or faster • Jumping rope • Heavy gardening (continuous digging or hoeing, with heart rate increases) • Hiking uphill or with a heavy backpack

Frequency and Duration

Aerobic physical activity should preferably be spread throughout the week. Research studies consistently show that activity performed on at least 3 days a week produces health benefits. Spreading physical activity across at least 3 days a week may help to reduce the risk of injury and avoid excessive fatigue.

Both moderate- and vigorous-intensity aerobic activity should be performed in episodes of at least 10 minutes. Episodes of this duration are known to improve cardiovascular fitness and some risk factors for heart disease and type 2 diabetes.

Intensity

The *Guidelines* for adults focus on two levels of intensity: moderate-intensity activity and vigorous–intensity activity. To meet the Guidelines, adults can do either moderate-intensity or vigorous-intensity aerobic activities, or a combination of both. It takes less time to get the same benefit from vigorous-intensity activities as from moderate-intensity activities. A general rule of thumb is that 2 minutes of moderate-intensity activity counts the same as 1 minute of vigorous-intensity activity. For example, 30 minutes of moderate-intensity activity a week is roughly the same as 15 minutes of vigorous-intensity activity. A person doing moderate-intensity aerobic activity can talk, but not sing, during the activity. A person doing vigorous intensity activity cannot say more than a few words without pausing for a breath.

Muscular Strength and Endurance

- **Muscular strength:** The ability of muscles to exert maximal effort.
- **Muscular endurance:** The ability of muscles to exert submaximal effort repetitively (contract over and over again or hold a contraction for a long time).

Activities for Muscular Strength and Endurance

These kind of activities, which includes **resistance training** and lifting weights, causes the body's muscles to work or hold against an applied force or weight. These activities often involve relatively heavy objects, such as weights, which are lifted multiple times to train various muscle groups. Muscle-strengthening activity can also be done by using elastic bands or body weight for resistance (climbing a tree or doing push-ups, for example).

Activities for Muscular Strength and Endurance also has three components:

- **Intensity,** or how much weight or force is used relative to how much a person is able to lift;
- **Frequency**, or how often a person does muscle strengthening activity; and
- **Repetitions**, or how many times a person lifts a weight (analogous to duration for aerobic activity). Repetitions play a key role in determining if an activity is improving muscular strength or endurance. Low repetitions with more weight will focus more on muscular strength, while high repetitions with less weight will focus more on muscular endurance. The effects of muscle-strengthening activity are limited to the muscles doing the work. It's important to work all the major muscle groups of the body: the legs, hips, back, abdomen, chest, shoulders, and arms.

Muscle-strengthening activities provide additional benefits not found with aerobic activity. The benefits of muscle-strengthening activity include increased bone strength and muscular fitness. Muscle-strengthening activities can also help maintain muscle mass during a program of weight loss.

Muscle-strengthening activities make muscles do more work than they are accustomed to doing. That is, they overload the muscles. Resistance training, including weight training, is a familiar example of muscle-strengthening activity. Other examples include working with resistance bands, doing calisthenics that use body weight for resistance (such as push-ups, pull-ups, and sit-ups), carrying heavy loads, and heavy gardening (such as digging or hoeing).

Muscle-strengthening activities count if they involve a moderate to high level of intensity or effort and work the major muscle groups of the body: the legs, hips, back, chest, abdomen, shoulders, and arms. Muscle strengthening activities for all the major muscle groups should be done at least 2 days a week.

No specific amount of time is recommended for muscle strengthening, but muscle strengthening exercises should be performed to the point at which it would be difficult to do another repetition without help. When resistance training is used to enhance muscle strength, one set of 8 to 12 repetitions of each exercise is effective, although two or three sets may be more effective. Development of muscle strength and endurance is progressive over time. Increases in the amount of weight or the days a week of exercising will result in stronger muscles.

Flexibility

Flexibility is the ability of moving a joint through the range of motion. Flexibility is an important part of physical fitness. Some types of physical activity, such as dancing, require more flexibility than others. Stretching exercises are effective in increasing flexibility, and thereby can allow people to more easily do activities that require greater flexibility. For this reason, flexibility activities are an appropriate part of a physical activity program, even though they have no known health benefits and it is unclear whether they reduce risk of injury. Time spent doing flexibility activities by themselves does not count toward meeting the aerobic or muscle-strengthening Guidelines. Although there are not specific national guidelines for flexibility, adults should do flexibility exercises at least two or three days each week to improve range of motion. This can be done by holding a stretch for 10-30 seconds to the point of tightness or slight discomfort. Repeat each stretch two to four times, accumulating 60 seconds per stretch.

Body composition

The percentage of the body composed of lean tissue (muscle, bone, fluids, etc.) and fat tissue. Changes in body composition

usually occur as a result of improvements in the other components of health related physical fitness, as well as changes in eating habits. This is discussed in more detail in the Weight Management and Healthy Eating Chapter.

There are also other components of fitness related to sports performance rather than just health. They are called skill-related components of fitness or motor fitness and include power, speed, agility, balance, and coordination. For the purpose of this class we will focus mainly on the health-related components of fitness.

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2.2.10.4: Adding Physical Activity to Your Life

Overcoming the Barrier to Being Physical Active

Given the health benefits of regular physical activity, we might have to ask why two out of three (60%) Americans are not active at recommended levels.

Many technological advances and conveniences that have made our lives easier and less active, as well as many personal variables, including physiological, behavioral, and psychological factors, may affect our plans to become more physically active. In fact, the 10 most common reasons adults cite for not adopting more physically active lifestyles are (Sallis and Hovell, 1990; Sallis et al., 1992):

- Do not have enough time to exercise
- Find it inconvenient to exercise
- Lack self-motivation
- Do not find exercise enjoyable
- Find exercise boring
- Lack confidence in their ability to be physically active (low self-efficacy)
- Fear being injured or have been injured recently
- Lack self-management skills, such as the ability to set personal goals, monitor progress, or reward progress toward such goals
- Lack encouragement, support, or companionship from family and friends, and
- Do not have parks, sidewalks, bicycle trails, or safe and pleasant walking paths convenient to their homes or offices.

Understanding common barriers to physical activity and creating strategies to overcome them may help you make physical activity part of your daily life. Please visit the link below to see a full table of SUGGESTIONS FOR OVERCOMING PHYSICAL ACTIVITY BARRIERS:

courses.candelalearning.com/...yto-your-life/

Creating your own Fitness Program

The first step to implementing a fitness program is to identify your goals. As discussed in earlier chapters, goals should be specific, measurable, action-oriented, realistic and time-bound (SMART). Progress can be difficult to track if goals are vague and open-ended, such as "*I will exercise more*." Here is an example of a SMART goal for fitness:

- Specific: "*I will walk for 30 minutes a day 3-5 days per week*"
- Measurable: *"I will improve my resting heart rate over the next month"*
- Action-Oriented: "*I will research walking routes around my home and campus"*
- Realistic: *"I will increase my walking to 45 minutes per day in one month"*
- Time Bound: *"I will try this walking program for one month and then reassess my goals"*

You can also make a SMART Goal in one statement, such as "*I will walk for 30 minutes 3-5 days per week for the next month in order to improve my resting heart rate*."

FITT Principle

Using the FITT principle is one way remember the guidelines for physical activity and create a prescription for improvement in your health-related physical fitness.

- **Frequency:** how often a person performs a health-related physical activity.
- **Intensity:** how hard a person exercises during a physical activity period. Intensity can be measured in different ways, depending on the related health-related component.
- **Time:** also known as duration. Refers to the amount of time or repetitions when performing a physical activity.

- **Type:** the kind of exercise or physical activity a person is performing.

Adapted from:

www.ode.state.or.us/teachlear...tprinciple.pdf)

Table 2.2.10.4.1

	Cardiorespiratory	Flexibility	Muscular Endurance	Muscular Strength
F Frequency	3-5 times per week Increase frequency as you get into better shape	Should be a regular part of your warm-up and cool-down Increase frequency as you get into better shape	Daily for some muscle groups Perform 3-4 times per week Increase frequency as you get into better shape	Perform 3 times per week Different muscle groups each time you work out Increase frequency as you get into better shape
I Intensity	50%-60% of heart rate reserve Increase intensity as you get into better shape	Stretch all major muscles and joints; hold for 15-30 seconds Perform 1-3 repetitions Increase intensity as you get into better shape	Less than 50% of your predicted 1-rep max Start with body weight then add resistance 15 or more reps/1-3 sets Increase intensity as you get into better shape	60%-80% of 1-rep max 8-12 reps / 1-3 sets Increase intensity as you get into better shape
T Time	20-60 minutes of continuous activity Increase the time as you get into better shape	10-20 minutes Increase the time as you get into better shape	30-60 minutes Increase the time as you get into better shape	15-60 minutes Increase the time as you get into better shape
T Type	Running, cycling, swimming, and activities that use large muscles	Perform static stretches and controlled dynamic stretches	Resistance training (body weight/ tubing/medicine balls/free weights)	Resistance training (body weight/ tubing/medicine balls/free weights)

Measuring Intensity

Target Heart Rate and Estimated Maximum Heart Rate

Exercise intensity can be measured using either heart rate or the rating of perceived exertion (RPE) method. We will look at each of these methods in turn. There are two methods of using heart rate to measure exercise intensity: the percentage of maximal heart rate method and the heart rate reserve (HRR), or karvonen method.

As its name suggests, the percentage of maximal heart rate method involves prescribing exercise at a certain percentage of maximum heart rate. To find out a person's true maximum heart rate we need to measure it in a laboratory. However, for most people this is impractical; therefore we can estimate maximum heart rate using the formula '220 – age'.

Example 1: Percentage Heart Rate Method

Case study: 'Mariella', age 30

1. **Calculate maximum heart rate (HR_{max})**
   - Estimated HR_{max}= 220 – age
   - = 220 – 30= **190 bpm** (beats per minute)
2. **Calculate exercise intensity**
   - ACSM guidelines = 55–90% of HR_{max}
   - Lower target (55%) = 190 × 55%
   - = 190 × 0.55 = **104.5 bpm** (we would round this up to 105 bpm)
   - Upper target (90%) = 190 × 90%
   - = 190 × 0.90 = **171 bpm**

This formula gives us an idea of maximum heart rate, but we must remember that it is just an estimate and not completely accurate. Therefore using this method, according to ACSM guidelines, Mariella should exercise at a heart rate somewhere between **105 and 171 bpm**. This is quite a wide range so, depending on her fitness levels, you would need to decide whether to prescribe Mariella exercise to the upper or lower end of this scale.

Please note that there are online calculators available to calculate all of this information for you. Once such calculator can be found at:

http://www.sparkpeople.com/resource/...tor_target.asp

The HRR method is thought to be more accurate than the percentage of maximal heart rate method because it takes the individual's resting heart rate into account. The formula for calculating HRR can be seen in Box 2. The ACSM recommends that to improve aerobic fitness, exercise intensity should be set at either 40–85 per cent of (HRR) or 55–90 per cent of maximum heart rate (HR_{max}) (Pollock et al., 1998). These ranges are deliberately broad to reflect different levels of fitness; that is, someone with relatively low levels of fitness who has just started an exercise programme may need to work on the lower end of the scale, whereas someone who has a higher level of fitness, perhaps who has been exercising for a while, may need to work at an intensity towards the upper end of the scale. This demonstrates the importance of *progression* in an exercise programme.

Example 2: Heart Rate Reserve Method

Case study: 'Mariella', age 30

1. **Calculate maximum heart rate (HR_{max})**
   - Estimated HR_{max} = 220 - age
   - = 220 – 30 = **190 bpm** (beats per minute)
2. **Measure resting heart rate (HR_{rest})**
   - You would measure this either using a heart rate monitor or manually, using your fingers. Ideally it should be measured first thing in the morning. Let's imagine that Mariella's HR_{rest} has been measured at **70 bpm.**
3. **Calculate heart rate reserve (HRR)**
   - HRR = HR_{max} – HR_{rest} = 190 – 70 = **120 bpm**
4. **Calculate exercise intensity**
   - ACSM guidelines = 40–85% HRR
   - Lower target (40%) = (HHR × 40%) + HR_{rest}
   - = (120 × 0.40) + 70
   - = 48 + 70 = **118 bpm**
   - Upper target (85%) = (HHR × 85%) + HR_{rest}
   - = (120 × 0.85) + 70
   - = 102 + 70
   - = **172 bpm**

Using this method, according to ACSM guidelines, Mariella should exercise somewhere between **118 and 172 bpm**.

Borg Scale

An alternative to using heart rate methods is the RPE method of measuring exercise intensity. However, you should note that it

is difficult to give a general recommendation for RPE, as it is by its very nature open to personal interpretation; that is, what I consider to be a 12 may be different to what you consider to be a 12. RPE can be a useful way of measuring exercise intensity when heart rate monitoring is difficult or inappropriate. For example, some types of medication (e.g. beta blockers) given to people with hypertension lower the heart rate, and therefore heart rate measurement is not appropriate for people on this type of medication. The **Borg Rating of Perceived Exertion (RPE) Scale** is one way to measure perceived exertion. In medicine, this is used to document the patient's exertion during a test, and sports coaches use the scale to assess the intensity of training and competition. The original scale introduced by Gunnar Borg rated exertion on a scale of 6-20. The seemingly odd range of 6-20 is to follow the general heart rate of a healthy adult by multiplying by 10. For instance, a perceived exertion of 12 would be expected to coincide with a heart rate of roughly 120 beats per minute.

Set Points on Scale

It ranges from 6 to 20, where 6 means "no exertion at all" and 20 means "maximal exertion." Choose the number from below that best describes your level of exertion. This will give you a good idea of the intensity level of your activity, and you can use this information to speed up or slow down your movements to reach your desired range.

Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

6. No exertion at all
7. Extremely light (7.5)
8. Very light
9. Light
10. Somewhat hard
11. Hard
12. Very Hard
13. Extremely hard
14. Maximal exertion

9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes.

13 On the scale is "somewhat hard" exercise, but it still feels OK to continue.

17, Or "very hard," is very strenuous. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

19 on the scale is an extremely strenuous exercise level. For most people this is the most strenuous exercise they have ever experienced.

Taking Your Heart Rate

Generally, to determine whether you are exercising within the heart rate target zone, you must stop exercising briefly to take your pulse. You can take the pulse at the neck, the wrist, or the chest. We recommend the wrist. You can feel the radial pulse on the artery of the wrist in line with the thumb. Place the tips of the index and middle fingers over the artery and press lightly. Do not use the thumb. Take a full 60-second count of the heartbeats, or take for 30 seconds and multiply by 2. Start the count on a beat, which is counted as "zero." If this number falls between 85 and 119 bpm in the case of the 50-year old person, he or she is active within the target range for moderate-intensity activity.



Figure 2.2.10.4.1 Taking your heart rate

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2.2.10.5: Implementing Your Fitness Plan

The Beneficial Effects of Increasing Physical Activity: It's About Overload, Progression, and Specificity

Creating a safe and effective fitness program involves knowing certain basic principles of physical fitness: overload, progression, and specificity. **Overload** is the physical stress placed on the body when physical activity is greater in amount or intensity than usual. The body's structures and functions respond and adapt to these stresses. For example, aerobic physical activity places a stress on the cardiorespiratory system and muscles, requiring the lungs to move more air and the heart to pump more blood and deliver it to the working muscles. This increase in demand increases the efficiency and capacity of the lungs, heart, circulatory system, and exercising muscles. In the same way, muscle–strengthening and bone-strengthening activities overload muscles and bones, making them stronger. **Progression** is closely tied to overload. Once a person reaches a certain fitness level, he or she progresses to higher levels of physical activity by continued overload and adaptation. Small, progressive changes in overload help the body adapt to the additional stresses while minimizing the risk of injury. **Specificity** means that the benefits of physical activity are specific to the body systems that are doing the work. For example, aerobic physical activity largely benefits the body's cardiovascular system. These principles should be taken into consideration during any exercise program if you expect to meet your goals.

Designing a program

Warm-up and Cool down Activities

Warm-up and cool-down activities are an important part of a person’s physical activity plan. Commonly, the warm-up and cool-down involve doing an activity at a slower speed or lower intensity. A warm-up before moderate-or vigorous-intensity aerobic activity allows a gradual increase in heart rate and breathing at the start of the episode of activity. A cool down after activity allows a gradual decrease at the end of the episode. Time spent doing warm-up and cool-down may count toward meeting the aerobic activity Guidelines if the activity is at least moderate intensity (for example, walking briskly as a warm-up before jogging). A warm-up for muscle-strengthening activity commonly involves doing exercises with lighter weight.

Physical Activity in a Weight Control Plan

The health benefits of physical activity are generally independent of body weight. The good news for people needing to lose weight is that regular physical activity provides major health benefits, no matter how their weight changes over time. Along with appropriate dietary intake, physical activity is an important part of maintaining healthy weight, losing weight, and keeping extra weight off once it has been lost. Physical activity also helps reduce abdominal fat and preserve muscle during weight loss. Adults should aim for a healthy, stable body weight. The amount of physical activity necessary to achieve this weight varies greatly from person to person.

The first step in achieving or maintaining a healthy weight is to meet the minimum level of physical activity in the Guidelines. For some people, this will result in a stable and healthy body weight, but for many it may not. People who are at a healthy body weight but slowly gaining weight can either gradually increase the level of physical activity (toward the equivalent of 300 minutes a week of moderate-intensity aerobic activity), or reduce caloric intake, or both, until their weight is stable. By regularly checking body weight, people can find the amount of physical activity that works for them.

Many adults will need to do more than the 150 minutes a week of moderate-intensity aerobic physical activity as part of a program to lose weight or keep it off. These adults should do more physical activity and/or further reduce their caloric intake. Some people will need to do the equivalent of 300 or more minutes of moderate-intensity physical activity a week to meet their weight-control goals. Combined with restricting caloric intake, these adults should gradually increase minutes or the intensity of aerobic physical activity per week, to the point at which the physical activity is effective in achieving a healthy weight.

Adults should strongly consider walking as one good way to get aerobic physical activity. Many studies show that walking has health benefits and a low risk of injury. It can be done year-round and in many settings. It is important to remember that all activities—both baseline and physical activity—“count” for energy balance. Active choices, such as taking the stairs rather than

the elevator or adding short episodes of walking to the day, are examples of activities that can be helpful in weight control. For weight control, vigorous intensity activity is far more time-efficient than moderate-intensity activity. For example, an adult who weighs 165 pounds (75 kg) will burn 560 calories from 150 minutes of brisk walking at 4 miles an hour (these calories are in addition to the calories normally burned by a body at rest). That person can burn the same number of additional calories in 50 minutes by running 5 miles at a 10 minutes-per-mile pace.

Achieving Your Physical Activities: The Possibilities are endless

These examples show how it's possible to meet the Guidelines by doing moderate-intensity or vigorous-intensity activity or a combination of both. Physical activity at this level provides substantial health benefits.

Ways to get the equivalent of 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic physical activity a week plus muscle-strengthening activities:

- Thirty minutes of brisk walking (moderate intensity) on 5 days, exercising with resistance bands (muscle strengthening) on 2 days;
- Twenty-five minutes of running (vigorous intensity) on 3 days, lifting weights on 2 days (muscle strengthening);
- Thirty minutes of brisk walking on 2 days, 60 minutes (1 hour) of social dancing (moderate intensity) on 1 evening, 30 minutes of mowing the lawn (moderate intensity) on 1 afternoon, heavy gardening (muscle strengthening) on 2 days;
- Thirty minutes of an aerobic dance class on 1 morning (vigorous intensity), 30 minutes of running on 1 day (vigorous intensity), 30 minutes of brisk walking on 1 day (moderate intensity), calisthenics (such as sit-ups, push-ups) on 3 days (muscle strengthening);
- Thirty minutes of biking to and from work on 3 days (moderate intensity), playing softball for 60 minutes on 1 day (moderate intensity), using weight machines on 2 days (muscle-strengthening on 2 days); and
- Forty-five minutes of doubles tennis on 2 days (moderate intensity), lifting weights after work on 1 day (muscle strengthening), hiking vigorously for 30 minutes and rock climbing (muscle strengthening) on 1 day.

Ways to be Even More Active

For adults who are already doing at least 150 minutes of moderate-intensity physical activity, here are a few ways to do even more. Physical activity at this level has even greater health benefits.

- Forty-five minutes of brisk walking every day, exercising with resistance bands on 2 or 3 days;
- Forty-five minutes of running on 3 or 4 days, circuit weight training in a gym on 2 or 3 days;
- Thirty minutes of running on 2 days, 45 minutes of brisk walking on 1 day, 45 minutes of an aerobics and weights class on 1 day, 90 minutes (1 hour and 30 minutes) of social dancing on 1 evening, 30 minutes of mowing the lawn, plus some heavy garden work on 1 day;
- Ninety minutes of playing soccer on 1 day, brisk walking for 15 minutes on 3 days, lifting weights on 2 days; and
- Forty-five minutes of stationary bicycling on 2 days, 60 minutes of basketball on 2 days, calisthenics on 3 days.

Be Safe and Active

Although physical activity has many health benefits, injuries and other adverse events do sometimes happen. The most common injuries affect the musculoskeletal system (the bones, joints, muscles, ligaments, and tendons). Other adverse events can also occur during activity, such as overheating and dehydration. On rare occasions, people have heart attacks during activity.

The good news is that scientific evidence strongly shows that physical activity is safe for almost everyone. Moreover, the health benefits of physical activity far outweigh the risks. Still, people may hesitate to become physically active because of concern they'll get hurt. For these people, there is even more good news: They can take steps that are proven to reduce their risk of injury and adverse events.

The Guidelines in this module provide advice to help people do physical activity safely. Most advice applies to people of all ages. Specific guidance for particular age groups and people with certain conditions is also provided.

Physical Activity is Safe for Almost Everyone

Most people are not likely to be injured when doing moderate-intensity activities in amounts that meet the *Physical Activity*

Guidelines. However, injuries and other adverse events do sometimes happen. The most common problems are musculoskeletal injuries. Even so, studies show that only one such injury occurs for every 1,000 hours of walking for exercise, and fewer than four injuries occur for every 1,000 hours of running.

Both physical fitness and total amount of physical activity affect risk of musculoskeletal injuries. People who are physically fit have a lower risk of injury than people who are not. People who do more activity generally have a higher risk of injury than people who do less activity. To do physical activity safely and reduce risk of injuries and other adverse events, people should:

- Understand the risks and yet be confident that physical activity is safe for almost everyone.
- Choose to do types of physical activity that are appropriate for their current fitness level and health goals, because some activities are safer than others.
- Increase physical activity gradually over time whenever more activity is necessary to meet guidelines or health goals. Inactive people should "start low and go slow" by gradually increasing how often and how long activities are done.
- Protect themselves by using appropriate gear and sports equipment, looking for safe environments, following rules and policies, and making sensible choices about when, where, and how to be active.
- Be under the care of a health-care provider if they have chronic conditions or symptoms. People with chronic conditions and symptoms should consult their health-care provider about the types and amounts of activity appropriate for them.

Choose Appropriate Types and Amounts of Activity

People can reduce their risk of injury by choosing appropriate types of activity. The safest activities are moderate intensity and low impact, and don't involve purposeful collision or contact. Walking for exercise, gardening or yard work, bicycling or exercise cycling, dancing, swimming, and golf are activities with the lowest injury rates. In the amounts commonly done by adults, walking (a moderate–intensity and low-impact activity) has a third or less of the injury risk of running (a vigorous-intensity and higher impact activity).

The risk of injury for a type of physical activity can also differ according to the purpose of the activity. For example, recreational bicycling or bicycling for transportation leads to fewer injuries than training for and competing in bicycle races. People who have had a past injury are at risk of injuring that body part again. The risk of injury can be reduced by performing appropriate amounts of activity and setting appropriate personal goals. Performing a variety of different physical activities may also reduce the risk of overuse injury. The risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity.

Increase Physical Activity Gradually Over Time

Scientific studies indicate that the risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity. The size of this gap is called the amount of overload. Creating a small overload and waiting for the body to adapt and recover reduces the risk of injury. When amounts of physical activity need to be increased to meet the Guidelines or personal goals, physical activity should be increased gradually over time, no matter what the person's current level of physical activity. Scientists have not established a standard for how to gradually increase physical activity over time. The following recommendations give general guidance for inactive people and those with low levels of physical activity on how to increase physical activity:

- Use relative intensity (intensity of the activity relative to a person's fitness) to guide the level of effort for aerobic activity.
- Generally, start with relatively moderate-intensity aerobic activity. Avoid relatively vigorous-intensity activity, such as shoveling snow or running. Adults with a low level of fitness may need to start with light activity, or a mix of light- to moderate-intensity activity.
- First, increase the number of minutes per session (duration), and the number of days per week (frequency) of moderate-intensity activity. Later, if desired, increase the intensity.
- Pay attention to the relative size of the increase in physical activity each week, as this is related to injury risk. For example, a 20-minute increase each week is safer for a person who does 200 minutes a week of walking (a 10 percent increase), than for a person who does 40 minutes a week (a 50 percent increase).

The available scientific evidence suggests that adding a small and comfortable amount of light- to moderate–intensity activity, such as 5 to 15 minutes of walking per session, 2 to 3 times a week, to one's usual activities has a low risk of musculoskeletal injury and no known risk of severe cardiac events. Because this range is rather wide, people should consider three factors in individualizing their rate of increase: age, level of fitness, and prior experience. The amount of time required to adapt to a new level of activity probably depends on age. Youth and young adults probably can safely increase activity by small amounts every week or 2. Older adults appear to require more time to adapt to a new level of activity, in the range of 2 to 4 weeks.

Level of Fitness

Less fit adults are at higher risk of injury when doing a given amount of activity, compared to fitter adults. Slower rates of increase over time may reduce injury risk. This guidance applies to overweight and obese adults, as they are commonly less physically fit.

Prior Experience

People can use their experience to learn to increase physical activity over time in ways that minimize the risk of overuse injury. Generally, if an overuse injury occurred in the past with a certain rate of progression, a person should increase activity more slowly the next time.

Take Appropriate Precautions

Taking appropriate precautions means using the right gear and equipment, choosing safe environments in which to be active, following rules and policies, and making sensible choices about how, when, and where to be active.

Use Protective Gear and Appropriate Equipment

Using personal protective gear can reduce the frequency of injury. Personal protective gear is something worn by a person to protect a specific body part. Examples include helmets, eyewear and goggles, shin guards, elbow and knee pads, and mouth guards. Using appropriate sports equipment can also reduce risk of injury. Sports equipment refers to sport or activity-specific tools, such as balls, bats, sticks, and shoes. For the most benefit, protective equipment and gear should be:

1. The right equipment for the activity
2. Appropriately fitted
3. Appropriately maintained
4. Used consistently and correctly.

Be Active in Safe Environments

People can reduce their injury risks by paying attention to the places they choose to be active. To help themselves stay safe, people can look for:

- Physical separation from motor vehicles, such as sidewalks, walking paths, or bike lanes;
- Neighborhoods with traffic-calming measures that slow down traffic;
- Places to be active that are well-lighted, where other people are present, and that are well-maintained (no litter, broken windows);
- Shock-absorbing surfaces on playgrounds;
- Well-maintained playing fields and courts without holes or obstacles;
- Breakaway bases at baseball and softball fields; and
- Padded and anchored goals and goal posts at soccer and football fields.

Follow Rules and Policies That Promote Safety

Rules, policies, legislation, and laws are potentially the most effective and wide-reaching way to reduce activity-related injuries. To get the benefit, individuals should look for and follow these rules, policies, and laws. For example, policies that promote the use of bicycle helmets reduce the risk of head injury among cyclists. Rules against diving into shallow water at swimming pools prevent head and neck injuries.

Make Sensible Choices about How, When, and Where To Be Active

A person's choices can obviously influence the risk of adverse events. By making sensible choices, injuries and adverse events can be prevented. Consider weather conditions, such as extremes of heat and cold. For example, during very hot and humid weather, people lessen the chances of dehydration and heat stress by:

- Exercising in the cool of early morning as opposed to mid-day heat;
- Switching to indoor activities (playing basketball in the gym rather than on the playground);
- Changing the type of activity (swimming rather than playing soccer);
- Lowering the intensity of activity (walking rather than running); and
- Paying close attention to rest, shade, drinking enough fluids, and other ways to minimize effects of heat.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries.

Exposure to air pollution is associated with several adverse health outcomes, including asthma attacks and abnormal heart rhythms. People who can modify the location or time of exercise may wish to reduce these risks by exercising away from heavy traffic and industrial sites, especially during rush hour or times when pollution is known to be high. However, current evidence indicates that the benefits of being active, even in polluted air, outweigh the risk of being inactive.

Advice from Health-Care Providers The protective value of a medical consultation for persons with or without chronic diseases who are interested in increasing their physical activity level is not established. People without diagnosed chronic conditions (such as diabetes, heart disease, or osteoarthritis) and who do not have symptoms (such as chest pain or pressure, dizziness, or joint pain) do not need to consult a health-care provider about physical activity.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries. A person who is habitually active with moderate-intensity activity can gradually increase to vigorous intensity without needing to consult a health-care provider. People who develop new symptoms when increasing their levels of activity should consult a health-care provider.

Health-care providers can provide useful personalized advice on how to reduce risk of injuries. For people who wish to seek the advice of a health-care provider, it is particularly appropriate to do so when contemplating vigorous-intensity activity, because the risks of this activity are higher than the risks of moderate-intensity activity.

The choice of appropriate types and amounts of physical activity can be affected by chronic conditions. People with symptoms or known chronic conditions should be under the regular care of a health-care provider. In consultation with their provider, they can develop a physical activity plan that is appropriate for them. People with chronic conditions typically find that moderate-intensity activity is safe and beneficial. However, they may need to take special precautions. For example, people with diabetes need to pay special attention to blood sugar control and proper footwear during activity.

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2.2.11: CARDIOVASCULAR DISEASE, DIABETES, AND CANCER

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels. Cardiovascular disease includes coronary artery diseases (CAD) such as angina and myocardial infarction (commonly known as a heart attack). Other CVDs include stroke, heart failure, hypertensive heart disease, rheumatic heart disease, cardiomyopathy, heart arrhythmia, congenital heart disease, valvular heart disease, carditis, aortic aneurysms, peripheral artery disease, thromboembolic disease, and venous thrombosis.

2.2.11.1: Cardiovascular Disease Intro

2.2.11.2: Stroke

2.2.11.3: Metabolic Syndrome

2.2.11.4: Diabetes

2.2.11.5: Cancer

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2.2.11.1: Cardiovascular Disease Intro

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels. Cardiovascular disease includes coronary artery diseases (CAD) such as angina and myocardial infarction (commonly known as a heart attack). Other CVDs include stroke, heart failure, hypertensive heart disease, rheumatic heart disease, cardiomyopathy, heart arrhythmia, congenital heart disease, valvular heart disease, carditis, aortic aneurysms, peripheral artery disease, thromboembolic disease, and venous thrombosis.

The underlying mechanisms vary depending on the disease. Coronary artery disease, stroke, and peripheral artery disease involve atherosclerosis, which is the narrowing of the inside of an artery due to the build up of plaque. This may be caused by high blood pressure, smoking, diabetes, lack of exercise, obesity, high blood cholesterol, poor diet, and excessive alcohol consumption, among others. High blood pressure results in 13% of CVD deaths, while tobacco results in 9%, diabetes 6%, lack of exercise 6% and obesity 5%. Rheumatic heart disease may follow untreated strep throat. It is estimated that 90% of CVD is preventable.

Coronary heart disease (CHD), also commonly referred to as just heart disease, is a common term for the buildup of plaque in the heart's arteries that could lead to heart attack. But is there a difference between coronary heart disease and coronary artery disease? The short answer is often no — health professionals frequently use the terms interchangeably. However, coronary heart disease, or CHD, is actually a result of coronary artery disease, or CAD. With coronary artery disease, plaque first grows within the walls of the coronary arteries until the blood flow to the heart's muscle is limited. View an illustration of coronary arteries below:

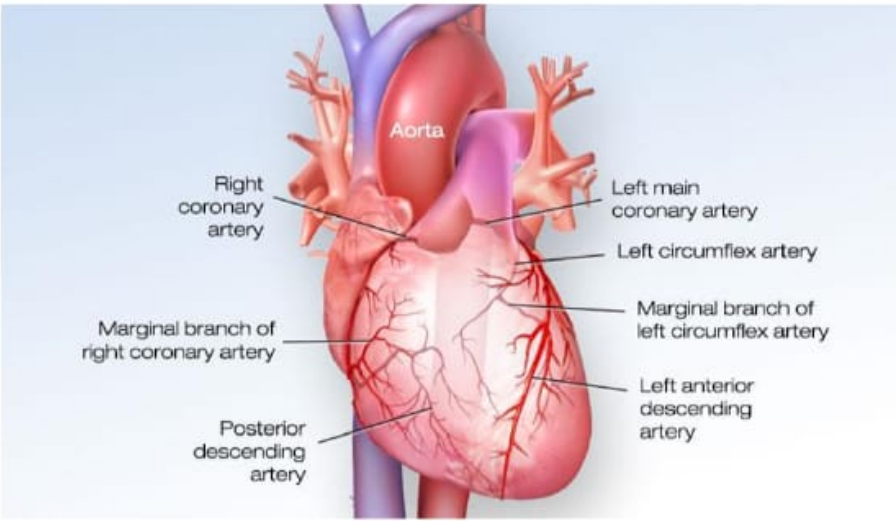


Figure 2.2.11.1.1 Coronary Arteries

The **Coronary Arteries** are the blood vessels that supply blood to your heart. They branch off of the aorta at its base. The right coronary artery, the left main coronary, the left anterior descending, and the left circumflex artery, are the four major coronary arteries. Blockage of these arteries is a common cause of angina, heart disease, heart attacks and heart failure.

This restriction of the blood supply to the tissues is also called ischemia. It may be chronic, narrowing of the coronary artery over time and limiting of the blood supply to part of the muscle. Or it can be acute, resulting from a sudden rupture of a plaque and formation of a thrombus or blood clot.

Anatomy of the Cardiovascular System

To fully understand Cardiovascular Diseases, it may be helpful to understand the anatomy of the cardiovascular system. It includes the following:

- **Heart:** the pump, divided into four chambers (R/L atria, R/L ventricles)
- **Arteries:** large vessels carrying oxygen-rich blood away from heart; have thick, muscular wall

- **Arterioles**: smaller arteries o Capillaries: smallest vessels where gas exchange takes place, oxygen is delivered to tissues and carbon dioxide is carried away
- **Veinuoles:** smallest veins, which carry carbon dioxide-rich blood, back to heart
- **Veins:** biggest vessels that carry carbon dioxide-rich blood back to heart; have one-way valves to prevent gravity from pulling blood backward (away from heart)
- **Atria**: the collecting chambers of the heart, located on top
- **Ventricles:** the pumping chambers of the heart, located on the bottom
- **Aorta:** the largest vessel (artery) in the body; all arteries branch from it

The right side of the heart (right atrium and right ventricle) takes CO2-rich blood and sends it to the lungs for oxygenation. The left side of the heart (left atrium and ventricle) takes O2-rich blood and delivers it to the body. The right side is said to be responsible for pulmonary circulation; the left side is said to be responsible for systemic circulation. Because of the distances involved, pulmonary circulation is a relatively low-pressure system, while systemic circulation is a relatively high-pressure system. In fact, when we measure blood pressure we're measuring systemic pressure.

Heart Disease and Stroke Facts

Heart Disease Facts

- Heart disease is the **leading cause** of death for both men and women.
- About **610,000 Americans** die from heart disease each year—that's **1 in every 4 deaths.**
- Coronary heart disease is the most common type of heart disease, killing about **365,000 people** in 2014.
- In the United States, someone has a heart attack **every 42 seconds**. Each minute, someone in the United States dies from a heart disease-related event.
- Heart disease is the **leading cause** of death for people of most racial/ethnic groups in the United States, including African Americans, Hispanics, and whites. For Asian Americans or Pacific Islanders and American Indians or Alaska Natives, heart disease is second only to cancer.
- Heart disease costs the United States about **$207 billion** each year. This total includes the cost of health care services, medications, and lost productivity.

Risk Factors

High blood pressure, high LDL cholesterol, and smoking are key risk factors for heart disease. About half of Americans (49%) have at least one of these three risk factors. Several other medical conditions and lifestyle choices can also put people at a higher risk for heart disease, including:

- Diabetes
- Overweight and obesity
- Poor diet
- Physical inactivity
- Excessive alcohol use

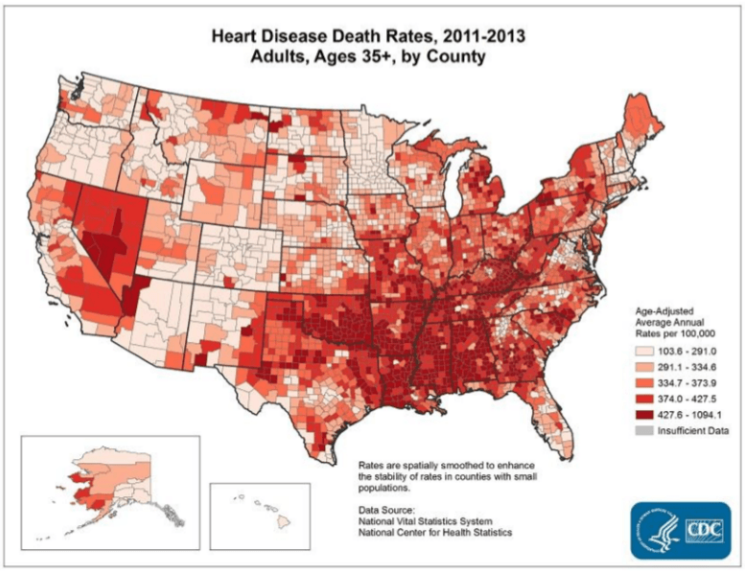


Figure 2.2.11.1.2 Heart Disease Death Rates

Stroke Facts

- Stroke is the fifth leading cause of death in the United States, killing more than **130,000 Americans** each year—that's **1 of every 20 deaths**.
- A stroke, sometimes called a brain attack, occurs when a clot blocks the blood supply to the brain or when a blood vessel in the brain bursts.
- Someone in the United States has a stroke every **40 seconds**. Every **four minutes**, someone dies of stroke.
- Every year, about **795,000 people** in the United States have a stroke. About 610,000 of these are first or new strokes; 185,000 are recurrent strokes.
- Stroke is an important cause of disability. Stroke reduces mobility in more than half of stroke survivors age 65 and over.
- Stroke costs the nation **$33 billion** annually, including the cost of health care services, medications, and lost productivity.
- You can't control some stroke risk factors, like heredity, age, gender, and ethnicity. Some medical conditions—including high blood pressure, high cholesterol, heart disease, diabetes, overweight or obesity, and previous stroke or transient ischemic attack (TIA)—can also raise your stroke risk. Avoiding smoking and drinking too much alcohol, eating a balanced diet, and getting exercise are all choices you can make to reduce your risk.

Common Stroke Warning Signs and Symptoms

- Sudden numbness or weakness of the face, arm, or leg—especially on one side of the body.
- Sudden confusion, trouble speaking or understanding.
- Sudden trouble seeing in one or both eyes.
- Sudden trouble walking, dizziness, loss of balance or coordination.
- Sudden severe headache with no known cause.

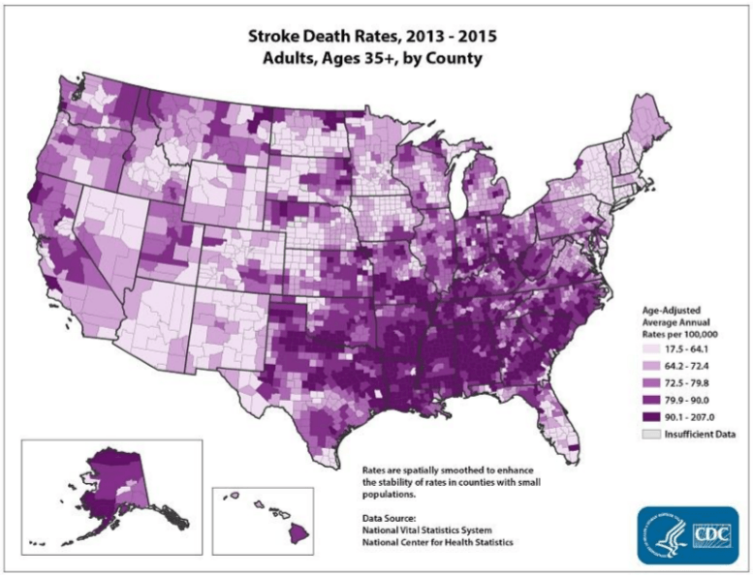


Figure 2.2.11.1.3. Stroke Death Rates

Coronary Artery Disease (CAD)

Coronary artery disease (CAD) is the most common type of heart disease in the United States. For some people, the first sign of CAD is a heart attack. Therefore, taking steps to reduce your risk for CAD is essential.

Research suggests that CAD (also referred to as coronary heart disease, abbreviated CHD) starts when certain factors damage the inner layers of the coronary arteries. These factors include:

- Smoking
- High levels of certain fats and cholesterol in the blood
- High blood pressure
- High levels of sugar in the blood due to insulin resistance or diabetes

Causes of CAD



Figure $PageIndex4$. Plaque Buildup

When damage occurs, your body starts a healing process. The healing may cause plaque to build up where the arteries are damaged. Plaque is made up of deposits of cholesterol and other substances in the artery. This progression of plaque build up is called **atherosclerosis.**

The buildup of plaque in the coronary arteries may start in childhood. Over time, plaque can narrow or block some of your coronary arteries. This reduces the flow of oxygen-rich blood to your heart muscle.

Eventually, an area of plaque can rupture (break open). If this happens, blood cell fragments called platelets will stick to the site of the injury and may clump together to form blood clots. Blood clots narrow the coronary arteries even more and worsen angina (chest discomfort or pain) or cause a heart attack.

Over time, CAD can weaken the heart muscle. This may lead to heart failure, a serious condition where the heart can't pump blood the way that it should. An irregular heartbeat, or arrhythmia, also can develop.

Other Conditions Related to Heart Disease

Coronary artery disease is the most common type of heart disease, but there are many other conditions that affect the heart:

- **Acute coronary syndrome** is a term that includes heart attack and unstable angina.
- **Angina**, a symptom of coronary artery disease, is chest pain or discomfort that occurs when the heart muscle is not getting enough blood. Angina may feel like pressure or a squeezing pain in the chest. The pain also may occur in the shoulders, arms, neck, jaw, or back. It may feel like indigestion. There are two forms of angina—stable or unstable:
  - Stable angina happens during physical activity or under mental or emotional stress.
  - Unstable angina is chest pain that occurs even while at rest, without apparent reason. This type of angina is a medical emergency.
- **Aortic aneurysm and dissection** are conditions that can affect the aorta, the major artery that carries blood from the heart to the body. An aneurysm is an enlargement in the aorta that can rupture or burst. A dissection is a tear in the aorta. Both of these conditions are medical emergencies.
- **Arrhythmias** are irregular or unusually fast or slow heartbeats. Arrhythmias can be serious. One example is called ventricular fibrillation. This type of arrhythmia causes an abnormal heart rhythm that leads to death unless treated right away with an electrical shock to the heart (called defibrillation). Other arrhythmias are less severe but can develop into more serious conditions, such as atrial fibrillation, which can cause a stroke.
- **Atherosclerosis** occurs when plaque builds up in the arteries that supply blood to the heart (called coronary arteries). Plaque is made up of cholesterol deposits. Plaque buildup causes arteries to narrow over time.
- **Atrial fibrillation** is a type of arrhythmia that can cause rapid, irregular beating of the heart's upper chambers. Blood may pool and clot inside the heart, increasing the risk for heart attack and stroke.
- **Cardiomyopathy** occurs when the heart muscle becomes enlarged or stiff. This can lead to inadequate heart pumping (or weak heart pump) or other problems. Cardiomyopathy has many causes, including family history of the disease, prior heart attacks, uncontrolled high blood pressure, and viral or bacterial infections.
- **Congenital heart defects** are problems with the heart that are present at birth. They are the most common type of major birth defect. Examples include abnormal heart valves or holes in the heart's walls that divide the heart's chambers. Congenital heart defects range from minor to severe.
- **Heart failure** is often called congestive heart failure because of fluid buildup in the lungs, liver, gastrointestinal tract, and the arms and legs. Heart failure is a serious condition that occurs when the heart can't pump enough blood to meet the body's needs. It does not mean that the heart has stopped but that muscle is too weak to pump enough blood. The majority of heart failure cases are chronic, or long-term heart failures.
  - The only cure for heart failure is a heart transplant. However, heart failure can be managed with medications or medical procedures.
- **Peripheral arterial disease (PAD)** occurs when the arteries that supply blood to the arms and legs (the periphery) become narrow or stiff. PAD usually results from atherosclerosis, the buildup of plaque and narrowing of the arteries. With this condition, blood flow and oxygen to the arm and leg muscles are low or even fully blocked. Signs and symptoms include leg pain, numbness, and swelling in the ankles and feet.
- **Rheumatic heart disease** is damage to the heart valves caused by a bacterial (streptococcal) infection called rheumatic fever.

Risk Factors for Coronary Heart Disease

Coronary heart disease risk factors are conditions or habits that raise your risk of coronary heart disease (CHD) and heart attack. These risk factors also increase the chance that existing CHD will worsen.

There are many known CHD risk factors. You can control some risk factors, but not others.

Risk factors you can control include:

- High blood cholesterol and triglyceride levels (a type of fat found in the blood)
- High blood pressure
- Diabetes and prediabetes
- Overweight and obesity
- Smoking
- Lack of physical activity
- Unhealthy diet
- Stress

The risk factors you can't control are age, gender, and family history of CHD.

Many people have at least one CHD risk factor. Your risk of CHD and heart attack increases with the number of risk factors you have and their severity. Also, some risk factors put you at greater risk of CHD and heart attack than others. Examples of these risk factors include smoking and diabetes. Many risk factors for coronary heart disease start during childhood. This is even more common now because many children are overweight and don't get enough physical activity. Researchers continue to study and learn more about CHD risk factors.

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2.2.11.2: Stroke

A stroke is a medical condition in which poor blood flow to the brain results in cell death. This results in part of the brain not functioning properly. The main types of stroke are:

- Ischemic stroke.
- Hemorrhagic stroke.
- Transient ischemic attack (a warning or “mini-stroke”).

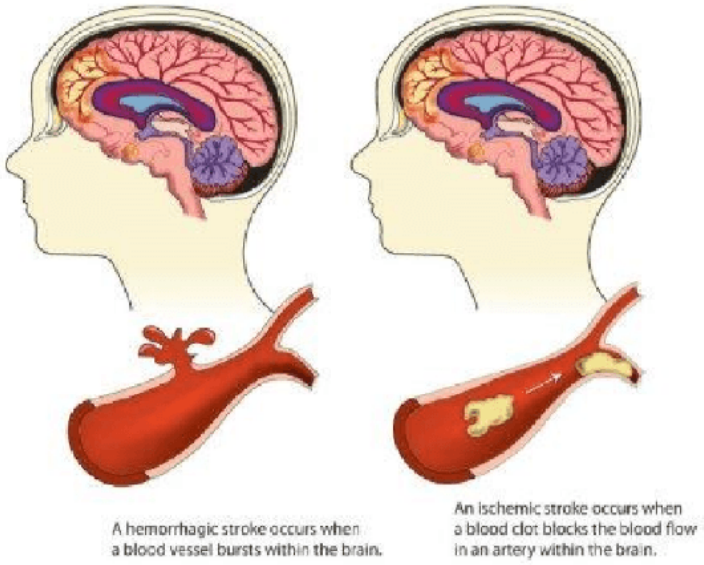


Figure 2.2.11.2.1 Hemorrhagic and Ischemic Strokes

Ischemic Stroke

Most strokes (85%) are ischemic strokes. If you have an ischemic stroke, the artery that supplies oxygen-rich blood to the brain becomes blocked.

Blood clots often cause the blockages that lead to ischemic strokes.

Hemorrhagic Stroke

A hemorrhagic stroke occurs when an artery in the brain leaks blood or ruptures (breaks open). The leaked blood puts too much pressure on brain cells, which damages them. High blood pressure and aneurysms—balloon-like bulges in an artery that can stretch and burst—are examples of conditions that can cause a hemorrhagic stroke.

There are two types of hemorrhagic strokes:

- **Intracerebral hemorrhage** is the most common type of hemorrhagic stroke. It occurs when an artery in the brain bursts, flooding the surrounding tissue with blood.
- **Subarachnoid hemorrhage** is a less common type of hemorrhagic stroke. It refers to bleeding in the area between the brain and the thin tissues that cover it.

Transient Ischemic Attack (TIA)

A transient ischemic attack (TIA) is sometimes called a “mini-stroke.” It is different from the major types of stroke because blood

flow to the brain is blocked for only a short time— usually no more than 5 minutes.

It is important to know that:

1. A TIA is a warning sign of a future stroke.
2. A TIA is a medical emergency, just like a major stroke.
3. Strokes and TIAs require emergency care. **Call 9-1-1** right away if you feel signs of a stroke or see symptoms in someone around you.
4. There is no way to know in the beginning whether symptoms are from a TIA or from a major type of stroke.
5. Like ischemic strokes, blood clots often cause TIAs.
6. More than a third of people who have a TIA end up having a major stroke within 1 year if they don't receive treatment, and 10%-15% will have a major stroke within 3 months of a TIA.

A health care team can usually find the cause and take steps to prevent a major stroke. Recognizing and treating TIAs can reduce the risk of a major stroke.

Recognizing a Stroke – Think FAST!

During a stroke, every minute counts! Fast treatment can lessen the brain damage that stroke can cause. By knowing the signs and symptoms of stroke, you can take quick action and perhaps save a life—maybe even your own.

Signs of Stroke in Men and Women

- Sudden **numbness** or weakness in the face, arm, or leg, especially on one side of the body
- Sudden **confusion,** trouble speaking, or difficulty understanding speech
- Sudden **trouble seeing** in one or both eyes
- Sudden **trouble walking**, dizziness, loss of balance, or lack of coordination
- Sudden **severe headache** with no known cause

Call 9-1-1 right away if you or someone else has any of these symptoms.

Acting F.A.S.T. can help stroke patients get the treatments they desperately need. The stroke treatments that work best are available only if the stroke is recognized and diagnosed within 3 hours of the first symptoms. Stroke patients may not be eligible for these if they don't arrive at the hospital in time.

If you think someone may be having a stroke, act F.A.S.T. and do the following simple test:

F—Face: Ask the person to smile. Does one side of the face droop?

A—Arms: Ask the person to raise both arms. Does one arm drift downward?

S—Speech: Ask the person to repeat a simple phrase. Is the speech slurred or strange?

T—Time: If you see any of these signs, call 9-1-1 right away.

Note the time when any symptoms first appear. This information helps health care providers determine the best treatment for each person. Do not drive to the hospital or let someone else drive you. Call an ambulance so that medical personnel can begin life-saving treatment on the way to the emergency room.

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2.2.11.3: Metabolic Syndrome

Metabolic syndrome is the name for a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke.

The term “metabolic” refers to the biochemical processes involved in the body’s normal functioning. Risk factors are traits, conditions, or habits that increase your chance of developing a disease.

In this article, “heart disease” refers to coronary heart disease (CHD). CHD (also called coronary artery disease, abbreviated CAD) is a condition in which a waxy substance called plaque builds up inside the coronary (heart) arteries.

Plaque hardens and narrows the arteries, reducing blood flow to your heart muscle. This can lead to chest pain, a heart attack, heart damage, or even death.

Metabolic Risk Factors

The five conditions described below are metabolic risk factors. You can have any one of these risk factors by itself, but they tend to occur together. You must have at least three metabolic risk factors to be diagnosed with metabolic syndrome.

A Large Waistline

Having a large waistline means that you carry excess weight around your waist (abdominal obesity). This is also called having an “apple-shaped” figure. Your doctor will measure your waist to find out whether you have a large waistline.

A waist measurement of 35 inches or more for women or 40 inches or more for men is a metabolic risk factor. A large waistline means you’re at increased risk for heart disease and other health problems.

A High Triglyceride Level

Triglycerides are a type of fat found in the blood. *A triglyceride level of 150 mg/dL or higher*(or being on medicine to treat high triglycerides) is a metabolic risk factor. (The mg/dL is milligrams per deciliter—the units used to measure triglycerides, cholesterol, and blood sugar.)

A Low HDL Cholesterol Level

HDL cholesterol sometimes is called “good” cholesterol. This is because it helps remove cholesterol from your arteries.

An HDL cholesterol level of less than 50 mg/dL for women and less than 40 mg/dL for men (or being on medicine to treat low HDL cholesterol) is a metabolic risk factor.

High Blood Pressure

A blood pressure of 130/85 mmHg or higher (or being on medicine to treat high blood pressure) is a metabolic risk factor. (The mmHg is millimeters of mercury—the units used to measure blood pressure.)

If only one of your two blood pressure numbers is high, you’re still at risk for metabolic syndrome.

High Fasting Blood Sugar

A normal fasting blood sugar level is less than 100 mg/dL. A fasting blood sugar level between 100–125 mg/dL is considered prediabetes. A fasting blood sugar level of 126 mg/dL or higher is considered diabetes.

A fasting blood sugar level of 100 mg/dL or higher (or being on medicine to treat high blood sugar) is a metabolic risk factor.

About 85 percent of people who have type 2 diabetes—the most common type of diabetes—also have metabolic syndrome. These people have a much higher risk for heart disease than the 15 percent of people who have type 2 diabetes without metabolic

syndrome.

Cholesterol Management

What Is Cholesterol? To understand high blood cholesterol, it helps to learn about cholesterol. Cholesterol is a waxy, fat-like substance that's found in all cells of the body. Your body needs some cholesterol to make hormones, vitamin D, and substances that help you digest foods. Your body makes all the cholesterol it needs. However, cholesterol also is found in some of the foods you eat. Cholesterol travels through your bloodstream in small packages called lipoproteins. These packages are made of fat (lipid) on the inside and proteins on the outside.

Two kinds of lipoproteins carry cholesterol throughout your body: low-density lipoproteins (LDL) and high-density lipoproteins (HDL). Having healthy levels of both types of lipoproteins is important.

LDL cholesterol sometimes is called "bad" cholesterol. A high LDL level leads to a buildup of cholesterol in your arteries. (Arteries are blood vessels that carry blood from your heart to your body.)

HDL cholesterol sometimes is called "good" cholesterol. This is because it carries cholesterol from other parts of your body back to your liver. Your liver removes the cholesterol from your body.

What Is High Blood Cholesterol?

High blood cholesterol is a condition in which you have too much cholesterol in your blood. By itself, the condition usually has no signs or symptoms. Thus, many people don't know that their cholesterol levels are too high.

People who have high blood cholesterol have a greater chance of getting coronary heart disease, also called coronary artery disease. (In this article, the term "heart disease" refers to coronary heart disease.) The higher the level of LDL cholesterol in your blood, the GREATER your chance is of getting heart disease. The higher the level of HDL cholesterol in your blood, the LOWER your chance is of getting heart disease.

Coronary heart disease is a condition in which plaque builds up inside the coronary (heart) arteries. Plaque is made up of cholesterol, fat, calcium, and other substances found in the blood. When plaque builds up in the arteries, the condition is called atherosclerosis.

What Causes High Blood Cholesterol?

Many factors can affect the cholesterol levels in your blood. You can control some factors, but not others.

Factors You Can Control

1. Diet:

Cholesterol is found in foods that come from animal sources, such as egg yolks, meat, and cheese. Some foods have fats that raise your cholesterol level.

For example, *saturated fat raises your low-density lipoprotein (LDL) cholesterol level more than anything else in your diet.* Saturated fat is found in some meats, dairy products, chocolate, baked goods, and deep-fried and processed foods.

Trans fatty acids (trans fats) raise your LDL cholesterol and lower your high-density lipoprotein (HDL) cholesterol. Trans fats are made when hydrogen is added to vegetable oil to harden it. Trans fats are found in some fried and processed foods.

Limiting foods with cholesterol, saturated fat, and trans fats can help you control your cholesterol levels.

2. Physical Activity and Weight

Lack of physical activity can lead to weight gain. Being overweight tends to raise your LDL level, lower your HDL level, and increase your total cholesterol level. (Total cholesterol is a measure of the total amount of cholesterol in your blood, including LDL and HDL.) Routine physical activity can help you lose weight and lower your LDL cholesterol. Being physically active also can help you raise your HDL cholesterol level.

Factors You Can't Control

1. Heredity

High blood cholesterol can run in families. An inherited condition called familial hypercholesterolemia causes very high LDL cholesterol. ("Inherited" means the condition is passed from parents to children through genes.) This condition begins at birth, and it may cause a heart attack at an early age.

2. Age and Sex

Starting at puberty, men often have lower levels of HDL cholesterol than women. As women and men age, their LDL cholesterol levels often rise. Before age 55, women usually have lower LDL cholesterol levels than men. However, after age 55, women can have higher LDL levels than men.

How Is High Blood Cholesterol Diagnosed?

Your doctor will diagnose high blood cholesterol by checking the cholesterol levels in your blood. A blood test called a lipoprotein panel can measure your cholesterol levels. Before the test, you'll need to fast (not eat or drink anything but water) for 9 to 12 hours.

The lipoprotein panel will give your doctor information about your:

- Total cholesterol. Total cholesterol is a measure of the total amount of cholesterol in your blood, including low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol.
- LDL cholesterol. LDL, or "bad," cholesterol is the main source of cholesterol buildup and blockages in the arteries.
- HDL cholesterol. HDL, or "good," cholesterol helps remove cholesterol from your arteries.
- Triglycerides (tri-GLIH-seh-rides). Triglycerides are a type of fat found in your blood. Some studies suggest that a high level of triglycerides in the blood may raise the risk of coronary heart disease, especially in women.

If it's not possible to have a lipoprotein panel, knowing your total cholesterol and HDL cholesterol can give you a general idea about your cholesterol levels.

Testing for total and HDL cholesterol does not require fasting. If your total cholesterol is 200 mg/dL or more, or if your HDL cholesterol is less than 40 mg/dL, your doctor will likely recommend that you have a lipoprotein panel. (Cholesterol is measured as milligrams (mg) of cholesterol per deciliter (dL) of blood.)

The tables below show total, LDL, and HDL cholesterol levels and their corresponding categories. See how your cholesterol numbers compare to the numbers in the tables below.

Table 2.2.11.3.1. Cholesterol Levels

Total Cholesterol Level	**Total Cholesterol Category**
Less than 200 mg/dL	Desirable
200-239 mg/dL	Borderline high
240 mg/dL and higher	High
LDL Cholesterol Level	**LDL Cholesterol**
Less than 100 mg/dL	Optimal
100-129 mg/dL	Near optimal/above optimal
130-159 mg/dL	Borderline high
160-189 mg/dL	High
190 mg/dL and higher	Very high
HDL Cholesterol Level	**HDL Cholesterol Category**
Less than 40 mg/dL	A major risk for heart disease

40-59 mg/dL	The higher, the better
60 mg/dL and higher	Considered protective against heart disease

Triglycerides also can raise your risk for heart disease. If your triglyceride level is borderline high (150–199 mg/dL) or high (200 mg/dL or higher), you may need treatment.

How Is High Blood Cholesterol Treated?

High blood cholesterol is treated with lifestyle changes and medicines. The main goal of treatment is to lower your low-density lipoprotein (LDL) cholesterol level enough to reduce your risk for coronary heart disease, heart attack, and other related health problems.

Your risk for heart disease and heart attack goes up as your LDL cholesterol level rises and your number of heart disease risk factors increases.

Some people are at high risk for heart attacks because they already have heart disease. Other people are at high risk for heart disease because they have diabetes or more than one heart disease risk factor.

Talk with your doctor about lowering your cholesterol and your risk for heart disease. Also, check the list to find out whether you have risk factors that affect your LDL cholesterol goal:

- Cigarette smoking
- High blood pressure (140/90 mmHg or higher), or you're on medicine to treat high blood pressure
- Low high-density lipoprotein (HDL) cholesterol (less than 40 mg/dL)
- Family history of early heart disease (heart disease in father or brother before age 55; heart disease in mother or sister before age 65)
- Age (men 45 years or older; women 55 years or older)

Lowering Cholesterol Using Therapeutic Lifestyle Changes (TLC)

TLC is a set of lifestyle changes that can help you lower your LDL cholesterol. The main parts of the TLC program are a healthy diet, weight management, and physical activity.

The TLC Diet

With the TLC diet, less than 7 percent of your daily calories should come from saturated fat. This kind of fat is found in some meats, dairy products, chocolate, baked goods, and deep-fried and processed foods.

No more than 25 to 35 percent of your daily calories should come from all fats, including saturated, trans, monounsaturated, and polyunsaturated fats.

You also should have less than 200 mg a day of cholesterol. The amounts of cholesterol and the types of fat in prepared foods can be found on the foods' Nutrition Facts labels.

Foods high in soluble fiber also are part of the TLC diet. They help prevent the digestive tract from absorbing cholesterol. These foods include:

- Whole-grain cereals such as oatmeal and oat bran
- Fruits such as apples, bananas, oranges, pears, and prunes
- Legumes such as kidney beans, lentils, chick peas, black-eyed peas, and lima beans

A diet rich in fruits and vegetables can increase important cholesterol-lowering compounds in your diet. These compounds, called plant stanols or sterols, work like soluble fiber.

A healthy diet also includes some types of fish, such as salmon, tuna (canned or fresh), and mackerel. These fish are a good source of omega-3 fatty acids. These acids may help protect the heart from blood clots and inflammation and reduce the risk of heart attack. Try to have about two fish meals every week.

You also should try to limit the amount of sodium (salt) that you eat. This means choosing low-salt and “no added salt” foods and seasonings at the table or while cooking. The Nutrition Facts label on food packaging shows the amount of sodium in the item.

Try to limit drinks with alcohol. Too much alcohol will raise your blood pressure and triglyceride level. (Triglycerides are a type of fat found in the blood.) Alcohol also adds extra calories, which will cause weight gain.

Men should have no more than two drinks containing alcohol a day. Women should have no more than one drink containing alcohol a day. One drink is a glass of wine, beer, or a small amount of hard liquor.

Weight Management

If you’re overweight or obese, losing weight can help lower LDL cholesterol. Maintaining a healthy weight is especially important if you have a condition called metabolic syndrome.

Metabolic syndrome is the name for a group of risk factors that raise your risk for heart disease and other health problems, such as diabetes and stroke.

The five metabolic risk factors are a large waistline (abdominal obesity), a high triglyceride level, a low HDL cholesterol level, high blood pressure, and high blood sugar. Metabolic syndrome is diagnosed if you have at least three of these metabolic risk factors.

Physical Activity

Routine physical activity can lower LDL cholesterol and triglycerides and raise your HDL cholesterol level.
People gain health benefits from as little as 60 minutes of moderate-intensity aerobic activity per week (however, 150 minutes per week is the recommendation). The more active you are, the more you will benefit.

Cholesterol-Lowering Medicines

In addition to lifestyle changes, your doctor may prescribe medicines to help lower your cholesterol. Even with medicines, you should continue the TLC program.

Medicines can help control high blood cholesterol, but they don’t cure it.

List of Treatments for Cardiovascular Disease

- Drugs: There are a number of drugs on the market that aid in the prevention and management of all of the aforementioned conditions. They cannot replace the benefits of diet, exercise, and stress management, but should be used in conjunction.
- Angiogram: One of many diagnostic tests used to determine location and extent of coronary artery disease.
- Angioplasty: A procedure where a balloon is fed through a catheter into a coronary artery and a blockage is opened when the balloon is inflated.
- Stent: A “prop” that keeps the artery open following angioplasty.
- Coronary Artery Bypass Graft: A surgical procedure in which blockages in coronary arteries are bypassed via grafting of vessels (vein & arterial tissues can be used) around the blockage. This used to be done only “open chest” or “open heart”; modern surgical practice allows for some blockages to be bypassed via small opening in between the ribs (rather than sawing open the breast bone).
- Endarcterectomy: When the carotid artery (feeds the brain) is opened via a procedure (angioplasty &/or stent, usually).
- Valve replacements: valves separate the chambers of the heart. Sometimes those valves become compromised either mechanically or via infection and have to be replaced. Porcine of mechanical valves can be used.
- Heart transplant: When a heart has been damaged beyond repair a patient may become a candidate for a transplant; a large percentage of patients awaiting transplants never receive one.

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2.2.11.4: Diabetes

Diabetes is a disease that occurs when your blood glucose, also called blood sugar, is too high. Blood glucose is your main source of energy and comes from the food you eat. Insulin, a hormone made by the pancreas, helps glucose from food get into your cells to be used for energy. Sometimes your body doesn't make enough—or any—insulin or doesn't use insulin well. Glucose then stays in your blood and doesn't reach your cells. Over time, having too much glucose in your blood can cause health problems. The most common types of diabetes are type 1, type 2, and gestational diabetes.

Type 1 diabetes

If you have type 1 diabetes, your body does not make insulin. Your immune system attacks and destroys the cells in your pancreas that make insulin. Type 1 diabetes is usually diagnosed in children and young adults, although it can appear at any age. People with type 1 diabetes need to take insulin every day to stay alive.

Type 2 diabetes

If you have type 2 diabetes, your body does not make or use insulin well. You can develop type 2 diabetes at any age, even during childhood. However, this type of diabetes occurs most often in middle-aged and older people. Type 2 is the most common type of diabetes.

Gestational diabetes

Gestational diabetes develops in some women when they are pregnant. Most of the time, this type of diabetes goes away after the baby is born. However, if you've had gestational diabetes, you have a greater chance of developing type 2 diabetes later in life. Sometimes diabetes diagnosed during pregnancy is actually type 2 diabetes.

Other types of diabetes

Less common types include monogenic diabetes, which is an inherited form of diabetes, and cystic fibrosis-related diabetes.

How common is diabetes?

As of 2015, 30.3 million people in the United States, or 9.4 percent of the population, had diabetes. More than 1 in 4 of them didn't know they had the disease. Diabetes affects 1 in 4 people over the age of 65. About 90-95 percent of cases in adults are type 2 diabetes.

Risk Factors for Type 2 Diabetes

Developing type 2 diabetes depends on a combination of risk factors such as genes and lifestyle. Although some risk factors are non-modifiable such as family history, age, or ethnicity, lifestyle risk factors around eating, physical activity, and weight are modifiable. These lifestyle changes can affect ones chances of developing type 2 diabetes. Read about risk factors for type 2 diabetes below and see which ones apply to you. You are more likely to develop type 2 diabetes if you

- are overweight or obese
- are age 45 or older
- have a family history of diabetes
- are African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, Native Hawaiian, or Pacific Islander
- have high blood pressure
- have a low level of HDL ("good") cholesterol, or a high level of triglycerides
- have a history of gestational diabetes or gave birth to a baby weighing 9 pounds or more
- are not physically active
- have a history of heart disease or stroke
- have depression
- have polycystic ovary syndrome, also called PCOS
- have acanthosis nigricans—dark, thick, and velvety skin around your neck or armpits

You can also take the Diabetes Risk Test to learn about your risk for type 2 diabetes.

What health problems can people with diabetes develop?

Over time, high blood glucose leads to problems such as

- heart disease
- stroke
- kidney disease
- eye problems
- dental disease
- nerve damage
- foot problems

Symptoms & Causes of Diabetes

Symptoms of diabetes include

- increased thirst and urination
- increased hunger
- fatigue
- blurred vision
- numbness or tingling in the feet or hands
- sores that do not heal
- unexplained weight loss

Symptoms of type 1 diabetes can start quickly, in a matter of weeks. Symptoms of type 2 diabetes often develop slowly—over the course of several years—and can be so mild that you might not even notice them. Many people with type 2 diabetes have no symptoms. Some people do not find out they have the disease until they have diabetes-related health problems, such as blurred vision or heart trouble.

What causes type 1 diabetes?

Type 1 diabetes occurs when your immune system, the body's system for fighting infection, attacks and destroys the insulin-producing beta cells of the pancreas. Scientists think type 1 diabetes is caused by genes and environmental factors, such as viruses, that might trigger the disease. Studies such as TrialNet are working to pinpoint causes of type 1 diabetes and possible ways to prevent or slow the disease.

What causes type 2 diabetes?

Type 2 diabetes—the most common form of diabetes—is caused by several factors, including lifestyle factors and genes.

Overweight, obesity, and physical inactivity

You are more likely to develop type 2 diabetes if you are not physically active and are overweight or obese. Extra weight sometimes causes insulin resistance and is common in people with type 2 diabetes. The location of body fat also makes a difference. Extra belly fat is linked to insulin resistance, type 2 diabetes, and heart and blood vessel disease.

Insulin resistance

Type 2 diabetes usually begins with insulin resistance, a condition in which muscle, liver, and fat cells do not use insulin well. As a result, your body needs more insulin to help glucose enter cells. At first, the pancreas makes more insulin to keep up with the added demand. Over time, the pancreas can't make enough insulin, and blood glucose levels rise.

Genes and family history

As in type 1 diabetes, certain genes may make you more likely to develop type 2 diabetes. The disease tends to run in families and occurs more often in these racial/ethnic groups:

- African Americans
- Alaska Natives

- American Indians
- Asian Americans
- Hispanics/Latinos
- Native Hawaiians
- Pacific Islanders

Genes also can increase the risk of type 2 diabetes by increasing a person's tendency to become overweight or obese.

What causes gestational diabetes?

Scientists believe gestational diabetes, a type of diabetes that develops during pregnancy, is caused by the hormonal changes of pregnancy along with genetic and lifestyle factors.

Insulin resistance

Hormones produced by the placenta contribute to insulin resistance, which occurs in all women during late pregnancy. Most pregnant women can produce enough insulin to overcome insulin resistance, but some cannot. Gestational diabetes occurs when the pancreas can't make enough insulin.

As with type 2 diabetes, extra weight is linked to gestational diabetes. Women who are overweight or obese may already have insulin resistance when they become pregnant. Gaining too much weight during pregnancy may also be a factor.



Figure 2.2.11.4.1. Pregnancy can sometimes contribute to diabetic complications

Hormonal changes, extra weight, and family history can contribute to gestational diabetes.

Genes and family history

Having a family history of diabetes makes it more likely that a woman will develop gestational diabetes, which suggests that genes play a role. Genes may also explain why the disorder occurs more often in African Americans, American Indians, Asians, and Hispanics/Latinas.

What else can cause diabetes?

Genetic mutations, other diseases, damage to the pancreas, and certain medicines may also cause diabetes.

Diagnosing diabetes and prediabetes?

Health care professionals most often use the fasting plasma glucose (FPG) test or the A1C test to diagnose diabetes. In some cases, they may use a random plasma glucose (RPG) test. The FPG blood test measures your blood glucose level at a single point

in time. For the most reliable results, it is best to have this test in the morning, after you fast for at least 8 hours. Fasting means having nothing to eat or drink except sips of water.

The A1C test is a blood test that provides your average levels of blood glucose over the past 3 months. Other names for the A1C test are hemoglobin A1C, HbA1C, glycated hemoglobin, and glycosylated hemoglobin test. You can eat and drink before this test. When it comes to using the A1C to diagnose diabetes, your doctor will consider factors such as your age and whether you have anemia or another problem with your blood.1 The A1C test is not accurate in people with anemia.

How can I lower my chances of developing type 2 diabetes?

Research such as the Diabetes Prevention Program shows that you can do a lot to reduce your chances of developing type 2 diabetes. Here are some things you can change to lower your risk:

- Lose weight and keep it off. You may be able to prevent or delay diabetes by losing 5 to 7 percent of your starting weight.1 For instance, if you weigh 200 pounds, your goal would be to lose about 10 to 14 pounds.
- Move more. Get at least 30 minutes of physical activity 5 days a week. If you have not been active, talk with your health care professional about which activities are best. Start slowly to build up to your goal.
- Eat healthy foods most of the time. Eat smaller portions to reduce the amount of calories you eat each day and help you lose weight. Choosing foods with less fat is another way to reduce calories. Drink water instead of sweetened beverages.

Manage Diabetes

Although diabetes has no cure, it can be managed by taking the right steps to stay healthy. The National Institute of Health recommends make the following recommendations for managing diabetes:

- **Follow a diabetes meal plan:** Choose fruits and vegetables, beans, whole grains, chicken or turkey without the skin, fish, lean meats, and nonfat or low-fat milk and cheese. Drink water instead of sugar-sweetened beverages. Choose foods that are lower in calories, saturated fat, trans fat, sugar, and salt. Learn more about eating, diet, and nutrition with diabetes.
- **Engage in physical activity daily:** Set a goal to be more physically active. Try to work up to 30 minutes or more of physical activity on most days of the week. Brisk walking and swimming are good ways to move more.
- **Take appropriate medicine:** Take medicine(s) for diabetes and any other health problems, even when feeling good or having reached a healthy blood glucose, blood pressure, and cholesterol goals.
- **Check your blood glucose levels:** For many people with diabetes, checking their blood glucose level each day is an important way to manage their diabetes. Monitoring blood glucose levels is most important for anyone taking insulin. The results of blood glucose monitoring can help diabetes sufferers make decisions about food, physical activity, and medicines.



Figure 2.2.11.4.2. Measuring Blood Glucose Levels is an important part of managing diabetes. The most common way to check a blood glucose level is at home is with a blood glucose meter. You get a drop of blood by pricking the side of your fingertip with a

lancet. Then you apply the blood to a test strip. The meter will show you how much glucose is in your blood at the moment.

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2.2.11.5: Cancer

What Is Cancer?

Cancer is the name given to a collection of related diseases. In all types of cancer, some of the body's cells begin to divide without stopping and spread into surrounding tissues. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place.

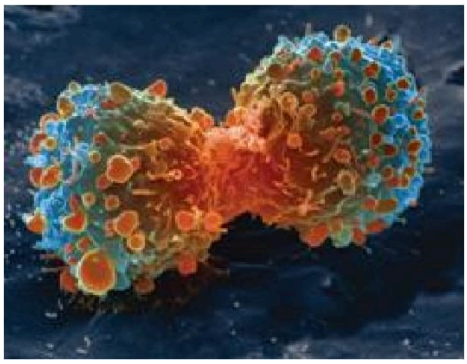


Figure 2.2.11.5.1**.** *Cancerous Cells*

When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old or damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may form growths called tumors. Cancerous tumors are malignant, which means they can spread into, or invade, nearby tissues. In addition, as these tumors grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumors far from the original tumor. Unlike malignant tumors, benign tumors do not spread into, or invade, nearby tissues. Benign tumors can sometimes be quite large, however. When removed, they usually don't grow back, whereas malignant tumors sometimes do. Unlike most benign tumors elsewhere in the body, benign brain tumors can be life threatening.

Key Cancer Terms

- **Neoplasms**: clusters of abnormal cells; aka "tumors." When the neoplasms or tumors grow out and replace normal cells they are said to be "infiltrating" or "metastasizing" which means traveling to other parts of the body via the blood or lymph.
- **Carcinoma**: most common form; starts in the epithelium.
- **Sarcoma:** forms in connective tissue: bones, muscles, blood vessels.
- **Leukemias:** form in blood-forming tissues: bone marrow, lymph nodes, and the spleen.
- **Lymphomas**: form in the cells of the lymph system (the system that filters out impurities and/or infection).
- Conceptually, cancer is thought to develop via the turning on of genes called "**oncogenes**" or genes that have gone awry. The DNA in these cells replicates at an accelerated rate. "Tumor suppressor genes", which are present in all of us, fail to stop these cells from dividing thereby allowing a tumor to form.
- A "**malignant**" tumor is a cancerous tumor, whereas a "benign" tumor is not cancerous and of no imminent danger to the body.

How Cancer Arises

Cancer is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Genetic changes that cause cancer can be inherited from our parents. They can also arise during a person's lifetime as a result of errors that occur as cells divide or because of damage to DNA caused by certain environmental exposures. Cancer-causing environmental exposures include substances, such as the chemicals in tobacco smoke, and radiation, such as ultraviolet rays from

the sun.

When Cancer Spreads

In metastasis, cancer cells break away from where they first formed (primary cancer), travel through the blood or lymph system, and form new tumors (metastatic tumors) in other parts of the body. The metastatic tumor is the same type of cancer as the primary tumor.

A cancer that has spread from the place where it first started to another place in the body is called metastatic cancer. *The process by which cancer cells spread to other parts of the body is called metastasis.*

Metastatic cancer has the same name and the same type of cancer cells as the original, or primary, cancer. For example, breast cancer that spreads to and forms a metastatic tumor in the lung is metastatic breast cancer, not lung cancer.

Under a microscope, metastatic cancer cells generally look the same as cells of the original cancer. Moreover, metastatic cancer cells and cells of the original cancer usually have some molecular features in common, such as the presence of specific chromosome changes.

Cancer Stages

Cancers are staged 1-3/4, depending on the cancer and the severity. When detected at stage 1, a person suffering from most types of cancer has about a 95% of surviving. The odds go down as you get to stage 3 or 4 (some cancers only have 3 stages, others 4). Doctors will often add an ‘A’ or ‘B’ to the staging as well, and this can relate to whether or not the cancer has invaded other tissues.

Tissue Changes That Are Not Cancer

Not every change in the body’s tissues is cancer. Some tissue changes may develop into cancer if they are not treated, however. Here are some examples of tissue changes that are not cancer but, in some cases, are monitored:

Hyperplasia occurs when cells within a tissue divide faster than normal and extra cells build up, or proliferate. However, the cells and the way the tissue is organized look normal under a microscope. Hyperplasia can be caused by several factors or conditions, including chronic irritation.

Dysplasia is a more serious condition than hyperplasia. In dysplasia, there is also a buildup of extra cells. But the cells look abnormal and there are changes in how the tissue is organized. In general, the more abnormal the cells and tissue look, the greater the chance that cancer will form.

Some types of dysplasia may need to be monitored or treated. An example of dysplasia is an abnormal mole (called a dysplastic nevus) that forms on the skin. A dysplastic nevus can turn into melanoma, although most do not.

Normal cells may become cancer cells. Before cancer cells form in tissues of the body, the cells go through abnormal changes called hyperplasia and dysplasia. In hyperplasia, there is an increase in the number of cells in an organ or tissue that appear normal under a microscope. In dysplasia, the cells look abnormal under a microscope but are not cancer. Hyperplasia and dysplasia may or may not become cancer.

Types of Cancer

There are more than 100 types of cancer. Types of cancer are usually named for the organs or tissues where the cancers form. For example, lung cancer starts in cells of the lung, and brain cancer starts in cells of the brain. Cancers also may be described by the type of cell that formed them, such as an epithelial cell or a squamous cell.

Common Cancer Types

This list of common cancer types includes cancers that are diagnosed with the greatest frequency in the United States, excluding non-melanoma skin cancers:

- **Bladder Cancer:** The most common type of bladder cancer is transitional cell carcinoma, also called urothelial carcinoma. Smoking is a major risk factor for bladder cancer. Bladder cancer is often diagnosed at an early stage.

- **Breast Cancer**: Breast cancer is the second most common cancer in women after skin cancer. Mammograms can detect breast cancer early, possibly before it has spread.
- **Colon and Rectal Cancer:** Colorectal cancer often begins as a growth called a polyp inside the colon or rectum. Finding and removing polyps can prevent colorectal cancer.
- **Endometrial Cancer:** Uterine cancers can be of two types: endometrial cancer (common) and uterine sarcoma (rare). Endometrial cancer can often be cured. Uterine sarcoma is often more aggressive and harder to treat.
- **Kidney Cancer:** Kidney cancer can develop in adults and children. The main types of kidney cancer are renal cell cancer, transitional cell cancer, and Wilms tumor. Certain inherited conditions increase the risk of kidney cancer.
- **Leukemia:** Leukemia is a broad term for cancers of the blood cells. The type of leukemia depends on the type of blood cell that becomes cancer and whether it grows quickly or slowly. Leukemia occurs most often in adults older than 55, but it is also the most common cancer in children younger than 15.
- **Lung Cancer:** Lung cancer includes two main types: non-small cell lung cancer and small cell lung cancer. Smoking causes most lung cancers, but nonsmokers can also develop lung cancer.
- **Melanoma:** Skin cancer is the most common type of cancer. The main types of skin cancer are squamous cell carcinoma, basal cell carcinoma, and melanoma. Melanoma is much less common than the other types but much more likely to invade nearby tissue and spread to other parts of the body. Most deaths from skin cancer are caused by melanoma.
- **Non-Hodgkin Lymphoma:** Lymphoma is a broad term for cancer that begins in cells of the lymph system. The two main types are Hodgkin lymphoma and nonHodgkin lymphoma (NHL). Hodgkin lymphoma can often be cured. The prognosis of NHL depends on the specific type.
- **Pancreatic Cancer:** Pancreatic cancer can develop from two kinds of cells in the pancreas: exocrine cells and neuroendocrine cells, such as islet cells. The exocrine type is more common and is usually found at an advanced stage. Pancreatic neuroendocrine tumors (islet cell tumors) are less common but have a better prognosis.
- **Prostate Cancer:** Prostate cancer is the most common cancer and the second leading cause of cancer death among men in the United States. Prostate cancer usually grows very slowly, and finding and treating it before symptoms occur may not improve men's health or help them live longer.
- **Thyroid Cancer:** Thyroid cancer can be of four main types, which vary in their aggressiveness. Anaplastic thyroid cancer is hard to cure with current treatments, whereas papillary (the most common), follicular, and medullary thyroid cancer can usually be cured.

Cancer incidence and mortality statistics reported by the American Cancer Society and other resources were used to create the list. To qualify as a common cancer for the list, the estimated annual incidence for 2016 had to be 40,000 cases or more.

The most common type of cancer on the list is breast cancer, with more than 249,000 new cases expected in the United States in 2016. The next most common cancers are lung cancer and prostate cancer.

Because colon and rectal cancers are often referred to as “colorectal cancers,” these two cancer types are combined for the list. For 2016, the estimated number of new cases of colon cancer and rectal cancer are 95,270 and 39,220, respectively, adding to a total of 134,490 new cases of colorectal cancer.

The following table gives the estimated numbers of new cases and deaths for each common cancer type:

Table 2.2.11.5.1. Cancer Types

Cancer Type	Estimated New Cases	Estimated Deaths
Bladder	76,960	16,390
Breast (Female - Male)	246,660 - 2,600	40,450 - 440
Colon and Rectal (Combined)	134,490	49,190
Endometrial	60,050	10,470
Kidney (Renal Cell and Renal Pelvis) Cancer	62,700	14,240
Leukemia (All Types)	60,140	24,400
Lung (Including Bronchus)	224,390	158,080
Melanoma	76,380	10,130
Non-Hodgkin Lymphoma	72,580	20,150

Pancreatic	53,070	41,780
Prostate	180,890	26,120
Thyroid	64,300	1,980

Risk Factors for Cancer

It is usually not possible to know exactly why one person develops cancer and another doesn't. But research has shown that certain risk factors may increase a person's chances of developing cancer. (There are also factors that are linked to a lower risk of cancer. These are called protective factors.)

Cancer risk factors include exposure to chemicals or other substances, as well as certain behaviors. They also include things people cannot control, like age and family history. A family history of certain cancers can be a sign of a possible inherited cancer syndrome.

Most cancer risk (and protective) factors are initially identified in epidemiology studies. In these studies, scientists look at large groups of people and compare those who develop cancer with those who don't. These studies may show that the people who develop cancer are more or less likely to behave in certain ways or to be exposed to certain substances than those who do not develop cancer.

Such studies, on their own, cannot prove that a behavior or substance causes cancer. For example, the finding could be a result of chance, or the true risk factor could be something other than the suspected risk factor. But findings of this type sometimes get attention in the media, and this can lead to wrong ideas about how cancer starts and spreads.

When many studies all point to a similar association between a potential risk factor and an increased risk of cancer, and when a possible mechanism exists that could explain how the risk factor could actually cause cancer, scientists can be more confident about the relationship between the two.

The list below includes the most studied known or suspected risk factors for cancer:

- Age
- Alcohol
- Cancer-Causing Substances
- Chronic Inflammation
- Diet
- Hormones
- Immunosuppression
- Infectious Agents
- Obesity
- Radiation
- Sunlight
- Tobacco



Figure 2.2.11.5.2. CDC Advertisement

Although some of these risk factors can be avoided, others—such as growing older— cannot. Limiting your exposure to avoidable risk factors may lower your risk of developing certain cancers.

TOBACCO

Tobacco use is a leading cause of cancer and of death from cancer. People who use tobacco products or who are regularly around environmental tobacco smoke (also called secondhand smoke) have an increased risk of cancer because tobacco products and secondhand smoke have many chemicals that damage DNA.

Tobacco use causes many types of cancer, including cancer of the lung, larynx (voice box), mouth, esophagus, throat, bladder, kidney, liver, stomach, pancreas, colon and rectum, and cervix, as well as acute myeloid leukemia. People who use smokeless tobacco (snuff or chewing tobacco) have increased risks of cancers of the mouth, esophagus, and pancreas.

There is no safe level of tobacco use. People who use any type of tobacco product are strongly urged to quit. People who quit smoking, regardless of their age, have substantial gains in life expectancy compared with those who continue to smoke. Also, quitting smoking at the time of a cancer diagnosis reduces the risk of death.

Scientists believe that cigarette smoking causes about 30% of all cancer deaths in the United States.

Cancer Prevention

The number of new cancer cases can be reduced and many cancer deaths can be prevented. Research shows that screening for cervical and colorectal cancers as recommended helps prevent these diseases by finding precancerous lesions so they can be treated before they become cancerous. Screening for cervical, colorectal, and breast cancers also helps find these diseases at an early stage, when treatment works best.

Vaccines (shots) also help lower cancer risk. The human papillomavirus (HPV) vaccine helps prevent most cervical cancers and several other kinds of cancer, and the hepatitis B vaccine can help lower liver cancer risk.

A person's cancer risk can be reduced with healthy choices like avoiding tobacco, limiting alcohol use, protecting your skin from the sun and avoiding indoor tanning, eating a diet rich in fruits and vegetables, keeping a healthy weight, and being physically active.

Avoiding Tobacco

Cigarette Smoking

Lung cancer is the leading cause of cancer death, and cigarette smoking causes almost all cases. Compared to nonsmokers,

current smokers are about 25 times more likely to die from lung cancer. Smoking causes about 80% to 90% of lung cancer deaths. Smoking also causes cancer of the mouth and throat, esophagus, stomach, colon, rectum, liver, pancreas, voicebox (larynx), trachea, bronchus, kidney and renal pelvis, urinary bladder, and cervix, and causes acute myeloid leukemia.

Visit smokefree.gov to learn how you can quit smoking.

Secondhand Smoke

Adults who are exposed to secondhand smoke at home or at work increase their risk of developing lung cancer by 20% to 30%. Concentrations of many cancer-causing and toxic chemicals are higher in secondhand smoke than in the smoke inhaled by smokers.

Protecting Your Skin

Skin cancer is the most common kind of cancer in the United States. Exposure to ultraviolet (UV) rays from the sun and tanning beds appears to be the most important environmental factor involved with developing skin cancer. To help prevent skin cancer while still having fun outdoors, protect yourself by seeking shade, applying sunscreen, and wearing sunprotective clothing, a hat, and sunglasses.

DETECTING MELANOMA

Melanoma is the most serious type of skin cancer. Often the first sign of melanoma is a change in the size, shape, color, or feel of a mole. Most melanomas have a black or black-blue area. Melanoma may also appear as a new mole. It may be black, abnormal, or "ugly looking."

Thinking of "**ABCDE**" can help you remember what to watch for:

- **A**symmetry – the shape of one half does not match the other
- **B**order – the edges are ragged, blurred or irregular
- **C**olor – the color is uneven and may include shades of black, brown and tan
- **D**iameter – there is a change in size, usually an increase (larger than 6 millimeters or about 1/4 inch)
- **E**volving – the mole has changed (in size, color, shape; it may start to itch or bleed) over the past few weeks or months

Limiting Alcohol Intake

Drinking alcohol raises the risk of some cancers. Drinking any kind of alcohol can contribute to cancers of the mouth and throat, larynx (voice box), esophagus, colon and rectum, liver, and breast (in women). The less alcohol you drink, the lower the risk of cancer.

Studies around the world have shown that drinking alcohol regularly increases the risk of getting mouth, voice box, and throat cancers.

A large number of studies provide strong evidence that drinking alcohol is a risk factor for primary liver cancer, and more than 100 studies have found an increased risk of breast cancer with increasing alcohol intake. The link between alcohol consumption and colorectal (colon) cancer has been reported in more than 50 studies.

Keeping a Healthy Weight

Research has shown that being overweight or obese substantially raises a person's risk of getting endometrial (uterine), breast, prostate, and colorectal cancers. Overweight is defined as a body mass index (BMI) of 25 to 29, and obesity is defined as a BMI of 30 or higher. You can learn more about eating healthy and maintaining a healthy weight in chapters 9 and 10.

Types of Cancer Treatment



Figure 2.2.11.5.3. Source: National Cancer Institute - https://www.cancer.gov/about-cancer/treatment/types

There are many types of cancer treatment. The types of treatment will depend on the type of cancer and how advanced it is. Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotherapy and/or radiation therapy.

Surgery

When used to treat cancer, surgery is a procedure in which a surgeon removes cancer from your body. Learn the different ways that surgery is used against cancer and what you can expect before, during, and after surgery.

Radiation Therapy

Radiation therapy is a type of cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. Learn about the types of radiation, why side effects happen, which ones you might have, and more.

Chemotherapy

Chemotherapy is a type of cancer treatment that uses drugs to kill cancer cells. Learn how chemotherapy works against cancer, why it causes side effects, and how it is used with other cancer treatments.

Immunotherapy

Immunotherapy is a type of treatment that helps your immune system fight cancer. Get information about the types of immunotherapy and what you can expect during treatment.

Targeted Therapy

Targeted therapy is a type of cancer treatment that targets the changes in cancer cells that help them grow, divide, and spread. Learn how targeted therapy works against cancer and about common side effects that may occur.

Hormone Therapy

Hormone therapy is a treatment that slows or stops the growth of breast and prostate cancers that use hormones to grow. Learn about the types of hormone therapy and side effects that may happen.

Stem Cell Transplant

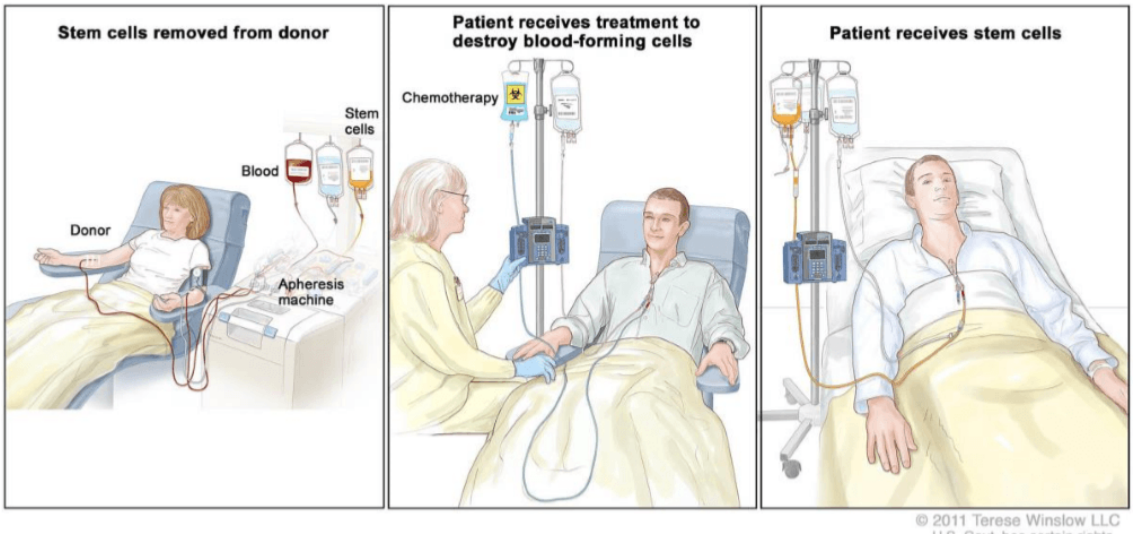


Figure 2.2.11.5.4. Stem Cell Transplant

Stem cell transplants are procedures that restore blood-forming stem cells in cancer patients who have had theirs destroyed by very high doses of chemotherapy or radiation therapy. Learn about the types of transplants, side effects that may occur, and how stem cell transplants are used in cancer treatment.

Precision Medicine

Precision medicine helps doctors select treatments that are most likely to help patients based on a genetic understanding of their disease. Learn about the role precision medicine plays in cancer treatment, including how genetic changes in a person's cancer are identified and used to select treatments.

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2.2.12: ENVIRONMENTAL HEALTH

Environmental health is the branch of public health that is concerned with all aspects of the natural and built environment that may affect human health. Health is the science, practice, and study of a human's well-being and their health and preventing illnesses and human injuries. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection.

2.2.12.1: Intro to Environmental Health

2.2.12.2: Overpopulation

2.2.12.3: Air Pollution

2.2.12.4: Climate Change

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2.2.12.6: Waste Management

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2.2.12.1: Intro to Environmental Health

Environmental health is the branch of public health that is concerned with all aspects of the natural and built environment that may affect human health. Health is the science, practice, and study of a human's well-being and their health and preventing illnesses and human injuries. Other terms referring to or concerning environmental health are environmental public health, and public health protection/environmental health protection. Environmental health and environmental protection are very much related. Environmental health is focused on the natural and built environments for the benefit of human health, whereas environmental protection is concerned with protecting the natural environment for the benefit of human health and the ecosystem. Research in the environmental health field tries to limit the harmful exposures through natural things such as soil, water, air food, etc.

The natural environment encompasses all living and non-living things occurring naturally, meaning in this case not artificial. The term is most often applied to the Earth or some parts of Earth. This environment encompasses the interaction of all living species, climate, weather, and natural resources that affect human survival and economic activity. The concept of the natural environment can be distinguished as components:

- Complete ecological units that function as natural systems without massive civilized human intervention, including all vegetation, microorganisms, soil, rocks, atmosphere, and natural phenomena that occur within their boundaries and their nature
- Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from civilized human activity

In contrast to the natural environment is the built environment. In such areas where man has fundamentally transformed landscapes such as urban settings and agricultural land conversion, the natural environment is greatly modified into a simplified human environment. Even acts which seem less extreme, such as building a mud hut or a photovoltaic system in the desert, modify the natural environment into an artificial one. Though many animals build things to provide a better environment for themselves, they are not human, hence beaver dams and the works of Mound-building termites are thought of as natural.

People seldom find absolutely natural environments on Earth, and naturalness usually varies in a continuum, from 100% natural in one extreme to 0% natural in the other. More precisely, we can consider the different aspects or components of an environment, and see that their degree of naturalness is not uniform. If, for instance, in an agricultural field, the mineralogic composition and the structure of its soil are similar to those of an undisturbed forest soil, but the structure is quite different.

The carrying capacity of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment. In population biology, carrying capacity is defined as the environment's maximal load, which is different from the concept of population equilibrium. Its effect on population dynamics may be approximated in a logistic model, although this simplification ignores the possibility of overshoot which real systems may exhibit.

Carrying capacity was originally used to determine the number of animals that could graze on a segment of land without destroying it. Later, the idea was expanded to more complex populations, like humans. For the human population, more complex variables such as sanitation and medical care are sometimes considered as part of the necessary establishment. As population density increases, birth rate often decreases and death rate typically increases. The difference between the birth rate and the death rate is the "natural increase". The carrying capacity could support a positive natural increase or could require a negative natural increase. Thus, the carrying capacity is the number of individuals an environment can support without significant negative impacts to the given organism and its environment. Below carrying capacity, populations typically increase, while above, they typically decrease. A factor that keeps population size at equilibrium is known as a regulating factor. Population size decreases above carrying capacity due to a range of factors depending on the species concerned, but can include insufficient space, food supply, or sunlight. The carrying capacity of an environment may vary for different species and may change over time due to a variety of factors including: food availability, water supply, environmental conditions and living space. The origins of the term "carrying capacity" are uncertain, with researchers variously stating that it was used "in the context of international shipping" or that it was first used during 19^{th}-century laboratory experiments with micro-organisms. A recent review finds the first use of the term in an 1845 report by the US Secretary of State to the US Senate.

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2.2.12.2: Overpopulation

Human overpopulation occurs when the *ecological footprint* of a human population in a specific geographical location exceeds the *carrying capacity* of the place occupied by that group. Overpopulation can further be viewed, in a long term perspective, as existing when a population cannot be maintained given the rapid depletion of *non-renewable resources* or given the degradation of the capacity of the environment to give support to the population.

The term *human overpopulation* refers to the relationship between the entire human population and its environment: the Earth, or to smaller geographical areas such as countries. Overpopulation can result from an increase in births, a decline in mortality rates, an increase in immigration, or an unsustainable biome and depletion of resources. It is possible for very sparsely populated areas to be overpopulated if the area has a nonexistent capability to sustain life (e.g. a desert). Advocates of population moderation cite issues like quality of life, carrying capacity and risk of starvation as a basis to argue against continuing high human population growth and for population decline. Scientists suggest that the human impact on the environment as a result of overpopulation, profligate consumption and proliferation of technology has pushed the planet into a new geological epoch known as the Anthropocene.

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2.2.12.3: Air Pollution

Air pollution occurs when harmful substances including particulates and biological molecules are introduced into Earth's atmosphere. It may cause diseases, allergies or death of humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. Human activity and natural processes can both generate air pollution.

Indoor air pollution and poor urban air quality are listed as two of the world's worst toxic pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report. According to the 2014 World Health Organization report, air pollution in 2012 caused the deaths of around 7 million people worldwide, an estimate roughly matched by the International Energy Agency.

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects. Different countries have their own air quality indices, corresponding to different national air quality standards. Some of these are the Air Quality Health Index (Canada), the Air Pollution Index (Malaysia), and the Pollutant Standards Index (Singapore).

Indoor air quality (IAQ) is a term that refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. IAQ can be affected by gases (including carbon monoxide, radon, volatile organic compounds), particulates, microbial contaminants (mold, bacteria), or any mass or energy stressor that can induce adverse health conditions. Source control, filtration and the use of ventilation to dilute contaminants are the primary methods for improving indoor air quality in most buildings. Residential units can further improve indoor air quality by routine cleaning of carpets and area rugs.

Determination of IAQ involves the collection of air samples, monitoring human exposure to pollutants, collection of samples on building surfaces, and computer modelling of air flow inside buildings.

IAQ is part of indoor environmental quality (IEQ), which includes IAQ as well as other physical and psychological aspects of life indoors (e.g., lighting, visual quality, acoustics, and thermal comfort). Indoor air pollution in developing nations is a major health hazard. A major source of indoor air pollution in developing countries is the burning of biomass (e.g. wood, charcoal, dung, or crop residue) for heating and cooking. The resulting exposure to high levels of particulate matter resulted in between 1.5 million and 2 million deaths in 2000.

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2.2.12.4: Climate Change

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as **global warming**.

Global warming is the observed century-scale rise in the average temperature of the Earth's climate system and its related effects. Multiple lines of scientific evidence show that the climate system is warming. Many of the observed changes since the 1950s are unprecedented in the instrumental temperature record which extends back to the mid-19th century, and in paleoclimate proxy records covering thousands of years.

In 2013, the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report concluded that "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century." The largest human influence has been the emission of greenhouse gases such as carbon dioxide, methane and nitrous oxide. Climate model projections summarized in the report indicated that during the 21st century, the global surface temperature is likely to rise a further 0.3 to 1.7 °C (0.5 to 3.1 °F) in the lowest emissions scenario, and 2.6 to 4.8 °C (4.7 to 8.6 °F) in the highest emissions scenario. These findings have been recognized by the national science academies of the major industrialized nations and are not disputed by any scientific body of national or international standing.

Future climate change and associated impacts will differ from region to region around the globe. Anticipated effects include increasing global temperatures, rising sea levels, changing precipitation, and expansion of deserts in the subtropics. Warming is expected to be greater over land than over the oceans and greatest in the Arctic, with the continuing retreat of glaciers, permafrost and sea ice. Other likely changes include more frequent extreme weather events such as heat waves, droughts, heavy rainfall with floods and heavy snowfall; ocean acidification; and species extinction due to shifting temperature regimes. Effects significant to humans include the threat to food security from decreasing crop yields and the abandonment of populated areas due to rising sea levels. Because the climate system has a large "inertia" and greenhouse gases will remain in the atmosphere for a long time, many of these effects will persist for not only decades or centuries, but for tens of thousands of years to come.

Possible societal responses to global warming include mitigation by emissions reduction, adaptation to its effects, building systems resilient to its effects, and possible future climate engineering. Most countries are parties to the United Nations Framework Convention on Climate Change (UNFCCC), whose ultimate objective is to prevent dangerous anthropogenic climate change. Parties to the UNFCCC have agreed that deep cuts in emissions are required and that global warming should be limited to well below 2.0 °C (3.6 °F) compared to pre-industrial levels, with efforts made to limit warming to 1.5 °C (2.7 °F).

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2.2.12.5: Water

Drought is a natural phenomenon during which regions or communities experience shifts in the balance between *precipitation* and *evapotranspiration* (the processes of evaporation and transpiration)—a balance that is inherent to the earth's water cycle (see the Understanding Natural Cycles in Water Distribution section). Several factors affect the impact of drought on humans and other life forms, including the timing of precipitation events, effectiveness of the rain that is falling (i.e., rainfall intensity and the number of rain events), characteristics of the built environment in the affected area, and local demand for water. Individual areas or communities can be affected differently by drought depending on several additional variables, including:

- the structure and capacity of existing water systems,
- economic development,
- the at-risk populations living within the affected area,
- local governance of water use, and
- other societal factors, such as the presence of local social networks.

Because the conditions that signify drought can vary substantially by U.S. region and locality, drought should ultimately be defined based on the context and location in which the water shortage is occurring.

Although drought most commonly is defined climatologically, drought can also be exacerbated by human activities. For example, even when precipitation is occurring at average rates within a specific area, urban expansion and development without regard to existing water supply and water system capacity can trigger a human-induced drought. Drought can occur anywhere in the world, and it is considered a transient environmental hazard except in arid geographical regions that historically receive very limited amounts of rainfall. In addition, because of the substantial amount of time that elapses between the warning signs of drought and any measurable negative consequences to human and environmental health, drought should be considered a chronic or "low rise" natural event rather than an acute emergency for public health preparedness and response purposes. Drought is unlike other natural emergencies such as hurricanes, floods, or earthquakes; drought-related conditions can take years to escalate to the point at which water supply becomes severely limited, and the length of time that drought conditions may persist and impact communities is unknown.

Water Recycling and Reuse

Because freshwater is only a minimal percentage of the total global water supply and water treatment and distribution are costly, water should be considered a scarce and valuable resource. Many groups are advocating new approaches to water use and distribution. For example, the U.S. Green Building Council has proposed that traditional water distribution systems could be modified to limit the distribution of potable water and that parallel systems be developed to enable the collection and redistribution of gray water. Some municipalities have installed distribution systems that encourage households and commercial operations to use recycled water in lieu of treated freshwater for specific applications (e.g., irrigation), thus conserving the freshwater that is available within their watersheds. However, this is an expensive option because it requires the establishment of separate piping systems for the recycled water. Alternative methods for using rainwater also are being developed. For example, buildings are increasingly being engineered with the capability to collect and use rainwater for non-potable applications (such as for flushing toilets and landscape irrigation).

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2.2.12.6: Waste Management

Waste management or waste disposal are all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things collection, transport, treatment and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling.

The term normally relates to all kinds of waste, whether generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, or other human activities, including municipal (residential, institutional, commercial), agricultural, and social (health care, household hazardous waste, sewage sludge). Waste management is intended to reduce adverse effects of waste on health, the environment or aesthetics.

Waste management practices are not uniform among countries (developed and developing nations); regions (urban and rural area), and sectors (residential and industrial).

Waste Hierarchy

The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste; see: resource recovery. The waste hierarchy is represented as a pyramid because the basic premise is for policy to take action first and prevent the generation of waste. The next step or preferred action is to reduce the generation of waste i.e. by re-use. The next is recycling which would include composting. Following this step is material recovery and waste-to-energy. Energy can be recovered from processes i.e. landfill and combustion, at this level of the hierarchy. The final action is disposal, in landfills or through incineration without energy recovery. This last step is the final resort for waste which has not been prevented, diverted or recovered. The waste hierarchy represents the progression of a product or material through the sequential stages of the pyramid of waste management. The hierarchy represents the latter parts of the life-cycle for each product.

Noise Pollution

Noise pollution is the disturbing noise with harmful impact on the activity of human or animal life. The source of outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles engines and trains. Outdoor noise is summarized by the word environmental noise. Poor urban planning may give rise to noise pollution, side-by-side industrial and residential buildings can result in noise pollution in the residential areas. Documented problems associated with urban environment noise go back as far as Ancient Rome. Noise from roadways and other urban factors can be mitigated by urban planning and better design of roads.

Outdoor noise can be caused by machines, construction activities, and music performances, especially in some workplaces. Noise-induced hearing loss can be caused by outside (e.g. trains) or inside (e.g. music) noise. High noise levels can contribute to cardiovascular effects in humans and an increased incidence of coronary artery disease. In animals, noise can increase the risk of death by altering predator or prey detection and avoidance, interfere with reproduction and navigation, and contribute to permanent hearing loss.

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2.2.13: HEALTH CARE CHOICES

2.2.13.1: Understanding your Health Care Choices

2.2.13.2: How to Read Health News

2.2.13.3: Health Care Choices - The Affordable Health Care Act (ACA)

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2.2.13.1: Understanding your Health Care Choices

Developing Health Literacy

The U.S. Department of Health and Human Services (HHS) defines **health literacy** as "The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions." In a recent report by the HHS, improved consumer health literacy was determined to be an important component of health communication, medical product safety, and oral health.

Health literacy includes the ability to understand instructions on prescription drug bottles, appointment slips, medical education brochures, doctor's directions and consent forms, and the ability to negotiate complex health care systems. Health literacy is not simply the ability to read. It requires a complex group of reading, listening, analytical, and decision-making skills, and the ability to apply these skills to health situations.

Health literacy varies by context and setting and is not necessarily related to years of education or general reading ability. A person who functions adequately at home or work may have marginal or inadequate literacy in a health care environment. With the move towards a more "consumer-centric" health care system as part of an overall effort to improve the quality of health care and to reduce health care costs, individuals need to take an even more active role in health care related decisions. To accomplish this people need strong health information skills.

Skills Needed for Health Literacy

Patients are often faced with complex information and treatment decisions. Some of the specific tasks patients are required to carry out may include:

- evaluating information for credibility and quality,
- analyzing relative risks and benefits,
- calculating dosages,
- interpreting test results, or
- locating health information.

In order to accomplish these tasks, individuals may need to be:

- visually literate (able to understand graphs or other visual information),
- computer literate (able to operate a computer),
- information literate (able to obtain and apply relevant information), and
- numerically or computationally literate (able to calculate or reason numerically).

Oral language skills are important as well. Patients need to articulate their health concerns and describe their symptoms accurately. They need to ask pertinent questions, and they need to understand spoken medical advice or treatment directions. In an age of shared responsibility between physician and patient for health care, patients need strong decision-making skills. With the development of the Internet as a source of health information, health literacy may also include the ability to search the Internet and evaluate websites. according to the American Medical Association, poor health literacy is "a stronger predictor of a person's health than age, income, employment status, education level, and race." In *Health Literacy: A Prescription to End Confusion*, the Institute of Medicine reports that ninety million people in the United States, nearly half the population, have difficulty understanding and using health information. As a result, patients often take medicines on erratic schedules, miss follow-up appointments, and do not understand instructions like "take on an empty stomach."

Vulnerable populations include:

- Elderly (age 65+) - Two thirds of U.S. adults age 60 and over have inadequate or marginal literacy skills, and 81% of patients age 60 and older at a public hospital could not read or understand basic materials such as prescription labels
- Minority populations
- Immigrant populations
- Low income - Approximately half of Medicare/Medicaid recipients read below the fifth grade level
- People with chronic mental and/or physical health conditions

Reasons for limited literacy skills include:

- Lack of educational opportunity - people with a high school education or lower
- Learning disabilities
- Cognitive declines in older adults
- Use it or lose it - Reading abilities are typically three to five grade levels below the last year of school completed. Therefore, people with a high school diploma, typically read at a seventh or eighth grade reading level.

The relationship between literacy and health is complex. Literacy impacts health knowledge, health status, and access to health services. Health status is influenced by several related socioeconomic factors. Literacy impacts income level, occupation, education, housing, and access to medical care. The poor and illiterate are more likely to work under hazardous conditions or be exposed to environmental toxins.

Economic Impact of Low Health Literacy

In addition to the effects of low health literacy on the individual patient, there are economic consequences of low health literacy to society. After adjusting for health status, education level, socioeconomic status, and other demographics factors, people with low functional literacy have less ability to care for chronic conditions and use more health care services.

Why Does Health Literacy Matter?

Every day, people confront situations that involve life-changing decisions about their health. These decisions are made in places such as grocery and drug stores, workplaces, playgrounds, doctors' offices, clinics and hospitals, and around the kitchen table. Obtaining, communicating, processing, and understanding health information and services are essential steps in making appropriate health decisions; however, research indicates that today's health information is presented in ways that are not usable by most adults. "Limited health literacy" occurs when people can't find and use the health information and services they need.

- Nearly 9 out of 10 adults have difficulty using the everyday health information that is routinely available in our healthcare facilities, retail outlets, media and communities.
- Without clear information and an understanding of the information's importance, people are more likely to skip necessary medical tests, end up in the emergency room more often, and have a harder time managing chronic diseases like diabetes or high blood pressure.

Who Does Limited Health Literacy Affect? Who is affected?

People of all ages, races, incomes, and education levels can find it difficult to obtain, communicate, process and understand health information and services. Literacy skills are only a part of health literacy. Even people with strong reading and writing skills can face health literacy challenges when:

- They are not familiar with medical terms or how their bodies work.
- They have to interpret or calculate numbers or risks that could have immediate effects on their health and safety.
- They are voting on a critical local issue affecting the community's health and are relying on unfamiliar technical information.
- They are diagnosed with a serious illness and are scared or confused.
- They have health conditions that require complicated self-care.

Health Promotion and Self Care

Ideally we adopt behaviors and practices that promote health and prevent chronic disease. Through education and health promotion we learn behaviors and practices to manage our own basic health care. Health promotion involves education, policy, and support that helps us to make health choices and promote positive behavior and self-care. Self-care and health promotion involve the following:

- health prevention practices, which help limit our need for formal interventions; we manage minor health concerns informally using self-care.
- primary prevention such as brushing our teeth, breast and testicular self exam, vaccinations, etc.
- managing uncomplicated injuries or illnesses with self diagnosis and treatment
- using home remedies and OTC drugs.

Self Care versus Formal Care

The World Health Organizations defines self-care in the following way:

> 'Self-Care is what people do for themselves to establish and maintain health, and to prevent and deal with illness. It is a broad concept encompassing hygiene (general and personal), nutrition (type and quality of food eaten), lifestyle (sporting activities, leisure etc), environmental factors (living conditions, social habits, etc.) socio-economic factors (income level, cultural beliefs, etc.) and self-medication.'

Self-care improves as we come to know our body and pay attention to the signals it gives us so we can take appropriate actions. Self-care helps us rely less on formal medical intervention. When we are more knowledgeable about our body and health issues we are better able to make better decisions about self-care and seeking formal care.

Examples of self-care are:

a. Recognition of symptoms or conditions that occur frequently but may not require a doctor's visit
b. Performing monthly breast and testicular self-exams
c. Learning first aid for common, uncomplicated injuries and conditions
d. Checking blood pressure, pulse, and temperature
e. Using home pregnancy tests, ovulation kits and HIV test kits
f. Doing periodic checks for blood cholesterol
g. Using home stool test kits for early colon cancer detection
h. Using self-help books, tapes, websites, and videos
i. Benefiting from relaxation techniques, including meditation, nutrition, rest, and exercise

Formal Care: Health care professionals often need to be consulted if there is a serious accident or injury, severe trauma, sudden onset of symptoms, or if any symptoms are unusual and recur over time. Formal Care is accessing a local provider through a community or privatized hospital, clinic or medical practice. Formal Care is best and most effective when you are an active participant and informed. A partnership between the patient and health care provider is desirable. The goal should be an exchange of information and coordination on interventions and solutions. Formal Care is enhanced through *health literacy*.

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2.2.13.2: How to Read Health News

If you've just read a health-related headline that has caused you to spit out your morning coffee ("Coffee causes cancer" usually does the trick), it's always best to follow the Blitz slogan: "Keep Calm and Carry On". On reading further, you'll often find the headline has left out something important, such as, "Injecting five rats with really highly concentrated coffee solution caused some changes in cells that might lead to tumors eventually. (Study funded by The Association of Tea Marketing)".

The most important rule to remember is: don't automatically believe the headline. It is there to draw you into buying the paper and reading the story. Would you read an article called, "Coffee pretty unlikely to cause cancer, but you never know"? Probably not.

To avoid spraying your newspaper with coffee in the future, you need to analyze the article to see what it says about the research it is reporting on. Consider the following questions to help you figure out which articles you're going to believe and which you're not.

Does the article support its claims with scientific research?

Your first concern should be the research behind the news article. If an article touts a treatment or some aspect of your lifestyle that is supposed to prevent or cause a disease, but doesn't give any information about the scientific research behind it, then treat it with a lot of caution. The same applies to research that has yet to be published.

Is the article based on a conference abstract?

Another area for caution is if the news article is based on a conference abstract. Research presented at conferences is often at a preliminary stage and usually hasn't been scrutinized by experts in the field. Also, conference abstracts rarely provide full details about methods, making it difficult to judge how well the research was conducted. For these reasons, articles based on conference abstracts should be no cause for alarm. Don't panic or rush off to your doctor.

Was the research in humans?

Quite often, the "miracle cure" in the headline turns out to have only been tested on cells in the laboratory or on animals. These stories are regularly accompanied by pictures of humans, which creates the illusion that the miracle cure came from human studies. Studies in cells and animals are crucial first steps and should not be undervalued. However, many drugs that show promising results in cells in laboratories don't work in animals, and many drugs that show promising results in animals don't work in humans. If you read a headline about a drug or food "curing" rats, there is a chance it might cure humans in the future, but unfortunately a larger chance that it won't. So there is no need to start eating large amounts of the "wonder food" featured in the article.

How many people did the research study include?

In general, the larger a study the more you can trust its results. Small studies may miss important differences because they lack statistical "power", and are also more susceptible to finding things (including things that are wrong) purely by chance.

You can visualize this by thinking about tossing a coin. We know that if we toss a coin the chance of getting a head is the same as that of getting a tail – 50/50. However, if we didn't know this and we tossed a coin four times and got three heads and one tail, we might conclude that getting heads was more likely than tails. But this chance finding would be wrong. If we tossed the coin 500 times - i.e. gave the experiment more "power" - we'd be more likely to get a heads/tails ratio close to 50/50, giving us a better idea of the true odds. When it comes to sample sizes, bigger is usually better. So when you see a study conducted in a handful of people, treat it with caution.

Did the study have a control group?

There are many different types of studies appropriate for answering different types of questions. If the question being asked is about whether a treatment or exposure has an effect or not, then the study needs to have a control group. A control group allows the researchers to compare what happens to people who have the treatment/exposure with what happens to people who don't. If the study doesn't have a control group, then it's difficult to attribute results to the treatment or exposure with any level of certainty.

Also, it's important that the control group is as similar to the treated/exposed group as possible. The best way to achieve this is to randomly assign some people to be in the treated/ exposed group and some people to be in the control group. This is what happens in a randomized controlled trial (RCT) and is why RCTs are considered the "gold standard" for testing the effects of treatments and exposures. So when reading about a drug, food or treatment that is supposed to have an effect, you want to look for evidence of a control group, and ideally, evidence that the study was an RCT. Without either, retain some healthy skepticism.

Did the study actually assess what's in the headline?

This one is a bit tricky to explain without going into a lot of detail about things called proxy outcomes. Instead, bear in mind this key point: the research needs to have examined what is being talked about in the headline and article. (Somewhat alarmingly, this isn't always the case.)

For example, you might read a headline that claims, "Tomatoes reduce the risk of heart attacks". What you need to look for is evidence that the study actually looked at heart attacks. You might instead see that the study found that tomatoes reduce blood pressure. This means that someone has extrapolated that tomatoes must also have some impact on heart attacks, as high blood pressure is a risk factor for heart attacks. Sometimes these extrapolations will prove to be true, but other times they won't. Therefore if a news story is focusing on a health outcome that was not examined by the research, treat it with a pinch of salt.

Who paid for and conducted the study?

This is a somewhat cynical point, but one that's worth making. The majority of trials today are funded by manufacturers of the product being tested – be it a drug, vitamin cream or foodstuff. This means they have a vested interest in the results of the trial, which can potentially affect what the researchers find and report in all sorts of conscious and unconscious ways. This is not to say that all manufacturer-sponsored trials are unreliable. Many are very good. However, it's worth seeing who funded the study to sniff out a potential conflict of interest.

Should you "shoot the messenger"?

Overblown claims might not necessarily be due to the news reporting itself. Although journalists can sometimes misinterpret a piece of research, at other times the researchers (or other interested parties) over-extrapolate, making claims their research doesn't support. These claims are then repeated by the journalists.

Given that erroneous claims can come from a variety of places, don't automatically assume they come from the journalist. Instead, use the questions above to figure out for yourself what you're going to believe and what you're not.

How and Where to Find Reliable Health Information on the Internet

The Healthfinder website (http://www.healthfinder.gov) is the federal government's gateway for reliable information from U.S. government agencies and other organizations. The site displays selected resources of consumer health and human services information. Here is an example of a source that has been reviewed and found reliable and credible: MedlinePlus Guide to Healthy Web Surfing

The Social Life of Health Information

Where do you go for health information? According to the Pew Research Center, most people seek information from doctors, nurses, and other health professionals first but the Internet and peers are also a significant source.

The Pew Research Center conducted a telephone survey in 2010 to find out how Americans are getting their health information.

"The survey finds that, of the 74% of adults who use the internet:

- 80% of internet users have looked online for information about any of 15 health topics such as a specific disease or treatment. This translates to 59% of all adults.
- 34% of internet users, or 25% of adults, have read someone else's commentary or experience about health or medical issues on an online news group, website, or blog.
- 25% of internet users, or 19% of adults, have watched an online video about health or medical issues.
- 24% of internet users, or 18% of adults, have consulted online reviews of particular drugs or medical treatments.
- 18% of internet users, or 13% of adults, have gone online to find others who might have health concerns similar to theirs.
- 16% of internet users, or 12% of adults, have consulted online rankings or reviews of doctors or other providers.
- 15% of internet users, or 11% of adults, have consulted online rankings or reviews of hospitals or other medical facilities.

Of those who use social network sites (62% of adult internet users, or 46% of all adults):

- 23% of social network site users, or 11% of adults, have followed their friends' personal health experiences or updates on the site.
- 17% of social network site users, or 8% of adults, have used social networking sites to remember or memorialize other people who suffered from a certain health condition.
- 15% of social network site users, or 7% of adults, have gotten any health information on the sites."

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2.2.13.3: Health Care Choices - The Affordable Health Care Act (ACA)

Health care choices in the United States can be broadly divided into two main categories: public health care (government-funded) and private health care (privately funded). The two main publicly funded health care programs are Medicare, which provides health services to people over 65 years old as well as people who meet other standards for disability, and Medicaid, which provides services to people with very low incomes who meet other eligibility requirements. Other government-funded programs include service agencies focused on Native Americans (the Indian Health Service), Veterans (the Veterans Health Administration), and children (the Children's Health Insurance Program).

Health care in the United States is a complex issue, and it will remain complex with the continued enactment of the Patient Protection and Affordable Care Act (PPACA). This Act, sometimes called "ObamaCare" for its most noted advocate, former President Barack Obama, represents large-scale federal reform of the United States' health care system. It expands eligibility to programs like Medicaid and CHIP, helps guarantee insurance coverage for people with pre-existing conditions, and establishes regulations to make sure that the premium funds collected by insurers and care providers go directly to medical care. It also includes an individual mandate, which requires everyone to have insurance coverage or pay a penalty. A series of provisions, including significant subsidies, are intended to address the discrepancies in income that are currently contributing to high rates of uninsurance and underinsurance.

How much do you know the Affordable Health Care Act?

You need to be fully informed about what the PPACA provides. Here is a list of key changes to the United States health care system as a result of the PPACA:

- Insurers are prohibited from denying coverage to individuals due to pre-existing conditions.
- Premiums must be the same for everyone of a given age, regardless of preexisting conditions.
- Dependents are permitted to remain on their parents' insurance plan until their 26th birthday.
- Individuals are required to buy health insurance or pay a penalty (known as the individual mandate). This applies to everyone not covered by an employer sponsored health plan, Medicaid, Medicare or other public insurance programs (such as Tricare). Also exempt were those facing a financial hardship or who were members in a recognized religious sect exempted by the Internal Revenue Service.
- Essential health benefits must be provided. The National Academy of Medicine defines the law's "essential health benefits" as "ambulatory patient services; emergency services; hospitalization; maternity and newborn care; mental health and substance use disorder services, including behavioral health treatment; prescription drugs; rehabilitative services and devices; laboratory services; preventive and wellness services and chronic disease management; and pediatric services, including oral and vision care" and others rated Level A or B by the U.S. Preventive Services Task Force. In determining what would qualify as an essential benefit, the law required that standard benefits should offer at least that of a "typical employer plan".
- Additional preventive care and screenings for women. This includes Well-woman visits, gestational diabetes screening for pregnant women, domestic and interpersonal violence screening and counseling, FDA-approved contraception methods, and contraceptive education and counseling, breastfeeding support, supplies, and counseling, HPV DNA testing, for women 30 or older, sexually transmitted infections counseling, and HIV screening and counseling for sexually active women. This mandate applies to all employers and educational institutions except for religious organizations. These regulations were included on the recommendations of the Institute of Medicine.
- Annual and lifetime coverage caps on essential benefits were banned.
- Prohibits insurers from dropping policyholders when they get sick.
- All health policies sold in the United States must provide an annual maximum out of pocket (MOOP) payment cap for an individual's or family's medical expenses (excluding premiums). After the MOOP payment cap is reached, the insurer must pay all remaining costs.
- Preventive care, vaccinations and medical screenings cannot be subject to co-payments, co-insurance or deductibles. Specific examples of covered services include: mammograms and colonoscopies, wellness visits, gestational diabetes screening, HPV testing, STI counseling, HIV screening and counseling, contraceptive methods, breastfeeding support/ supplies and domestic violence screening and counseling.
- The law established four tiers of coverage: bronze, silver, gold and platinum. All categories offer the essential health benefits.

The categories vary in their division of premiums and out-of-pocket costs: bronze plans have the lowest monthly premiums and highest out-of-pocket costs, while platinum plans are the reverse. The percentages of health care costs that plans are expected to cover through premiums (as opposed to out-of-pocket costs) are, on average: 60% (bronze), 70% (silver), 80% (gold), and 90% (platinum).

- Insurers are required to implement an appeals process for coverage determination and claims on all new plans.
- Employer mandate. Businesses that employ 50 or more people but do not offer health insurance to their full-time employees pay a tax penalty if the government has subsidized a full-time employee's healthcare through tax deductions or other means. This is commonly known as the employer mandate. This provision was included to encourage employers to continue providing insurance once the exchanges began operating. Approximately 44% of the population was covered directly or indirectly through an employer.
- Insurers must spend at least 80–85% of premium dollars on health costs; rebates must be issued to policyholders if this is violated.

Many Americans worry that governmental oversight of health care represents a federal overstepping of constitutional guarantees of individual freedom. Others welcome a program that they believe will make health care accessible and affordable to everyone.

Watch this tour of the HealthCare.gov website to find out more.

Covered California

In California, the health care marketplace is called Covered California. This is where Californians can shop and compare health insurance plans under the Patient Protection and Affordable Care Act. The Department of Health Care Services sponsors Covered California to help health insurance shoppers get the coverage and care that is right for them. Visit CoveredCA.com for more information.

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2.2.13.4: Health Insurance - Key Terms

Part of health literacy is understanding key health insurance terms. This will allow for educated decisions when choosing a health insurance plan. Below are some basic key terms that are helpful to understand when researching health insurance plans:

In-Network Providers: health care providers who are contracted with your health insurance plan to provide services at a contracted or discounted rate.

Out-of-Network Providers: health care providers who are not contracted with your health insurance plan. Out-of-network coinsurance usually costs you more than in-network coinsurance because there is no contracted or discounted rate.

Exclusive Provider Organization (EPO): A managed care plan where services are covered only if you use doctors, specialists, or hospitals in the plan's network (except in an emergency).

Health Maintenance Organization (HMO): A type of health insurance plan that usually limits coverage to care from doctors who work for or contract with the HMO. It generally won't cover out-of-network care except in an emergency. An HMO may require you to live or work in its service area to be eligible for coverage. HMOs often provide integrated care and focus on prevention and wellness.

Point of Service (POS): A type of plan where you pay less if you use doctors, hospitals, and other health care providers that belong to the plan's network. POS plans require you to get a referral from your primary care doctor in order to see a specialist.

Preferred Provider Organization (PPO): A type of health plan where you pay less if you use providers in the plan's network. You can use doctors, hospitals, and providers outside of the network without a referral for an additional cost.

Premium: The amount paid for your health insurance every month. In addition to your premium, you usually have to pay other costs for your health care, including a deductible, copayments, and coinsurance.

Deductible: The amount you pay for covered health care services before your insurance plan starts to pay. With a $2,000 deductible, for example, you pay the first $2,000 of covered services yourself.

Many health insurance plans cover certain services such as check-ups, disease management, and preventive services before the deductible has been met. Family plans often have both an individual deductible, which applies to each person, and a family deductible, which applies to all family members.

Generally, plans with lower monthly premiums have higher deductibles. Plans with high monthly premiums usually have lower deductibles. Those who use their health insurance often would probably be wise to choose a plan with a slightly higher premium but a lower deductible, which may save money in the long-term.

After paying the deductible, you will usually pay only a copayment or coinsurance for covered services. Your insurance company pays the rest.

Copayment: A fixed amount ($20, for example) you pay for a covered health care service after you've paid your deductible. Let's say your health insurance plan's allowable cost for a doctor's office visit is $100. Your copayment for a doctor visit is $20. If you've paid your deductible: You pay $20, usually at the time of the visit. If you haven't met your deductible: You pay $100, the full allowable amount for the visit.

Copayments (sometimes called "copays") can vary for different services within the same plan, like drugs, lab tests, and visits to specialists.

Coinsurance: The percentage of costs of a covered health care service you pay (20%, for example) after you've paid your deductible. Let's say your health insurance plan's allowed amount for an office visit is $100 and your coinsurance is 20%. If you've paid your deductible: You pay 20% of $100, or $20. The insurance company pays the rest. If you haven't met your deductible: You pay the full allowed amount, $100.

Out-of-pocket maximum: The most you have to pay for covered services in a plan year. After you spend this amount on deductibles, copayments, and coinsurance, your health plan pays 100% of the costs of covered benefits.

Although this is not an all-encompassing list of key terms for health insurance, these are some of the terms you are likely to encounter when shopping for health insurance.

More in-depth information can be found at Healthcare.gov/glossary.

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2.2.13.5: Choices in Medical Care

Choosing the right medical professional can be difficult and will vary depending on your day-to-day health status. Below is a brief list of medical professionals you can visit for a variety of health issues:

Primary Care Practitioner (PCP) is a medical professional whom you can go to for routine ailments, preventive care, general medical advice, and appropriate referrals. The primary care provider for most people is a medically trained family practitioner, an internist, or a pediatrician.

Conventional or Allopathic medicine, or traditional Western medical practice, is based on scientifically validated methods and procedures and involves the application of the scientific method; cause and effect.

Complementary medicine and alternative medicine; unconventional practices used alongside or instead of conventional medicine. Examples include chiropractic's, massage therapy, acupuncture, acupressure, and herbal remedies.

Other PCP include

Osteopath: general practitioner who receives medical training similar to MD , but is more involved in musculoskeletal focus than internal focus.

Nurse practitioners are professional nurses with advanced training obtained through either a master's degree program or specialized nurse practitioner program. They have the authority and training to conduct diagnostic tests and prescribe medications (in some states). Nurses may also earn the clinical doctor of nursing degree (ND), a doctorate of nursing science (DNS or DNSc), or a research-based doctorate (PhD) in nursing.

Physician assistants must work under the supervision of a physician and are legally permitted to prescribe drugs in all states.

Other practitioners:

Nurses are highly trained and strictly regulated practitioners who provide a wide range of services including patient education, counseling, community health and disease prevention information, and administration of medications.

Licensed registered nurses (RN) have completed either a 4-year program leading to a Bachelor of Science degree (BSN) or a 2-year associate degree program.

Licensed practical or vocational nurses (LPN or LVN) have completed a one- to two-year training program.

Ophthalmologist holds a medical degree and can perform surgery. An optometrist evaluates visual problems but is not a trained physician.

Podiatrist: specialize in care of the foot; extensive training similar to MD; can prescribe and perform surgery.

Dentists are specialists who diagnose and treat diseases of the teeth, gums, and oral cavity. Orthodontists are specialists in the alignment of teeth. Oral surgeons perform surgical procedures to correct problems of the mouth, face, and jaw.

Questions are the Answer

Whichever health care professional you choose to visit, your health depends on good communication. Asking questions and providing information to your doctor and other care providers can improve your care. Quality health care is a team effort. You play an important role. One of the best ways to communicate with your doctor and health care team is by asking questions. Because time is limited during medical appointments, you will feel less rushed if you prepare your questions before your appointment.

- Your doctor wants your questions.
- Doctors know a lot about a lot of things, but they don't always know everything about you or what is best for you.

- Your questions give your doctor and health care team important information about you, such as your most important health care concerns.
- That is why they need you to speak up.

Health Facilities

Health facilities are places that provide health care. They include hospitals, clinics, outpatient care centers and specialized care centers, such as birthing centers and psychiatric care centers. When you choose a health facility, you might want to consider

- How close it is
- Whether your health insurance will pay for services there
- Whether your health care provider can treat you there
- The quality of the facility

Quality is important. Some facilities do a better job than others. One way to learn about the quality of a facility is to look at report cards developed by state and consumer groups.

Look for a hospital that:

- Is accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO).
- Is rated highly by the State and by consumer groups or other organizations.
- Has a lot of experience and success in treating your condition.
- Monitors quality of care and works to improve quality.

In choosing a nursing home or other long-term care facility, look for one that:

- Has been found by State agencies and other groups to provide quality care.
- Provides a level of care, including staff and services, that will meet your needs.

Choosing the right medications: Brand Name vs. Generic

You may need to take medicines every day, or only once in a while. Either way, you want to make sure that the medicines are safe and will help you get better. In the United States, the Food and Drug Administration is in charge of assuring the safety and effectiveness of both prescription and over-the-counter medicines.

Even safe drugs can cause unwanted side effects or interactions with food or other medicines you may be taking. They may not be safe during pregnancy. To reduce the risk of reactions and make sure that you get better, it is important for you to take your medicines correctly.

Understanding Generic Drugs

Generic drugs are important options that allow greater access to health care for all Americans. They are copies of brand-name drugs and are the same as those brand name drugs in dosage form, safety, strength, route of administration, quality, performance characteristics and intended use.

Health care professionals and consumers can be assured that FDA approved generic drug products have met the same rigid standards as the innovator drug. All generic drugs approved by FDA have the same high quality, strength, purity and stability as brand-name drugs. And, the generic manufacturing, packaging, and testing sites must pass the same quality standards as those of brand name drugs.

Generic Drugs: Questions and Answers

What are generic drugs?

A generic drug is identical -- or bioequivalent -- to a brand name drug in dosage form, safety, strength, route of administration, quality, performance characteristics and intended use. Although generic drugs are chemically identical to their branded counterparts, they are typically sold at substantial discounts from the branded price. According to the Congressional Budget Office, generic drugs save consumers an estimated $8 to $10 billion a year at retail pharmacies. Even more billions are saved

when hospitals use generics.

Are generic drugs as effective as brand-name drugs?

Yes. A generic drug is the same as a brand-name drug in dosage, safety, strength, quality, the way it works, the way it is taken and the way it should be used.

FDA requires generic drugs have the same high quality, strength, purity and stability as brand-name drugs.

Not every brand-name drug has a generic drug. When new drugs are first made they have drug patents. Most drug patents are protected for 20 years. The patent, which protects the company that made the drug first, doesn't allow anyone else to make and sell the drug. When the patent expires, other drug companies can start selling a generic version of the drug. But, first, they must test the drug and the FDA must approve it.

Creating a drug costs lots of money. Since generic drug makers do not develop a drug from scratch, the costs to bring the drug to market are less; therefore, generic drugs are usually less expensive than brand-name drugs. But, generic drug makers must show that their product performs in the same way as the brand-name drug.

How are generic drugs approved?

Drug companies must submit an abbreviated new drug application (ANDA) for approval to market a generic product. The Drug Price Competition and Patent Term Restoration Act of 1984, more commonly known as the Hatch-Waxman Act, made ANDAs possible by creating a compromise in the drug industry. Generic drug companies gained greater access to the market for prescription drugs, and innovator companies gained restoration of patent life of their products lost during FDA's approval process.

New drugs, like other new products, are developed under patent protection. The patent protects the investment in the drug's development by giving the company the sole right to sell the drug while the patent is in effect. When patents or other periods of exclusivity expire, manufacturers can apply to the FDA to sell generic versions.

The ANDA process does not require the drug sponsor to repeat costly animal and clinical research on ingredients or dosage forms already approved for safety and effectiveness. This applies to drugs first marketed after 1962.

What standards do generic drugs have to meet?

Health professionals and consumers can be assured that FDA approved generic drugs have met the same rigid standards as the innovator drug. To gain FDA approval, a generic drug must:

- contain the same active ingredients as the innovator drug (inactive ingredients may vary)
- be identical in strength, dosage form, and route of administration
- have the same use indications
- be bioequivalent
- meet the same batch requirements for identity, strength, purity, and quality
- be manufactured under the same strict standards of FDA's good manufacturing practice regulations required for innovator products

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2.2.13.6: Alternative Medical Practices

Complementary and alternative medicine (CAM) is the term for medical products and practices that are not part of standard care. Standard care is what medical doctors, doctors of osteopathy and allied health professionals, such as registered nurses and physical therapists, practice. Alternative medicine means treatments that you use instead of standard ones. Complementary medicine means nonstandard treatments that you use along with standard ones. Examples of CAM therapies are acupuncture, chiropractic and herbal medicines.

The claims that CAM treatment providers make about their benefits can sound promising. However, researchers do not know how safe many CAM treatments are or how well they work. Studies are underway to determine the safety and usefulness of many CAM practices.

What Is Complementary and Alternative Medicine?

Many Americans use complementary and alternative medicine (CAM) in pursuit of health and well-being. The 2007 National Health Interview Survey (NHIS), which included a comprehensive survey of CAM use by Americans, showed that approximately 38 percent of adults use CAM.

Defining CAM

Defining CAM is difficult, because the field is very broad and constantly changing. NCCAM defines CAM as a group of diverse medical and health care systems, practices, and products that are not generally considered part of conventional medicine. Conventional medicine (also called Western or allopathic medicine) is medicine as practiced by holders of M.D. (medical doctor) and D.O. (doctor of osteopathic medicine) degrees and by allied health professionals, such as physical therapists, psychologists, and registered nurses. The boundaries between CAM and conventional medicine are not absolute, and specific CAM practices may, over time, become widely accepted.

"Complementary medicine" refers to use of CAM together with conventional medicine, such as using acupuncture in addition to usual care to help lessen pain. Most use of CAM by Americans is complementary. "Alternative medicine" refers to use of CAM in place of conventional medicine. "Integrative medicine" combines treatments from conventional medicine and CAM for which there is some high-quality evidence of safety and effectiveness. It is also called integrated medicine.

Types of CAM

CAM practices are often grouped into broad categories, such as natural products, mind and body medicine, and manipulative and body-based practices. Although these categories are not formally defined, they are useful for discussing CAM practices. Some CAM practices may fit into more than one category.

Natural Products

This area of CAM includes use of a variety of herbal medicines (also known as botanicals), vitamins, minerals, and other "natural products." Many are sold over the counter as dietary supplements. (Some uses of dietary supplements—e.g., taking a multivitamin to meet minimum daily nutritional requirements or taking calcium to promote bone health—are not thought of as CAM.)

CAM "natural products" also include probiotics—live microorganisms (usually bacteria) that are similar to microorganisms normally found in the human digestive tract and that may have beneficial effects. Probiotics are available in foods (e.g., yogurts) or as dietary supplements. They are not the same thing as prebiotics — nondigestible food ingredients that selectively stimulate the growth and/or activity of microorganisms already present in the body.

Interest in and use of CAM natural products have grown considerably in the past few decades. The 2007 NHIS found that 17.7 percent of American adults had used a nonvitamin/nonmineral natural product. These products were the most popular form of CAM among both adults and children. The most commonly used product among adults was fish oil/omega 3s (reported by 37.4 percent of all adults who said they used natural products); popular products for children included echinacea (37.2 percent) and fish oil/omega 3s (30.5 percent).

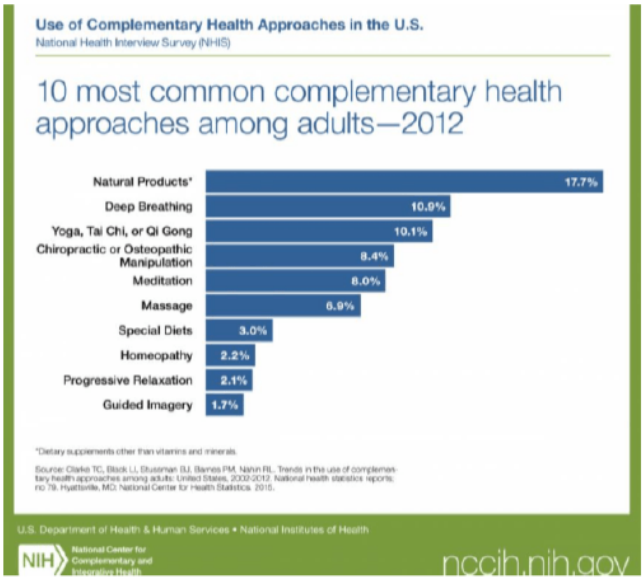


Figure 2.2.13.6.1. NIH

Mind and Body Medicine

Mind and body practices focus on the interactions among the brain, mind, body, and behavior, with the intent to use the mind to affect physical functioning and promote health. Many CAM practices embody this concept—in different ways.

- Meditation techniques include specific postures, focused attention, or an open attitude toward distractions. People use meditation to increase calmness and relaxation, improve psychological balance, cope with illness, or enhance overall health and well-being.
- The various styles of yoga used for health purposes typically combine physical postures, breathing techniques, and meditation or relaxation. People use yoga as part of a general health regimen, and also for a variety of health conditions.
- Acupuncture is a family of procedures involving the stimulation of specific points on the body using a variety of techniques, such as penetrating the skin with needles that are then manipulated by hand or by electrical stimulation. It is one of the key components of traditional Chinese medicine, and is among the oldest healing practices in the world.

Other examples of mind and body practices include **deep-breathing exercises, guided imagery, hypnotherapy, progressive relaxation, qi gong,** and **tai chi**.

Historical note: The concept that the mind is important in the treatment of illness is integral to the healing approaches of traditional Chinese medicine and Ayurvedic medicine, dating back more than 2,000 years. Hippocrates also noted the moral and spiritual aspects of healing and believed that treatment could occur only with consideration of attitude, environmental influences, and natural remedies.

Current use: Several mind and body approaches ranked among the top 10 CAM practices reported by adults in the 2007 NHIS. For example, the survey found that 12.7 percent of adults had used deep-breathing exercises, 9.4 percent had practiced meditation, and 6.1 percent had practiced yoga; use of these three CAM practices had increased significantly since the previous (2002) NHIS. Progressive relaxation and guided imagery were also among the top 10 CAM therapies for adults; deep breathing and yoga ranked high among children. Acupuncture had been used by 1.4 percent of adults and 0.2 percent of children. Acupuncture is considered to be a part of mind and body medicine, but it is also a component of energy medicine, manipulative and body-based practices, and traditional Chinese medicine.

Manipulative and Body-Based Practices

Manipulative and body-based practices focus primarily on the structures and systems of the body, including the bones and joints, soft tissues, and circulatory and lymphatic systems. Two commonly used therapies fall within this category:

- Spinal manipulation is performed by chiropractors and by other health care professionals such as physical therapists, osteopathic physicians, and some conventional medical doctors. Practitioners use their hands or a device to apply a

controlled force to a joint of the spine, moving it beyond its passive range of motion; the amount of force applied depends on the form of manipulation used. Spinal manipulation is among the treatment options used by people with low-back pain - a very common condition that can be difficult to treat.
- The term massage therapy encompasses many different techniques. In general, therapists press, rub, and otherwise manipulate the muscles and other soft tissues of the body. People use massage for a variety of health-related purposes, including to relieve pain, rehabilitate sports injuries, reduce stress, increase relaxation, address anxiety and depression, and aid general well-being.

Other CAM Practices

CAM also encompasses **movement therapies**—a broad range of Eastern and Western movement-based approaches used to promote physical, mental, emotional, and spiritual well-being. Examples include Feldenkrais method, Alexander technique, Pilates, Rolfing Structural Integration, and Trager psychophysical integration. According to the 2007 NHIS, 1.5 percent of adults and 0.4 percent of children used movement therapies.

Practices of traditional healers can also be considered a form of CAM. Traditional healers use methods based on indigenous theories, beliefs, and experiences handed down from generation to generation. A familiar example in the United States is the Native American healer/medicine man. The 2007 NHIS found that 0.4 percent of adults and 1.1 percent of children had used a traditional healer (usage varied for the seven specific types of healers identified in the survey).

Some CAM practices involve manipulation of various energy fields to affect health. Such fields may be characterized as veritable (measurable) or putative (yet to be measured). Practices based on veritable forms of energy include those involving electromagnetic fields (e.g., magnet therapy and light therapy). Practices based on putative energy fields (also called biofields) generally reflect the concept that human beings are infused with subtle forms of energy; qi gong, Reiki, and healing touch are examples of such practices. The 2007 NHIS found relatively low use of putative energy therapies. Only 0.5 percent of adults and 0.2 percent of children had used energy healing/Reiki (the survey defined energy healing as the channeling of healing energy through the hands of a practitioner into the client's body).

Finally, whole medical systems, which are complete systems of theory and practice that have evolved over time in different cultures and apart from conventional or Western medicine, may be considered CAM. Examples of ancient whole medical systems include Ayurvedic medicine and traditional Chinese medicine. More modern systems that have developed in the past few centuries include homeopathy and naturopathy. The 2007 NHIS asked about the use of Ayurveda, homeopathy, and naturopathy. Although relatively few respondents said they had used Ayurveda or naturopathy, homeopathy ranked 10th in usage among adults (1.8 percent) and 5th among children (1.3 percent).

Health Fraud

You have probably seen ads for miracle cures - a supplement to cure cancer, a diet to cure diabetes. But remember - if it sounds too good to be true, then it probably is. Health fraud involves selling drugs, devices, foods or cosmetics that have not been proven effective. At best, these scams don't work. At worst, they're dangerous. They also waste money, and they might keep you from getting the treatment you really need. Health scams often target older people. Most victims in the United States are older than 65.

To protect yourself

- Question claims of miracle cures or breakthroughs
- Know that newspapers, magazines, and radio and TV stations do not have to make sure that the ads they run are true
- Find out about products before you buy them
- Don't let salespeople force you into making snap decisions
- Check with your doctor before taking products

Beware of Health Scams

You see the ads everywhere these days — “Smart Drugs” for long life or “Arthritis Aches and Pains Disappear Like Magic!” or even statements claiming, “This treatment cured my cancer in 1 week.” It’s easy to understand the appeal of these promises. But there is still plenty of truth to the old saying, “If it sounds too good to be true, it probably is!”

Health scams and the marketing of unproven cures have been around for many years. Today, there are more ways than ever to

sell these untested products. In addition to TV, radio, magazines, newspapers, infomercials, mail, telemarketing, and even word-of-mouth, these products are now offered over the Internet—with websites describing miracle cures and emails telling stories of overnight magic. Sadly, older people are often the target of such scams.

The problem is serious. Untested remedies may be harmful. They may get in the way of medicines prescribed by your doctor. They may also waste money. And, sometimes, using these products keeps people from getting the medical treatment they need.

False Hopes

Why do people fall for these sales pitches? Unproven remedies promise false hope. They offer cures that appear to be painless or quick. At best, these treatments are worthless. At worst, they are dangerous. Health scams prey on people who are frightened or in pain. Living with a chronic health problem is hard. It's easy to see why people might fall for a false promise of a quick and painless cure. The best way for scientists to find out if a treatment works is through a clinical trial.

These scams usually target diseases that have no cures, like diabetes, arthritis, and Alzheimer's disease.

How Can You Protect Yourself From Health Scams?

Be wary. Question what you see or hear in ads or on the Internet. Newspapers, magazines, radio, and TV stations do not always check to make sure the claims in their ads are true. Find out about a product before you buy. Don't let a salesperson talk you into making a snap decision. Check with your healthcare provider first.

- Promise a quick or painless cure
- Claim the product is made from a special, secret, or ancient formula
- Offer products and services only by mail or from one company
- Use statements or unproven case histories from so-called satisfied patients
- Claim to be a cure for a wide range of ailments
- Claim to cure a disease (such as arthritis or Alzheimer's disease) that hasn't been cured by medical science
- Promise a no-risk, money-back guarantee
- Offer an additional "free" gift or a larger amount of the product as a "special promotion"
- Require advance payment and claim there is a limited supply of the product

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2.2.13.7: Health Disparity

Despite prevention efforts, some groups of people are affected by HIV/AIDS, viral hepatitis, STI's, and TB, more than other groups of people. The occurrence of these diseases at greater levels among certain population groups more than among others is often referred to as a health disparity. Differences may occur by gender, race or ethnicity, education, income, disability, geographic location and sexual orientation among others. Social determinants of health like poverty, unequal access to health care, lack of education, stigma, and racism are linked to health disparities.

Health in the United States is a complex and often contradictory issue. One the one hand, as one of the wealthiest nations, the United States fares well in health comparisons with the rest of the world. However, the United States also lags behind almost every industrialized country in terms of providing care to all its citizens. The following sections look at different aspects of health in America.

Health by Race and Ethnicity

When looking at the social epidemiology of the United States, it is hard to miss the disparities among races. The discrepancy between African Americans and white Americans shows the gap clearly; in 2008, the average life expectancy for white males was approximately five years longer than for African American males: 75.9 compared to 70.9. An even stronger disparity was found in 2007: the infant mortality rate for African Americans was nearly twice that of white Americans at 13.2 compared to 5.6 per 1,000 live births (U.S. Census Bureau 2011). According to a report from the Henry J. Kaiser Foundation (2007), African Americans also have higher incidence of several other diseases and causes of mortality, from cancer to heart disease to diabetes. In a similar vein, it is important to note that ethnic minorities, including Mexican Americans and Native Americans, also have higher rates of these diseases and causes of mortality than whites. Lisa Berkman (2009) notes that this gap started to narrow during the Civil Rights movement in the 1960s, but it began widening again in the early 1980s.

What accounts for these perpetual disparities in health among different ethnic groups?

Much of the answer lies in the level of health care that these groups receive. The National Healthcare Disparities Report (2010) shows that even after adjusting for insurance differences, racial and ethnic minority groups receive poorer quality of care and less access to care than dominant groups. The Report identified these racial inequalities in care: Black Americans, American Indians, and Alaskan Natives received inferior care than Caucasian Americans for about 40 percent of measures Asian ethnicities received inferior care for about 20 percent of measures Among whites, Hispanic whites received 60 percent inferior care of measures compared to non-Hispanic whites (Agency for Health Research and Quality 2010). When considering access to care, the figures were comparable.

Health by Socioeconomic Status

Discussions of health by race and ethnicity often overlap with discussions of health by socioeconomic status, since the two concepts are intertwined in the United States. As the Agency for Health Research and Quality (2010) notes, "racial and ethnic minorities are more likely than non-Hispanic whites to be poor or near poor," so many of the data pertaining to subordinate groups is also likely to be pertinent to low socioeconomic groups. Marilyn Winkleby and her research associates (1992) state that "one of the strongest and most consistent predictors of a person's morbidity and mortality experience is that person's socioeconomic status (SES). This finding persists across all diseases with few exceptions, continues throughout the entire lifespan, and extends across numerous risk factors for disease."It is important to remember that economics are only part of the SES picture; research suggests that education also plays an important role. Phelan and Link (2003) note that many behavior-influenced diseases like lung cancer (from smoking), coronary artery disease (from poor eating and exercise habits), and AIDS initially were widespread across SES groups. However, once information linking habits to disease was disseminated, these diseases decreased in high SES groups and increased in low SES groups. This illustrates the important role of education initiatives regarding a given disease, as well as possible inequalities in how those initiatives effectively reach different SES groups.

Health by Gender

Women are affected adversely both by unequal access to and institutionalized sexism in the health care industry. According a recent report from the Kaiser Family Foundation, women experienced a decline in their ability to see needed specialists between 2001 and 2008. In 2008, one quarter of females questioned the quality of her health care (Ranji and Salganico 2011). In this report, we also see the explanatory value of intersection theory. Feminist sociologist Patricia Hill Collins developed this theory, which suggests we cannot separate the effects of race, class, gender, sexual orientation, and other attributes. Further examination of the lack of confidence in the health care system by women, as identified in the Kaiser study, found, for example, women categorized as low income were more likely (32 percent compared to 23 percent) to express concerns about health care quality, illustrating the multiple layers of disadvantage caused by race and sex.

We can see an example of institutionalized sexism in the way that women are more likely than men to be diagnosed with certain kinds of mental disorders. Psychologist Dana Becker notes that 75 percent of all diagnoses of Borderline Personality Disorder (BPD) are for women according to the Diagnostic Statistical Manual of Mental Disorders. This diagnosis is characterized by instability of identity, of mood, and of behavior, and Becker argues that it has been used as a catch-all diagnosis for too many women. She further decries the pejorative connotation of the diagnosis, saying that it predisposes many people, both within and outside of the profession of psychotherapy, against women who have been so diagnosed (Becker).

Many critics also point to the medicalization of women's issues as an example of institutionalized sexism. Medicalization refers to the process by which previously normal aspects of life are redefined as deviant and needing medical attention to remedy. Historically and contemporaneously, many aspects of women's lives have been medicalized, including menstruation, pre-menstrual syndrome, pregnancy, childbirth, and menopause.

The medicalization of pregnancy and childbirth has been particularly contentious in recent decades, with many women opting against the medical process and choosing a more natural childbirth. Fox and Worts (1999) find that all women experience pain and anxiety during the birth process, but that social support relieves both as effectively as medical support. In other words, medical interventions are no more effective than social ones at helping with the difficulties of pain and childbirth. Fox and Worts further found that women with supportive partners ended up with less medical intervention and fewer cases of postpartum depression. Of course, access to quality birth care outside of the standard medical models may not be readily available to women of all social classes.

Summary

Despite generally good health in the U.S. compared with less-developed countries, America is still facing challenging issues such as a prevalence of obesity and diabetes. Moreover, Americans of historically disadvantaged racial groups, ethnicities, socioeconomic status, and gender experience lower levels of health care. Mental health and disability are health issues that are significantly impacted by social norms.

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2.3.1: INTRODUCTION TO HEALTH AND WELLNESS

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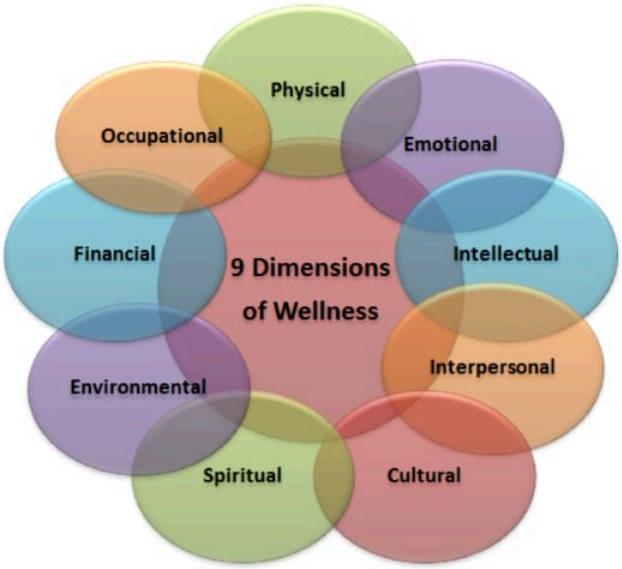
2.3.1.1: Dimensions of Wellness

What is Wellness?

Wellness is being in good physical and mental health. Because mental health and physical health are linked, problems in one area can impact the other. At the same time, improving your physical health can also benefit your mental health, and vice versa. It is important to make healthy choices for both your physical and mental well-being.

Remember that wellness is not just the absence of illness or stress. You can still strive for wellness even if you are experiencing these challenges in your life.

What are the Nine Dimensions of Wellness?



Learning about the Nine Dimensions of Wellness can help you choose how to make wellness a part of your everyday life. Wellness strategies are practical ways to start developing healthy habits that can have a positive impact on your physical and mental health.

The Nine Dimensions of Wellness are:

1. **Emotional**: Coping effectively with life and expressing emotions in an appropriate manner.
2. **Environmental**: Occupying pleasant, healthy, and safe environments that support well-being; positively impacting the quality of our surroundings (including protecting and preserving nature).
3. **Financial**: Achieving satisfaction with current and future financial situations; handling finances wisely.
4. **Intellectual**: Recognizing creative abilities and finding ways to expand knowledge and skills; being open-minded.
5. **Occupational**: Personal fulfillment and enrichment from one's work and/or responsibilities.
6. **Physical**: Recognizing the need for physical activity, healthy foods, and adequate sleep; avoiding unhealthy habits.
7. **Social**: Developing a sense of connection, belonging, and sustained support system; having positive relationships.
8. **Spiritual**: Having a sense of purpose and meaning in life; establishing peace, harmony, and balance in our lives.
9. ***Cultural**: The way you interact with others who are different than you; understanding and celebrating our differences. (*recently added).

Learn more about the Eight Dimensions of Wellness (does not include Cultural wellness) by watching the video below:

YouTube Video

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https://www.youtube.com/watch?v=tDzQdRvLAfM

Your Own Views on Health and Wellness

Reflect on the following questions:

- What does health mean to you?
- How important is health to you?
- What are some of your healthy habits?
- Which dimensions of wellness do you need to work on the most?

Query 2.3.1.1.1

Check your Learning: The 9 Dimensions of Wellness

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2.3.1.2: Healthy People 2020

In December 2010, the Department of Health and Human Services launched Healthy People 2020, which has four overarching goals:



- Attain high-quality, longer lives free of preventable disease, disability, injury, and premature death;
- Achieve health equity, eliminate disparities, and improve the health of all groups;
- Create social and physical environments that promote good health for all; and
- Promote quality of life, healthy development, and healthy behaviors across all life stages.

Healthy People 2020 tracks approximately 1,200 objectives organized into 42 topic areas, each of which represents an important public health area. At the time of the December 2010 launch 911 objectives were measurable with baseline data and established targets. A few objectives that have achieved high levels of success are being tracked without a target for informational purposes. Targets will be set during the decade for these objectives if warranted. The rest of the objectives did not have baseline data and were considered developmental. Targets for the developmental objectives will be set when baseline data become available. Healthy People 2020 also includes a new Foundation section which addresses several important health topics: General Health Status, Health-Related Quality of Life and Well-Being, Determinants of Health, and Disparities.

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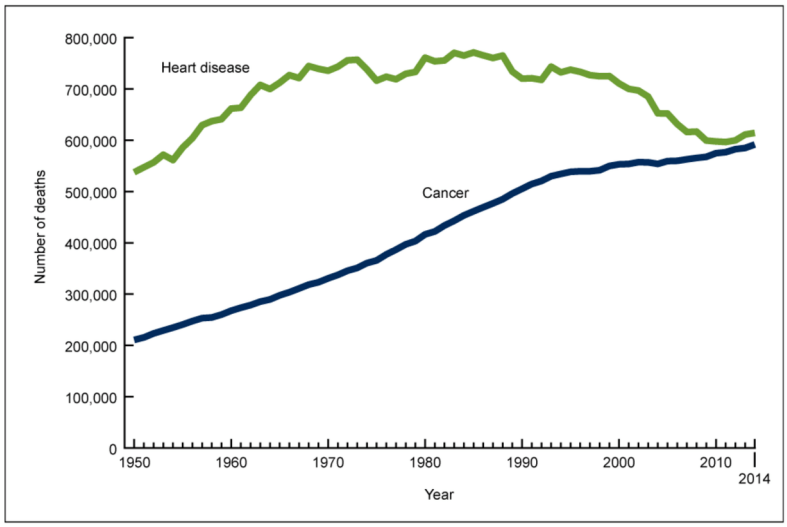
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2.3.1.3: Major Health Concerns

Leading Causes of Death in the United States

Do you know what the top two leading causes of death are for Americans? Heart disease takes the number one spot, followed by cancer. As you can see by the graph below, cancer death rates have been steadily increasing throughout the years. What does this potentially mean for the future? Is cancer going to take over as the number one leading cause of death? It certainly appears to be headed in that direction.

Figure 1. Number of deaths due to heart disease and cancer: United States, 1950–2014



NOTES: Leading cause is based on number of deaths. Access data table for Figure 1 at: http://www.cdc.gov/nchs/data/databriefs/db254_table.pdf#1.
SOURCE: NCHS, National Vital Statistics System, Mortality.

The 10 Leading Causes of Death in the United States:

1. Heart disease: 614,348
2. Cancer: 591,699
3. Chronic lower respiratory diseases: 147,101
4. Accidents (unintentional injuries): 136,053
5. Stroke (cerebrovascular diseases): 133,103
6. Alzheimer's disease: 93,541
7. Diabetes: 76,488
8. Influenza and Pneumonia: 55,227
9. Nephritis, nephrotic syndrome and nephrosis: 48,146
10. Intentional self-harm (suicide): 42,773

CDC Winnable Battles

To keep pace with emerging public health challenges and to address the leading causes of death and disability, CDC initiated an effort called Winnable Battles to achieve measurable impact quickly. Winnable Battles are public health priorities with large-scale impact on health and known effective strategies to address them. By identifying priority strategies, defining clear targets and working closely with our public health partners, we are making significant progress in reducing health disparities and the overall health burden from these diseases and conditions.

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2.3.1.4: Risk Factors and Levels of Disease Prevention

What is a Risk Factor?

Part of learning how to take charge of your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control. You may be born with them or exposed to them through no fault of your own.

Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some risk factors you can control include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs

In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

Levels of Disease Prevention

Prevention includes a wide range of activities — known as "interventions" — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviors that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)

- education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems. Examples include:

- regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- support groups that allow members to share strategies for living well
- vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

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2.3.1.5: Behavior Change and Goal Setting

Transtheoretical Model (Stages of Change)

The transtheoretical model of behavior change, developed by Prochaska and DiClemente, assesses an individual's readiness to implement a healthier behavior, and provides insight into the decision making process that leads to action. For many people, changing or modifying a behavior that is unhealthy or potentially harmful can be quite challenging. Here are the stages that lead to behavior change:

- **Precontemplation (Not Ready)** – You are not intending to take action in the foreseeable future, and can be unaware that your behavior is problematic
- **Contemplation (Getting Ready)** – You are beginning to recognize that your behavior is problematic, and start to look at the pros and cons of your continued actions
- **Preparation (Ready)** – You are intending to take action in the immediate future, and may begin taking small steps toward behavior change
- **Action** – You are making actual changes to your problem behavior by incorporating healthy choices/behaviors into your life
- **Maintenance** – You have been able to sustain action for at least six months and are working to prevent relapse into previous unhealthy behaviors

Check out this supplemental video to review the main concepts of the Transtheoretical Model:

YouTube Video

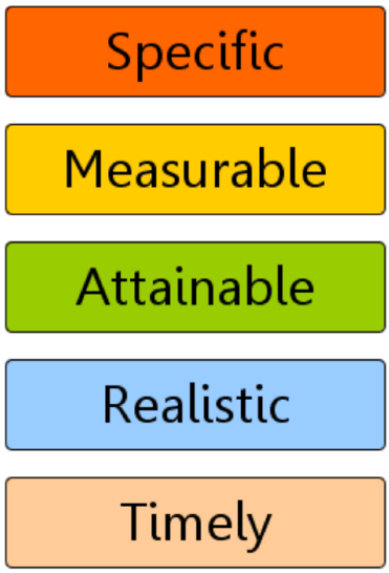
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View this YouTube Video online

YouTube Video: Improve Your Life Using the Stages of Change (Transtheoretical) Model - Dr Wendy Guess (https://www.youtube.com/watch?v=Twlow2pXsv0)

SMART Goal Setting

Have you ever said to yourself that you need to "eat healthier" or "exercise more" to improve your overall health? How well did that work for you? In most cases, probably not very well. That's because these statements are too vague and do not give us any direction for what truly needs to be done to achieve such goals. To have a better chance at being successful, try using the SMART acronym for setting your goals (S= Specific, M= Measurable, A=Attainable, R= Realistic, T= Time-oriented):



Specific – Create a goal that has a focused and clear path for what you actually need to do. Examples:

- I will drink 8 ounces of water 3 times per day
- I will walk briskly for 30 minutes, 5 times per week
- I will reduce my soda intake to no more than 2 cans of soda per week

Do you see how that is more helpful than just saying you will eat healthier or exercise more? It gives you direction.

Measurable – This enables you to track your progress, and ties in with the "specific" component. The above examples all have actual numbers associated with the behavior change that let you know whether or not it has been met.

Attainable – Make sure that your goal is within your capabilities and not too far out of reach. For example, if you have not been physically active for a number of years, it would be highly unlikely that you would be able to achieve a goal of running a marathon within the next month.

Realistic – Try to ensure that your goal is something you will be able to continue doing and incorporate as part of your regular routine/lifestyle. For example, if you made a goal to kayak 2 times each week, but don't have the financial resources to purchase or rent the equipment, no way to transport it, or are not close enough to a body of water in which to partake in kayaking, then this is not going to be feasible.

Time-oriented – Give yourself a target date or deadline in which the goal needs to be met. This will keep you on track and motivated to reach the goal, while also evaluating your progress.

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2.3.2: EXERCISE AND PHYSICAL ACTIVITY

2.3.2.1: Health Benefits of Physical Activity

2.3.2.2: Physical Activity Guidelines for Adults

2.3.2.3: Developing a Personal Exercise Program

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2.3.2.1: Health Benefits of Physical Activity

Regular physical activity is one of the most important things you can do for your health. In many studies covering a wide range of issues, researchers have focused on exercise, as well as on the more broadly defined concept of physical activity. Exercise is a form of physical activity that is planned, structured, repetitive, and performed with the goal of improving health or fitness. So, ***although all exercise is physical activity, not all physical activity is exercise***. Being more physically active and also doing more exercise can help to:

- Control your weight
- Reduce your risk of cardiovascular disease
- Reduce your risk for type 2 diabetes and metabolic syndrome
- Reduce your risk of some cancers
- Strengthen your bones and muscles
- Improve your mental health and mood
- Improve your ability to do daily activities and prevent falls
- Increase your chances of living longer

Begin Taking Steps to be More Physically Active Everyday

If you're not sure about becoming active or boosting your level of physical activity because you're afraid of getting hurt, the good news is that moderate-intensity aerobic activity, like brisk walking, is generally safe for most people.

Start slowly. Cardiac events, such as a heart attack, are rare during physical activity. But the risk does go up when you suddenly become much more active than usual. For example, you can put yourself at risk if you don't usually get much physical activity and then all of a sudden do vigorous-intensity aerobic activity, like shoveling snow. That's why it's important to start slowly and gradually increase your level of activity.

If you have a chronic health condition such as arthritis, diabetes, or heart disease, talk with your doctor to find out if your condition limits, in any way, your ability to be active. Then, work with your doctor to come up with a physical activity plan that matches your abilities. If your condition stops you from meeting the minimum Guidelines, try to do as much as you can. What's important is that you avoid being inactive. Even 60 minutes a week of moderate-intensity aerobic activity is good for you.

The bottom line is – the health benefits of physical activity far outweigh the risks of getting hurt. The following list explains how being more active can positively impact your health:

Control Your Weight

Looking to get to or stay at a healthy weight? Both diet and physical activity play a critical role in controlling your weight. You gain weight when the calories you burn, including those burned during physical activity, are less than the calories you eat or drink. When it comes to weight management, people vary greatly in how much physical activity they need. You may need to be more active than others to achieve or maintain a healthy weight.

To maintain your weight: Work your way up to 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent mix of the two each week. Strong scientific evidence shows that physical activity can help you maintain your weight over time. However, the exact amount of physical activity needed to do this is not clear since it varies greatly from person to person. It's possible that you may need to do more than the equivalent of 150 minutes of moderate-intensity activity a week to maintain your weight.
To lose weight and keep it off: You will need a high amount of physical activity unless you also adjust your diet and reduce the amount of calories you're eating and drinking. Getting to and staying at a healthy weight requires both regular physical activity and a healthy eating plan. The CDC has some great tools and information about nutrition, physical activity and weight loss. For more information, visit Healthy Weight.

Reduce Your Risk of Cardiovascular Disease

Heart disease and stroke are two of the leading causes of death in the United States. But following the Guidelines and getting at least 150 minutes a week (2 hours and 30 minutes) of moderate-intensity aerobic activity can put you at a lower risk for these diseases. You can reduce your risk even further with more physical activity. Regular physical activity can also lower your blood pressure and improve your cholesterol levels.

Reduce Your Risk of Type 2 Diabetes and Metabolic Syndrome

Regular physical activity can reduce your risk of developing type 2 diabetes and metabolic syndrome. Metabolic syndrome is a condition in which you have some combination of too much fat around the waist, high blood pressure, low HDL cholesterol, high triglycerides, or high blood sugar. Research shows that lower rates of these conditions are seen with 120 to 150 minutes (2 hours to 2 hours and 30 minutes) a week of at least moderate-intensity aerobic activity. And the more physical activity you do, the lower your risk will be.

Already have type 2 diabetes? Regular physical activity can help control your blood glucose levels. To find out more, visit Managing Diabetes.

Reduce Your Risk of Some Cancers

Being physically active lowers your risk for two types of cancer: colon and breast. Research shows that:

- Physically active people have a lower risk of colon cancer than do people who are not active.
- Physically active women have a lower risk of breast cancer than do people who are not active.

Reduce your risk of endometrial and lung cancer. Although the research is not yet final, some findings suggest that your risk of endometrial cancer and lung cancer may be lower if you get regular physical activity compared to people who are not active.

Improve your quality of life. If you are a cancer survivor, research shows that getting regular physical activity not only helps give you a better quality of life, but also improves your physical fitness.

Strengthen Your Bones and Muscles

As you age, it's important to protect your bones, joints and muscles. Not only do they support your body and help you move, but keeping bones, joints and muscles healthy can help ensure that you're able to do your daily activities and be physically active. Research shows that doing aerobic, muscle-strengthening and bone-strengthening physical activity of at least a moderately-intense level can slow the loss of bone density that comes with age.

Hip fracture is a serious health condition that can have life-changing negative effects, especially if you're an older adult. But research shows that people who do 120 to 300 minutes of at least moderate-intensity aerobic activity each week have a lower risk of hip fracture.

Regular physical activity helps with arthritis and other conditions affecting the joints. If you have arthritis, research shows that doing 130 to 150 (2 hours and 10 minutes to 2 hours and 30 minutes) a week of moderate-intensity, low-impact aerobic activity can not only improve your ability to manage pain and do everyday tasks, but it can also make your quality of life better.

Build strong, healthy muscles. Muscle-strengthening activities can help you increase or maintain your muscle mass and strength. Slowly increasing the amount of weight and number of repetitions you do will give you even more benefits, no matter your age

Improve Your Mental Health and Mood

Regular physical activity can help keep your thinking, learning, and judgment skills sharp as you age. It can also reduce your risk of depression and may help you sleep better. Research has shown that doing aerobic or a mix of aerobic and muscle-strengthening activities 3 to 5 times a week for 30 to 60 minutes can give you these mental health benefits. Some scientific evidence has also shown that even lower levels of physical activity can be beneficial.

Improve Your Ability to do Daily Activities and Prevent Falls

A functional limitation is a loss of the ability to do everyday activities such as climbing stairs, grocery shopping, or playing with your grandchildren.

How does this relate to physical activity? If you're a physically active middle-aged or older adult, you have a lower risk of functional limitations than people who are inactive

Already have trouble doing some of your everyday activities? Aerobic and muscle-strengthening activities can help improve your ability to do these types of tasks.

Are you an older adult who is at risk for falls? Research shows that doing balance and muscle-strengthening activities each week along with moderate-intensity aerobic activity, like brisk walking, can help reduce your risk of falling.

Increase Your Chances of Living Longer

Science shows that physical activity can reduce your risk of dying early from the leading causes of death, like heart disease and some cancers. This is remarkable in two ways:

1. Only a few lifestyle choices have as large an impact on your health as physical activity. People who are physically active for about 7 hours a week have a 40 percent lower risk of dying early than those who are active for less than 30 minutes a week.
2. You don't have to do high amounts of activity or vigorous-intensity activity to reduce your risk of premature death. You can put yourself at lower risk of dying early by doing at least 150 minutes a week of moderate-intensity aerobic activity.

Everyone can gain the health benefits of physical activity – age, ethnicity, shape or size do not matter.

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2.3.2.2: Physical Activity Guidelines for Adults

Adults who are physically active are healthier and less likely to develop many chronic diseases than adults who are inactive. They also have better fitness, including a healthier body size and composition. These benefits are gained by men and women and people of all races and ethnicities who have been studied.

Overall Components of Physical Fitness:

- **Cardiorespiratory fitness** – ability to sustain aerobic activity for a prolonged period of time
- **Muscular strength** – amount of force a muscle is able to exert in one contraction
- **Muscular endurance** – ability of the muscle to continue to perform without fatigue
- **Flexibility** – ability to move joints freely through their full range of motion
- **Body Composition** – the relative proportions of fat mass and lean mass in the body

The Physical Activity Guidelines for Adults include three main recommendations: Avoid inactivity, do aerobic activity, and strengthen muscles.

Avoid Inactivity

All adults should avoid inactivity. Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits.

Do Aerobic Activity

In this kind of physical activity (also called cardiorespiratory fitness), the body's large muscles move in a rhythmic manner for a sustained period of time. Brisk walking, running, bicycling, jumping rope, and swimming are all examples.

Aerobic activity causes a person's heart to beat faster than usual.

Aerobic physical activity has three components:

- **Intensity**, or how hard a person works to do the activity. The intensities most often examined are moderate intensity (equivalent in effort to brisk walking) and vigorous intensity (equivalent in effort to running or jogging);
- **Frequency**, or how often a person does aerobic activity; and
- **Duration**, or how long a person does an activity in any one session.

For substantial health benefits, adults should do at least one of the following:

- 150 minutes (2 hours and 30 minutes) each week of moderate-intensity aerobic physical activity (such as brisk walking or tennis)
- 75 minutes (1 hour and 15 minutes) each week of vigorous-intensity aerobic physical activity (such as jogging or swimming laps)
- An equivalent combination of moderate- and vigorous-intensity aerobic physical activity

For additional and more extensive health benefits, adults should increase their aerobic physical activity to one of the following:

- Increase moderate-intensity aerobic physical activity to 300 minutes (5 hours) each week
- Increase vigorous-intensity aerobic physical activity for 150 minutes (2 hours and 30 minutes) each week
- An equivalent combination of moderate- and vigorous-intensity activity

Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week.

Examples of Different Aerobic Physical Activities and Intensities

Moderate Intensity	Vigorous Intensity
• Walking briskly (3 miles per hour or faster, but not race-walking) • Water aerobics • Bicycling slower than 10 miles per hour • Tennis (doubles) • Ballroom dancing • General gardening	• Racewalking, jogging, or running • Swimming laps • Tennis (singles) • Aerobic dancing • Bicycling 10 miles per hour or faster • Jumping rope • Heavy gardening (continuous digging or hoeing, with heart rate increases) • Hiking uphill or with a heavy backpack

Aerobic Intensity: Target Heart Rate Zone

One way of monitoring physical activity intensity is to determine whether a person's pulse or heart rate is within the target zone during physical activity.

When starting an exercise program, calculating a target heart rate zone can be very beneficial to ensure that you are exercising safely and effectively. Heart rates are referred to as "beats per minute" or bpm. The maximum rate is based on the person's age. An estimate of a person's maximum age-related heart rate can be obtained by subtracting the person's age from 220.

220 – Age = Maximum Heart Rate

For moderate-intensity physical activity, a person's target heart rate should be 50 to 70% of his or her maximum heart rate. For vigorous-intensity physical activity, a person's target heart rate should be 70 to 85% of his or her maximum heart rate.

Example of Target Heart Rate for a 50 year old adult:
220 – 50 years = 170 beats per minute (bpm). The 50% and 70% levels would be: • 50% level: 170 x 0.50 = 85 bpm • 70% level: 170 x 0.70 = 119 bpm • 85% level: 170 x .85 = 145 bpm Thus, moderate-intensity physical activity for a 50-year-old person will require that the heart rate remains between 85 and 119 bpm during physical activity. Vigorous intensity for a 50-year old adult would be a heart rate between 119 - 145 bpm.

Taking Your Heart Rate

Generally, to determine whether you are exercising within the heart rate target zone, you must stop exercising briefly to take your pulse. You can take the pulse at the neck, the wrist, or the chest. We recommend the wrist. You can feel the radial pulse on the artery of the wrist in line with the thumb. Place the tips of the index and middle fingers over the artery and press lightly. Do not use the thumb. Take a full 60-second count of the heartbeats, or take for 30 seconds and multiply by 2. Start the count on a beat,

which is counted as “zero.” If this number falls between 85 and 119 bpm in the case of the 50-year-old person, he or she is active within the target range for moderate-intensity activity.



Find your Target Heart Rate Zone

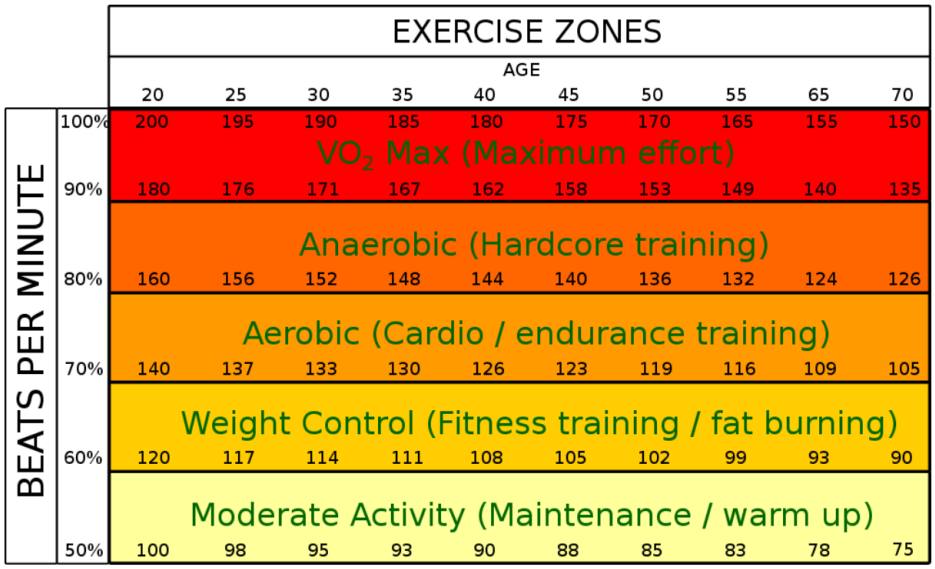


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Strengthen Muscles

Do muscle-strengthening activities (such as lifting weights or using resistance bands) that are moderate or high intensity and involve all major muscle groups on 2 or more days a week.

Muscle-Strengthening Activity

Muscle-strengthening activities provide additional benefits not found with aerobic activity. The benefits of muscle-strengthening activity include increased bone strength and muscular fitness. Muscle-strengthening activities can also help maintain muscle

mass during a program of weight loss.

Muscle-strengthening activities make muscles do more work than they are accustomed to doing. That is, they overload the muscles. Resistance training, including weight training, is a familiar example of muscle-strengthening activity. Other examples include working with resistance bands, doing calisthenics that use body weight for resistance (such as push-ups, pull-ups, and sit-ups), carrying heavy loads, and heavy gardening (such as digging or hoeing).

Muscle-strengthening activities count if they involve a moderate to high level of intensity or effort and work the major muscle groups of the body: the legs, hips, back, chest, abdomen, shoulders, and arms. muscle strengthening activities for all the major muscle groups should be done at least 2 days a week.

No specific amount of time is recommended for muscle strengthening, but muscle-strengthening exercises should be performed to the point at which it would be difficult to do another repetition without help. When resistance training is used to enhance muscle strength, one set of 8 to 12 repetitions of each exercise is effective, although two or three sets may be more effective. Development of muscle strength and endurance is progressive over time. Increases in the amount of weight or the days a week of exercising will result in stronger muscles.

Muscle-strengthening activity also has three components:

- **Intensity**, or how much weight or force is used relative to how much a person is able to lift;
- **Frequency,** or how often a person does muscle strengthening activity; and
- **Repetitions,** or how many times a person lifts a weight (analogous to duration for aerobic activity). The effects of muscle-strengthening activity are limited to the muscles doing the work. It's important to work all the major muscle groups of the body: the legs, hips, back, abdomen, chest, shoulders, and arms.

Bone-Strengthening Activity

This kind of activity (sometimes called weight-bearing or weight-loading activity) produces a force on the bones that promotes bone growth and strength. This force is commonly produced by impact with the ground. Examples of bone-strengthening activity include jumping jacks, running, brisk walking, and weight-lifting exercises. As these examples illustrate, bone-strengthening activities can also be aerobic and muscle strengthening.

Click here to view a summary

To review the key recommendations, as well as learn more about "what counts" as moderate or vigorous intensity aerobic activity, watch the videos below:

YouTube Video

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You Tube Video: Physical Activity Guidelines -- Introduction (https://youtu.be/nhECLmOznoM)

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You Tube Video: Physical Activity Guidelines - What Counts As Aerobic? (https://www.youtube.com/watch?v=GEvJlmpZCoM)

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Check your learning: Health and Skill Related Components of Fitness
Drag the elements to the correct area.

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2.3.2.3: Developing a Personal Exercise Program

To help you follow the guidelines for physical activity use the FITT chart to design your weekly exercise routine. FITT stands for Frequency, Intensity, Time, and Type.

	CRE: cardiorespiratory endurance (Aerobic exercises)	MS/ME: Muscular strength /Endurance	FL: Flexibility
F (Frequency)	3-5 days/week	2-3 days/week	Most if not all days/ week
I (Intensity)	Keep heart rate in the Target heart rate zone. 50-70% of HRmax for moderate intensity and 70-85% for vigorous intensity	Sufficient resistance to fatigue muscles. Ensure the last repetitions are difficult.	To the point of tension.
T (Time)	At least 10 minutes at a time and for a total of 2:30 hours/week of moderate activity or 1:15 minutes/week of vigorous activity.	For general fitness do 1-2 sets of 8-12 repetitions.	2-4 reps of each exercise held for 15-30 seconds
T (Type)	Continuous rhythmic activities that keep the heart rate elevated. Example: running, walking, swimming, cycling	Choose a strength training exercises that target all major muscle groups.	Stretching exercises that target all major muscle groups.

Make Physical Activity a Regular Part of the Day



Choose activities that you enjoy and can do regularly. Fitting activity into a daily routine can be easy — such as taking a brisk 10 minute walk to and from the parking lot, bus stop, or subway station. Or, join an exercise class. Keep it interesting by trying something different on alternate days. Every little bit adds up and doing something is better than doing nothing.

Be physically active at least 10 minutes at a time, because shorter bursts of activity will not have the same health benefits. For example, walk your dog for 10 minutes before and after work, and go for a 10-minute walk at lunchtime. That adds up to 30

minutes of moderate exercise for the day. If you don't have a dog to walk, then you could take a brisk 10-minute walk to and from the parking lot or bus stop before and after work or class.

Gradually Increase Your Level of Physical Activity

Inactive adults or those who don't yet do 150 minutes of physical activity a week should work gradually toward this goal. The initial amount of activity should be at a light or moderate intensity, for short periods of time, with the sessions spread throughout the week. The good news is that "some is better than none."

To reduce risk of injury, it is important to increase the amount of physical activity gradually over a period of weeks to months. For example, an inactive person could start with a walking program consisting of 5 minutes of walking several times each day, 5 to 6 days a week. The length of time could then gradually be increased to 10 minutes per session, 3 times a day, and the walking speed could be increased (to ultimately meet the time and intensity guidelines).

Muscle-strengthening activities should also be gradually increased over time. Initially, these activities can be done just 1 day a week starting at a light or moderate level of effort. Over time, the number of days a week can be increased to 2, and then possibly to more than 2. Each week, the level of effort (intensity) can be increased slightly until it becomes moderate to high.

Warm-up and Cool-down

Commonly, the warm-up and cool-down involve doing an activity at a slower speed or lower intensity. A warm-up before moderate- or vigorous-intensity aerobic activity allows a gradual increase in heart rate and breathing at the start of the episode of activity. A cool-down after activity allows a gradual decrease at the end of the episode. Time spent doing warm-up and cool-down may count toward meeting the aerobic activity guidelines if the activity is at least moderate intensity (for example, walking briskly as a warm-up before jogging). A warm-up for muscle-strengthening activity commonly involves doing exercises with lighter weight. Stretching is often incorporated during the warm-up and cool-down, and is helpful for reducing the risk of injury, as well as improving flexibility.

Ways to Get Moving

- Many activities can be worked into your daily routine so that you don't have to go to the gym or an exercise class.
- Always be prepared. Keep a pair of walking or running shoes and some comfortable clothes readily available.
- Walk (briskly)! Do it in your neighborhood, find a local trail, or go to the mall and walk around before you shop. Walk during your lunch break, in between classes, or to do your errands. Take the stairs instead of the elevator. Park in the farthest parking spot and take an extended route to your classroom, office, or store.
- Make exercise a social event. Walk with friends, a family member, or even join a walking group to make it more fun. Take dancing lessons, or a Zumba class.
- Get a jump rope! Jumping rope is an inexpensive exercise that can be done anywhere.
- Add calisthenics (jumping jacks, push-ups, squats, crunches, etc.) to the mix for muscle strengthening.
- Participate in a sport such as tennis, softball, basketball or touch football. Play golf, but push or carry your golf bag rather than ride in a golf cart. Keep your activities interesting by trying something different on alternate days.
- Do household chores that increase your heart rate. Vacuuming, mopping, and sweeping can get your heart pumping. Mow the lawn with a push mower, garden/shovel, rake leaves, or wash and wax your car.
- Make exercise a family activity. Get outdoors and hike, ride bikes, skate, swim, go canoeing, kayaking, or just take a brisk walk together.

Achieving Target Levels of Physical Activity

Key Points:

- Going to the gym is NOT required for achieving the recommended guidelines
- Incorporating more brisk walking throughout the day can add up to reaching your goals – just be sure it occurs for at least 10 minutes at a time
- Getting started is the first important step – gradually work your way to the recommended levels

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Check your learning: FITT Principle Recommendations

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2.3.3: NUTRITION

2.3.3.1: Nutrition Basics

2.3.3.2: Dietary Guidelines for Americans

2.3.3.3: Disease Risk and Nutrition

2.3.3.4: Nutrition Facts Label

2.3.3.5: Organic Foods

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2.3.3.1: Nutrition Basics

What is your food made of?



Food provides the energy and nutrients you need to be healthy.

Nutrients include:

- protein
- carbohydrates
- fats
- vitamins
- minerals
- water

Energy of Food

When energy is used to describe the foods you consume, energy is referring to calories. Calories are what provides the body with the energy it needs to survive and stay healthy. Our body uses calories to breathe, think, and talk. We also use calories to exercise! The three categories of nutrients that provide us with calories, or energy, are Proteins, Carbohydrates, and Fats. If you were to go to McDonalds and eat a Big Mac you would be consuming 540 calories. How much of those calories come from Proteins, Carbohydrates, and Fats?

Protein

Protein is in every cell in the body. Our bodies need protein from the foods we eat to build and maintain bones, muscles and skin. We get proteins in our diet from meat, dairy products, nuts, and certain grains and beans. Proteins from meat and other animal products are complete proteins. This means they supply all of the amino acids the body can't make on its own. Most plant proteins are incomplete. You should eat different types of plant proteins every day to get all of the amino acids your body needs.

It is important to get enough dietary protein. You need to eat protein every day, because your body doesn't store it the way it stores fats or carbohydrates. How much you need depends on your age, sex, health, and level of physical activity. Most Americans eat enough protein in their diet.

Protein provides us with 4 calories per gram consumed. If you eat a Big Mac from McDonald's, it will provide you with 25 grams of protein. 25 grams of protein is equal to 100 calories, therefore 100 calories of the 540 total calories from a Big Mac come from proteins. Big Mac's are 19% protein.

Carbohydrates

Carbohydrates are one of the main types of nutrients. They are the most important source of energy for your body. Your digestive system changes carbohydrates into glucose (blood sugar). Your body uses this sugar for energy for your cells, tissues and organs. It stores any extra sugar in your liver and muscles for when it is needed.

Carbohydrates are called simple or complex, depending on their chemical structure. Simple carbohydrates include sugars found naturally in foods such as fruits, vegetables, milk, and milk products. They also include sugars added during food processing and refining. Complex carbohydrates include whole grain breads and cereals, starchy vegetables and legumes. Many of the complex carbohydrates are good sources of fiber.

Fiber is commonly classified as soluble, which dissolves in water, or insoluble, which doesn't dissolve.

- **Soluble fiber.** This type of fiber dissolves in water to form a gel-like material. It can help lower blood cholesterol and glucose levels. Soluble fiber is found in oats, barley, nuts, seeds, beans, lentils, peas, and some fruits and vegetables.
- **Insoluble fiber.** This type of fiber promotes the movement of material through your digestive system and adds bulk to the stool, so it can be of benefit to those who struggle with constipation or irregular stools. Insoluble fiber is found in foods such as wheat bran, vegetables, and whole grains.

For a healthy diet, limit the amount of added sugar that you eat and choose whole grains over refined grains.

Carbohydrates provide us with 4 calories per gram consumed. If you eat a Big Mac from McDonald's, it will provide you with 46 grams of carbohydrates. 46 grams of protein is equal to 184 calories, therefore 184 calories of the 540 total calories from a Big Mac come from carbohydrates. Big Mac's are 34% carbohydrates.

Fats

We need a certain amount of fat in our diets to stay healthy. Fats provide needed energy in the form of calories. Fats help our bodies absorb important vitamins—called fat-soluble vitamins—including vitamins A, D and E. Fats also make foods more flavorful and help us feel full. Fats are especially important for infants and toddlers, because dietary fat contributes to proper growth and development.

Problems arise, though, if we eat too much fat. Dietary fats have more than twice as many calories per gram as either proteins or carbohydrates like sugar and starch. Excess calories, of course, can pack on the pounds and raise your risk for diabetes, cancer and other conditions.

Foods can contain a mixture of different fats. Unsaturated fats are considered "good" fats. They're sometimes listed as "monounsaturated" and "polyunsaturated" fat on Nutrition Facts labels. These can promote health if eaten in the right amounts. They are generally liquid at room temperature, and are known as oils. You'll find healthful unsaturated fats in fish, nuts and most vegetable oils, including canola, corn, olive and safflower oils.

The so-called "bad" fats are saturated fats and trans fats. They tend to be solid at room temperature. Solid fats include butter, meat fats, stick margarine, shortening, and coconut and palm oils. They're often found in chocolates, baked goods, and deep-fried and processed foods.

Fats provide us with 9 calories per gram consumed. If you eat a Big Mac from McDonald's, it will provide you with 28 grams of fats. 28 grams of fat is equal to 252 calories, therefore 252 calories of the 540 total calories from a Big Mac come from fats. Big Mac's are 47% fats.

Example: McDonald's Big Mac



540 total calories

- Proteins = 25 grams = 100 calories = 19%
- Carbohydrates = 46 grams = 184 calories = 34%
- Fats = 28 grams = 252 calories = 47%

**Note: Many times the total calories from breaking down the macronutrients will not match the total calories and this is due to rounding the numbers.*

We know the Big Mac provides us with a lot of Fat, but what kind of Fat is it? Is it good fat or bad fat? We can try to determine this by looking at the breakdown of Fats. The nutrition label tells us that 10 grams of the 28 grams comes from Saturated Fat and 1 grams comes from trans Fats.

Vitamins

Vitamins are substances that your body needs to grow and develop normally. There are 13 vitamins your body needs. They are:

- Vitamin A
- B vitamins (thiamine, riboflavin, niacin, pantothenic acid, biotin, vitamin B-6, vitamin B-12 and folate)
- Vitamin C
- Vitamin D
- Vitamin E
- Vitamin K

Vitamins are classified as either fat soluble (vitamins A, D, E and K) or water soluble (vitamins B and C). This difference between the two groups is very important as it determines how each vitamin acts within the body.

You can usually get all your vitamins from the foods you eat. Your body can also make vitamins D and K. People who eat a vegetarian diet may need to take a vitamin B12 supplement.

Each vitamin has specific jobs. If you have low levels of certain vitamins, you may get health problems. For example, if you don't get enough vitamin C, you could become anemic. Some vitamins may help prevent medical problems. Vitamin A prevents night blindness.

The best way to get enough vitamins is to eat a balanced diet with a variety of foods. In some cases, you may need to take vitamin supplements. It's a good idea to ask your healthcare provider first. High doses of some vitamins can cause problems.

Minerals

Minerals are important for your body to stay healthy. Your body uses minerals for many different jobs, including building bones,

making hormones and regulating your heartbeat.
There are two kinds of minerals: macrominerals and trace minerals. Macrominerals are minerals your body needs in larger amounts. They include calcium, phosphorus, magnesium, sodium, potassium, chloride and sulfur. Your body needs just small amounts of trace minerals. These include iron, manganese, copper, iodine, zinc, cobalt, fluoride and selenium.

Water

Water is your body's principal chemical component and makes up about 60 percent of your body weight. Every system in your body depends on water. For example, water flushes toxins out of vital organs, carries nutrients to your cells, and provides a moist environment for ear, nose and throat tissues.

Lack of water can lead to dehydration, a condition that occurs when you don't have enough water in your body to carry out normal functions. Even mild dehydration can drain your energy and make you tired.

Every day you lose water through your breath, perspiration, urine and bowel movements. For your body to function properly, you must replenish its water supply by consuming beverages and foods that contain water.

What are Antioxidants?

Antioxidants are substances we consume that may help to reduce cell damage. Antioxidants may come from the foods we eat or from dietary supplements.

Examples of antioxidants include

- Beta-carotene
- Lutein
- Lycopene
- Selenium
- Vitamin A
- Vitamin C
- Vitamin E

Antioxidants may help to reduce cell damage caused by free radicals. **Free radicals** are highly unstable molecules that are naturally formed when you exercise and when your body converts food into energy. Free radicals have been shown to cause "oxidative stress" in the body thus damaging healthy cells. Although not conclusive, research shows that antioxidants work to reduce the chances of cellular damage. Because antioxidants help to reduce cell damage, it had been theorized that they in turn help to reduce chances of many diseases, including cancer.

Query 2.3.3.1.1

Try this Nutrition Facts Pre-Test to see how much you already know about nutrition.

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2.3.3.2: Dietary Guidelines for Americans

Every 5 years since 1980, a new edition of the Dietary Guidelines for Americans has been published. Its goal is to make recommendations about the components of a healthy and nutritionally adequate diet to help promote health and prevent chronic disease for current and future generations. Although many of its recommendations have remained relatively consistent over time, the Dietary Guidelines has evolved as scientific knowledge has grown. These advancements have provided a greater understanding of, and focus on, the importance of healthy eating patterns as a whole, and how foods and beverages act synergistically to affect health. Therefore, healthy eating patterns is a focus of the 2015-2020 Dietary Guidelines.

Key Recommendations: Components of Healthy Eating Patterns

The Dietary Guidelines' Key Recommendations for healthy eating patterns should be applied in their entirety, given the interconnected relationship that each dietary component can have with others.

Consume a healthy eating pattern that accounts for all foods and beverages within an appropriate calorie level.

A healthy eating pattern includes:

- A variety of vegetables from all of the subgroups—dark green, red and orange, legumes (beans and peas), starchy, and other
- Fruits, especially whole fruits
- Grains, at least half of which are whole grains
- Fat-free or low-fat dairy, including milk, yogurt, cheese, and/or fortified soy beverages
- A variety of protein foods, including seafood, lean meats and poultry, eggs, legumes (beans and peas), and nuts, seeds, and soy products
- Oils (such as olive and canola oil)

A healthy eating pattern limits:

- Saturated fats and trans fats, added sugars, and sodium

Key Recommendations that are quantitative are provided for several components of the diet that should be limited. These components are of particular public health concern in the United States, and the specified limits can help individuals achieve healthy eating patterns within calorie limits:

- Consume less than 10 percent of calories per day from added sugars
- Consume less than 10 percent of calories per day from saturated fats
- Consume less than 2,300 milligrams (mg) per day of sodium
- If alcohol is consumed, it should be consumed in moderation—up to one drink per day for women and up to two drinks per day for men—and only by adults of legal drinking age

Implementation of the Dietary Guidelines Through Using MyPlate





Click here to compare MyPlate to the Harvard Healthy Eating Plate.

Choose Nutrient Dense Foods!

To eat well, it's best to choose a mix of nutrient-dense foods every day. Nutrient-dense foods are foods that have a lot of nutrients but relatively few calories. Look for foods that contain vitamins, minerals, complex carbohydrates, lean protein, and healthy fats.

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2.3.3.3: Disease Risk and Nutrition

Nutrition and Health Are Closely Related

Over the past century, essential nutrient deficiencies have dramatically decreased, many infectious diseases have been conquered, and the majority of the U.S. population can now anticipate a long and productive life. However, as infectious disease rates have dropped, the rates of noncommunicable diseases—specifically, chronic diet-related diseases—have risen, due in part to changes in lifestyle behaviors.

A history of poor eating and physical activity patterns have a cumulative effect and have contributed to significant nutrition- and physical activity-related health challenges that now face the U.S. population. About half of all American adults—117 million individuals—have one or more preventable chronic diseases, many of which are related to poor quality eating patterns and physical inactivity. These include cardiovascular disease, high blood pressure, type 2 diabetes, some cancers, and poor bone health.

More than two-thirds of adults and nearly one-third of children and youth are overweight or obese. These high rates of overweight and obesity and chronic disease have persisted for more than two decades and come not only with increased health risks, but also at high cost. In 2008, the medical costs associated with obesity were estimated to be $147 billion. In 2012, the total estimated cost of diagnosed diabetes was $245 billion, including $176 billion in direct medical costs and $69 billion in decreased productivity.

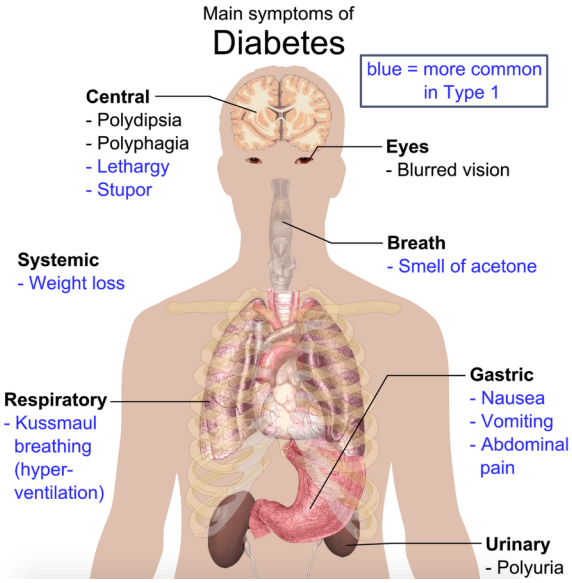
Type 2 Diabetes

Diabetes is a disease in which blood glucose levels are above normal. Most of the food we eat is turned into glucose, or sugar, for our bodies to use for energy. The pancreas, an organ that lies near the stomach, makes a hormone called insulin to help glucose get into the cells of our bodies. When you have diabetes, your body either doesn't make enough insulin or can't use its own insulin as well as it should. This causes sugar to build up in your blood.

Diabetes can cause serious health complications including heart disease, blindness, kidney failure, and lower-extremity amputations.

What is prediabetes?

Prediabetes is when the amount of glucose in your blood is above normal yet not high enough to be called diabetes. With prediabetes, your chances of getting type 2 diabetes, heart disease, and stroke are higher. With some weight loss and moderate physical activity, you can delay or prevent type 2 diabetes. You can even return to normal glucose levels, possibly without taking any medicines.



What are the signs and symptoms of diabetes?

The signs and symptoms of diabetes are:

- being very thirsty
- urinating often
- feeling very hungry
- feeling very tired
- losing weight without trying
- sores that heal slowly
- dry, itchy skin
- feelings of pins and needles in your feet
- losing feeling in your feet
- blurry eyesight

Some people with diabetes don't have any of these signs or symptoms. The only way to know if you have diabetes is to have your doctor do a blood test.
Click here to see a Snapshot of Diabetes in the United States.

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2.3.3.4: Nutrition Facts Label

Changes to the Nutrition Facts Label

On May 20, 2016, the FDA announced the new Nutrition Facts label for packaged foods to reflect new scientific information, including the link between diet and chronic diseases such as obesity and heart disease. The new label will make it easier for consumers to make better informed food choices. FDA published the final rules in the Federal Register on May 27, 2016.



Highlights of the Final Nutrition Facts Label

1. Features a Refreshed Design

- The "iconic" look of the label remains, but we are making important updates to ensure consumers have access to the information they need to make informed decisions about the foods they eat. These changes include increasing the type size for "Calories," "servings per container," and the "Serving size" declaration, and bolding the number of calories and the "Serving size" declaration to highlight this information.
- Manufacturers must declare the actual amount, in addition to percent Daily Value of vitamin D, calcium, iron and potassium. They can voluntarily declare the gram amount for other vitamins and minerals.
- The footnote is changing to better explain what percent Daily Value means. It will read: "*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice."

2. Reflects Updated Information about Nutrition Science

- "Added sugars," in grams and as percent Daily Value, will be included on the label. Scientific data shows that it is difficult to meet nutrient needs while staying within calorie limits if you consume more than 10 percent of your total daily calories from added sugar, and this is consistent with the 2015-2020 Dietary Guidelines for Americans.
- The list of nutrients that are required or permitted to be declared is being updated. Vitamin D and potassium will be required on the label. Calcium and iron will continue to be required. Vitamins A and C will no longer be required but can be included on a voluntary basis.
- While continuing to require "Total Fat," "Saturated Fat," and "Trans Fat" on the label, "Calories from Fat" is being removed because research shows the type of fat is more important than the amount.
- Daily values for nutrients like sodium, dietary fiber and vitamin D are being updated based on newer scientific evidence from the Institute of Medicine and other reports such as the 2015 Dietary Guidelines Advisory Committee Report, which was used in developing the 2015-2020 Dietary Guidelines for Americans. Daily values are reference amounts of nutrients

to consume or not to exceed and are used to calculate the percent Daily Value (% DV) that manufacturers include on the label. The %DV helps consumers understand the nutrition information in the context of a total daily diet.

3. **Updates Serving Sizes and Labeling Requirements for Certain Package Sizes**



- By law, serving sizes must be based on amounts of foods and beverages that people are actually eating, not what they should be eating. How much people eat and drink has changed since the previous serving size requirements were published in 1993. For example, the reference amount used to set a serving of ice cream was previously ½ cup but is changing to â…" cup. The reference amount used to set a serving of soda is changing from 8 ounces to 12 ounces.
- Package size affects what people eat. So for packages that are between one and two servings, such as a 20 ounce soda or a 15-ounce can of soup, the calories and other nutrients will be required to be labeled as one serving because people typically consume it in one sitting.
- For certain products that are larger than a single serving but that could be consumed in one sitting or multiple sittings, manufacturers will have to provide “dual column” labels to indicate the amount of calories and nutrients on both a “per serving” and “per package”/“per unit” basis. Examples would be a 24-ounce bottle of soda or a pint of ice cream. With dual-column labels available, people will be able to easily understand how many calories and nutrients they are getting if they eat or drink the entire package/unit at one time.

Compliance Date

Manufacturers will need to use the new label by July 26, 2018. However, manufacturers with less than $10 million in annual food sales will have an additional year to comply.

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2.3.3.5: Organic Foods

Organic 101: What the USDA Organic Label Means



Amidst nutrition facts, ingredients lists, and dietary claims on food packages, “organic” might appear as one more piece of information to decipher when shopping for foods. So understanding what “organic” really means can help shoppers make informed choices during their next visit to the store or farmers’ market.

USDA certified organic foods are grown and processed according to federal guidelines addressing, among many factors, soil quality, animal raising practices, pest and weed control, and use of additives. Organic producers rely on natural substances and physical, mechanical, or biologically based farming methods to the fullest extent possible.

Produce can be called organic if it’s certified to have grown on soil that had no prohibited substances applied for three years prior to harvest. Prohibited substances include most synthetic fertilizers and pesticides. In instances when a grower has to use a synthetic substance to achieve a specific purpose, the substance must first be approved according to criteria that examine its effects on human health and the environment (see other considerations in “Organic 101: Allowed and Prohibited Substances”).

As for organic meat, regulations require that animals are raised in living conditions accommodating their natural behaviors (like the ability to graze on pasture), fed 100% organic feed and forage, and not administered antibiotics or hormones.
When it comes to processed, multi-ingredient foods, the USDA organic standards specify additional considerations. Regulations prohibit organically processed foods from containing artificial preservatives, colors, or flavors and require that their ingredients are organic, with some minor exceptions. For example, processed

organic foods may contain some approved non-agricultural ingredients, like enzymes in yogurt, pectin in fruit jams, or baking soda in baked goods.

When packaged products indicate they are “made with organic [specific ingredient or food group],” this means they contain at least 70% organically produced ingredients. The remaining non-organic ingredients are produced without using prohibited practices (genetic engineering, for example) but can include substances that would not otherwise be allowed in 100% organic products. “Made with organic” products will not bear the USDA organic seal, but, as with all other organic products, must still identify the USDA-accredited certifier. You can look for the identity of the certifier on a packaged product for verification that the organic product meets USDA’s organic standards.

As with all organic foods, none of it is grown or handled using genetically modified organisms, which the organic standards expressly prohibit (see “Organic 101: What Organic Farming (and Processing) Doesn’t Allow”).

Becoming familiar with the USDA organic label and understanding its claims empower consumers to make informed decisions about the food they purchase. While there are many marketing claims that add value to foods, consumers can be assured that USDA organic products are verified organic at all steps between the farm and the store.

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2.3.4: STRESS MANAGEMENT

2.3.4.1: Stress Overview

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2.3.4.1: Stress Overview

Stress — just the word may be enough to set your nerves on edge. Everyone feels stressed from time to time. Some people may cope with stress more effectively or recover from stressful events quicker than others. It's important to know your limits when it comes to stress to avoid more serious health effects.



What is stress?

Stress can be defined as the brain's response to any demand. Many things can trigger this response, including change. Changes can be positive or negative, as well as real or perceived. They may be recurring, short-term, or long-term and may include things like commuting to and from school or work every day, traveling for a yearly vacation, or moving to another home. Changes can be mild and relatively harmless, such as winning a race, watching a scary movie, or riding a rollercoaster. Some changes are major, such as marriage or divorce, serious illness, or a car accident. Other changes are extreme, such as exposure to violence, and can lead to traumatic stress reactions.

How does stress affect the body?

Not all stress is bad. All humans and animals have a stress response, which can be life-saving in some situations. The nerve chemicals and hormones released during stressful times prepares us to face a threat or flee to safety. When you face a dangerous situation, your pulse quickens, you breathe faster, your muscles tense, your brain uses more oxygen and increases activity—all functions aimed at survival.

However, with chronic stress, those same nerve chemicals that are life-saving in short bursts can suppress functions that aren't needed for immediate survival. Your immunity is lowered and your digestive, excretory, and reproductive systems stop working normally. Once the threat has passed, other body systems act to restore normal functioning. Problems occur if the stress response goes on too long, such as when the source of stress is constant, or if the response continues after the danger has subsided.

How does stress affect your overall health?

There are at least three different types of stress, all of which carry physical and mental health risks:

- Routine stress related to the pressures of work, family and other daily responsibilities.
- Stress brought about by a sudden negative change, such as losing a job, divorce, or illness.

- Traumatic stress, experienced in an event like a major accident, war, assault, or a natural disaster where one may be seriously hurt or in danger of being killed.

The body responds to each type of stress in similar ways. Different people may feel it in different ways. For example, some people experience mainly digestive symptoms, while others may have headaches, sleeplessness, depressed mood, anger and irritability. People under chronic stress are prone to more frequent and severe viral infections, such as the flu or common cold, and vaccines, such as the flu shot, are less effective for them.

Of all the types of stress, changes in health from routine stress may be hardest to notice at first. Because the source of stress tends to be more constant than in cases of acute or traumatic stress, the body gets no clear signal to return to normal functioning. Over time, continued strain on your body from routine stress may lead to serious health problems, such as heart disease, high blood pressure, diabetes, depression, anxiety disorder, and other illnesses.

How can I cope with stress?

The effects of stress tend to build up over time. Taking practical steps to maintain your health and outlook can reduce or prevent these effects. The following are some tips that may help you to cope with stress:

- Seek help from a qualified mental health care provider if you are overwhelmed, feel you cannot cope, have suicidal thoughts, or are using drugs or alcohol to cope.
- Get proper health care for existing or new health problems.
- Stay in touch with people who can provide emotional and other support. Ask for help from friends, family, or community organizations to reduce stress due to work burdens or family issues, such as caring for a loved one.
- Recognize signs of your body's response to stress, such as difficulty sleeping, increased alcohol and other substance use, being easily angered, feeling depressed, and having low energy.
- Set priorities – decide what must get done and what can wait, and learn to say no to new tasks if they are putting you into overload.
- Note what you have accomplished at the end of the day, not what you have been unable to do.
- Avoid dwelling on problems. If you can't do this on your own, seek help from a qualified mental health professional who can guide you.
- Exercise regularly – just 30 minutes per day of walking can help boost mood and reduce stress.
- Schedule regular times for healthy and relaxing activities.
- Explore stress coping programs, which may incorporate meditation, yoga, tai chi, or other related exercises.

If you or someone you know is overwhelmed by stress, ask for help from a health professional. If you or someone close to you is in crisis, call the toll-free, 24-hour National Suicide Prevention Lifeline at 1-800-273-TALK (1-800-273-8255).

Key Takeaway

We all have stress sometimes. For some people, it happens before having to speak in public. For other people, it might be before a first date. What causes stress for you may not be stressful for someone else. Sometimes stress is helpful—it can encourage you to meet a deadline or get things done. But feeling stressed for an extended amount of time can take a toll on your mental and physical health. Even though it may seem hard to find ways to de-stress with all the things you have to do, it's important to find those ways. Your health depends on it.

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2.4.1.1: Why Study Wellness?

As most college students do, you have probably set goals. Obviously, your individual goals differ from those of your fellow classmates, but everyone's goals share one common attribute: their intention to improve individual wellbeing. However, there are as many ideas about how to do that as there are individuals. Do your goals involve making more money, achieving better health, improving your relationships? Holistic wellness involves all those aspects of life and more. This chapter explains the importance of overall wellness, which is about more than being physically and mentally healthy, free from illness and disease. In fact, the study of wellness incorporates all aspects of life. Achieving overall wellness means living actively and fully. People in this state exude confidence, optimism, and self-efficacy; they have the energy reserves to do what needs to be done today and to plan for a better tomorrow. The most effective and transformative goals are those designed to achieve the highest level of personal wellness.

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2.4.1.2: Dimensions of Wellness

Wellness is a familiar term, but what is its true definition? Is it simply the absence of disease? This chapter will define all the components of holistic wellness and describe the factors that contribute to not only a person's physical and mental health, but also their ability to develop, thrive, succeed, enjoy life, and meet challenges head on with confidence and resolve.

To achieve this type of overall wellness, a person must be healthy in nine interconnected dimensions of wellness: physical, emotional, intellectual, spiritual, social, environmental, occupational, financial, and cultural. A description of each dimension follows.

The Nine Dimensions of Wellness

- *Occupational Wellness*
  An occupationally well person enjoys the pursuit of a career which is fulfilling on a variety of levels. This person finds satisfaction and enrichment in work, while always in pursuit of opportunities to reach the next level of professional success.
- *Financial Wellness*
  Those who are financially well are fully aware of their current financial state. They set long- and short-term goals regarding finances that will allow them to reach their personal
- *Physical Wellness*
  People who are physically well actively make healthy decisions on a daily basis. They eat a nutritionally balanced diet; they try to get an adequate amount of sleep, and they visit the doctor routinely. They make a habit of exercising three to five times per week; they have the ability to identify their personal needs and are aware of their body's limitations. They maintain positive interpersonal relationships and make healthy sexual decisions that are consistent with their personal values and beliefs.
- *Emotional Wellness*
  An emotionally well person successfully expresses and manages an entire range of feelings, including anger, doubt, hope, joy, desire, fear, and many others. People who are emotionally well maintain a high level of self-esteem. They have a positive body-image and the ability to regulate their feelings. They know where to seek support and help regarding their mental health, including but not limited to, seeking professional counseling services.
- *Intellectual Wellness*
  Those who enjoy intellectual wellness engage in lifelong learning. They seek knowledge and activities that further develop their critical thinking and heighten global awareness. They engage in activities associated with the arts, philosophy, and reasoning.
- *Spiritual Wellness*
  People who can be described as spiritually well have identified a core set of beliefs that guide their decision making, and other faith- based endeavors. While firm in their spiritual beliefs, they understand others may have a distinctly different set of guiding principles. They recognize the relationship between spirituality and identity in all individuals.
- *Social Wellness*
  A socially well person builds healthy relationships based on interdependence, trust, and respect. Those who are socially well have a keen awareness of the feelings of others. They develop a network of friends and co-workers who share a common purpose, and who provide support and validation.
- *Environmental Wellness*
  An environmentally well person appreciates the external cues and stimuli that an environment can provide. People who have achieved environmental wellness recognize the limits to controlling an environment and seek to understand the role an individual plays in the environment.
- *Cultural Wellness*
  Culturally well people are aware of their own cultural background, as well as the diversity and richness present in other cultural backgrounds. Cultural wellness implies understanding, awareness and intrinsic respect for aspects of diversity. A culturally well person acknowledges and accepts the impact of these aspects of diversity on sexual orientation, religion, gender, racial and ethnic backgrounds, age groups, and disabilities.[1]

For more information on the nine dimensions of wellness, click on the link below:

Nine Dimensions of Wellness

A video about the nine dimensions of wellness,

YouTube Video

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2.4.1.3: Health Problems in the United States

Americans today experience health problems that people who lived 100 years ago did not encounter. What are the factors that account for these health problems that have arisen over the past 100 years? Most health problems faced by people in the U.S. are chronic diseases that are preventable and caused by everyday choices and unhealthy lifestyles.

The link below provides more information about the leading causes of death in the United States:

Leading Causes of Death

To see a 2014 chart that shows the leading cause of death by age group, click on the link below:

Leading Cause of Death by Age Group

In the video below, you will learn about the determinants of health as outlined by Healthy People 2020. Healthy People 2020 is a federal advisory committee comprised of non-federal, independent subject matter experts who gather data and provide advice on how to promote health and prevent disease in America:

YouTube Video

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In the meantime, the Healthy People 2020 program has updated, and been renamed Healthy People 2030 website, which contains data and technical information about the program's objectives. The video below is the announcement for the update

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This open textbook for Concepts of Fitness and Wellness is written by Scott Flynn, Lisa Jellum, Jonathan Howard, Althea Moser, David Mathis, Christin Collins, Sharryse Henderson, and Connie Watjen. The text emphasizes the holistic approach to health, integrating physical fitness, mental well-being, and social health. It explores the significance of physical activity, nutrition, and lifestyle choices in promoting long-term health. The text also highlights the importance of personal responsibility in managing wellness, setting achievable goals, and maintaining a balanced life to improve overall quality of life.

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2.4.1: HEALTHY BEHAVIORS AND WELLNESS

By Jonathan Howard

Learning Objectives

- Define the nine dimensions of wellness
- Identify health problems in the United States
- Identify the behaviors that promote wellness
- Behavior Modification: how change occurs, barriers to change, and how to successfully
- overcome barriers and make lasting lifestyle changes

2.4.1.1: Why Study Wellness?

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2.4.1.4: Behaviors That Promote Wellness

Bad habits are hard to break, but choosing to eat healthier and exercise more provides benefits that go far beyond a more ideal body weight and shape. Being physically fit can stave off many of the diseases and medical conditions discussed in the previous section, including heart disease, the number 1 killer in America. Exercise reduces stress and eases depression. Healthier employees are also more productive. Being physically fit nurtures the mind, body, and spirit and is the cornerstone of wellness. The links below provide information about behaviors within your control that contribute to an improved quality of life and increased wellness.

Six Behaviors That Contribute to Wellness

A video on lifestyle choices and their effect on wellbeing

YouTube Video

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Behaviors that Contribute to Wellness Presentation

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2.4.1.5: Behavior Modification

Making permanent lifestyle changes is one of the greatest challenges a person can face. This section will explore how changes to behavior occur, the psychological barriers that hamper efforts to change, and tips for making lasting change.

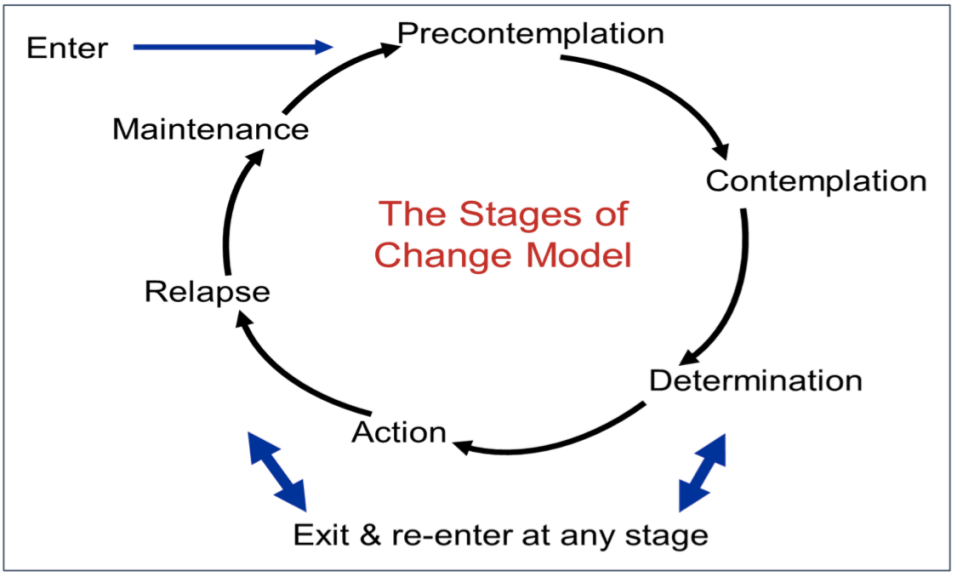
How Changes in Behavior Occur

The Transtheoretical Model, also called the **Stages of Change Model**, was developed by James Prochaska and Carlo DiClemente in the late 1970s. Considered the dominant model for describing how behavior changes occur, it evolved through studies examining the experiences of smokers who quit on their own and comparing them with the experiences of those requiring further treatment. The goal of those studies was to understand why some people were capable of quitting on their own. It was determined that people quit smoking if they were ready to do so. Thus, the Transtheoretical Model (TTM) focuses on the decision-making of the individual and is a model of intentional change. The TTM operates on the assumption that people do not change behaviors quickly and decisively. Rather, change in behavior, especially habitual behavior, occurs continuously through a cyclical process. The TTM is not a theory but a model; different behavioral theories and constructs can be applied to various stages of the model where they may be most effective.

The TTM posits that individuals move through six stages of change: precontemplation, contemplation, preparation, action, maintenance, and termination. Termination was not part of the original model and is less often used in application of stages of change for health- related behaviors. For each stage of change, different intervention strategies are most effective at moving the person to the next stage of change and subsequently through the model to maintenance, the ideal stage of behavior.

Six Stages of Change:

- *Stage 1: Precontemplation*
  In this stage, people do not intend to take action in the foreseeable future (defined as within the next 6 months). People are often unaware that their behavior is problematic or produces negative consequences. People in this stage often underestimate the pros of changing behavior and place too much emphasis on the cons of changing behavior.



- *Stage 2: Contemplation*
  In this stage, people are intending to start the healthy behavior in the foreseeable future (defined as within the next 6 months). People recognize that their behavior may be problematic, and a more thoughtful and practical consideration of the pros and cons of changing the behavior takes place, with equal emphasis placed on both. Even with this recognition, people may still feel ambivalent toward changing their behavior.

- *Stage 3: Preparation (Determination)*
  In this stage, people are ready to take action within the next 30 days. People start to take small steps toward the behavior change, and they believe changing their behavior can lead to a healthier life.
- *Stage 4: Action*
  In this stage, people have recently changed their behavior (defined as within the last 6 months) and intend to keep moving forward with that behavior change. People may exhibit this by modifying their problem behavior or acquiring new healthy behaviors.
- *Stage 5: Maintenance*
  In this stage, people have sustained their behavior change for a while (defined as more than 6 months) and intend to maintain the behavior change going forward. People in this stage work to prevent relapse to earlier stages.
- *Stage 6: Termination*
  In this stage, people have no desire to return to their unhealthy behaviors and are sure they will not relapse. Since this is rarely reached, and people tend to stay in the maintenance stage, this stage is often not considered in health promotion programs.

To progress through the stages of change, people apply cognitive, affective, and evaluative processes. Ten processes of change have been identified, with some processes being more relevant to a specific stage of change than other processes. These processes result in strategies that help people make and maintain change.

Ten Processes of Change:

1. *Consciousness Raising*Increasing awareness about the healthy behavior.
2. *Dramatic Relief*
   Emotional arousal about the health behavior, whether positive or negative arousal.
3. *Self-Reevaluation*
   Self-reappraisal to realize the healthy behavior is part of who they want to be.
4. *Environmental Reevaluation*
   Social reappraisal to realize how their unhealthy behavior affects others.
5. *Social Liberation*
   Environmental opportunities that exist to show society is supportive of the healthy behavior.
6. *Self-Liberation*
   Commitment to change behavior based on the belief that achievement of the healthy behavior is possible.
7. *Helping Relationships*
   Finding supportive relationships that encourage the desired change.
8. *Counter-Conditioning*
   Substituting healthy behaviors and thoughts for unhealthy behaviors and thoughts.
9. *Reinforcement Management*Rewarding the positive behavior and reducing the rewards that come from negative behavior.
10. *Stimulus Control*
    Re-engineering the environment to have reminders and cues that support and encourage the healthy behavior and remove those that encourage the unhealthy behavior.

Limitations of the Transtheoretical Model

Limitations of the model include the following:

- The theory ignores the social context in which change occurs, such as socioeconomic status and income.
- The lines between the stages can be arbitrary with no set criteria of how to determine a person's stage of change. The questionnaires that have been developed to assign a person to a stage of change are not always standardized or validated.
- No clear sense exists for how much time is needed for each stage, or how long a person can remain in a stage.
- The model assumes that individuals make coherent and logical plans in their decision-making process when this is not always true.

The Transtheoretical Model provides suggested strategies for public health interventions to address people at various stages of the decision-making process. Using strategies suggested by TTM can result in interventions that are more effective because they are tailored for a specific group of people. In other words, the interventions involve a message or program component that has been specifically created for a target population's level of knowledge and motivation. The TTM encourages an assessment of an individual's current stage of change and accounts for relapse in people's decision- making process.[2]

For more information about TTM, especially as it relates to exercise, watch the video

YouTube Video

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One of the most effective tools for changing behavior is goal setting. The links below provide information on how to set goals effectively to achieve greater success in goal attainment.

Goal Setting Info from Oregon State University's Academic Success Center

Two videos that may help

YouTube Video

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YouTube Video

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Making S.M.A.R.T. Goals Activity

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2.4.1.6: Lifestyle Modification Barriers

Dr. James M. Olson, a psychology professor at the University of Western Ontario, London, has identified several psychological barriers that commonly prevent people from taking action, even when inaction poses a threat to their health. These barriers occur during 3 stages of behavior modification: admission of the problem, initial attempts to change, and long-term change as outlined below:

- *Barriers to Admission of the problem*
  The first step in lasting change is admitting a problem exists. People often fail to change behavior that poses a risk to their health because they deny a risk exists, trivialize their personal risk, feel invulnerable, make a faulty conceptualization, (i.e., they attribute early warning signs to a benign cause), or experience debilitating emotions when contemplating preventative measures.
- *Barriers to Initial Attempts to Change*
  At this stage, people acknowledge the need to change but struggle to accomplish their goals. This failure is a result of lack of knowledge, low self-efficacy (the belief in one's own ability to succeed at change), and dysfunctional attitudes.
- *Barriers to long-term change*
  Just because a person has experienced success in changing a behavior, that doesn't mean the change is permanent. Barriers to long-term change include cognitive and motivational drift (diminishing enthusiasm for the need to change), lack of perceived improvement, lack of social support, and lapses.

To read more about these barriers to change, including strategies for overcoming these barriers, read Dr. Olson's entire article linked below:

Psychological Barriers to Behavior Change

A presentation on overcoming barriers to change by the National Institute for Health and Clinical Excellence (NHS) is linked below:

Overcoming Barriers to Change

Fostering Wellness in Your Life

You are once again feeling motivated to eat better, exercise more, drink less caffeine or make any number of the positive lifestyle changes you have been telling yourself you want to make. You have tried before— probably declaring another attempt as a New Year's resolution—but without experiencing much success. Making a lifestyle change is challenging, especially when you want to transform many things at once. This time, think of those changes not as a resolution but as an evolution.

Lifestyle changes are a process that take time and require support. Once you are ready to make a change, the difficult part is committing and following through. So do your research and make a plan that will prepare you for success. Careful planning means setting small goals and taking things one step at a time.

Here are five tips from the American Psychological Association (APA) that will assist you in making lasting, positive lifestyle and behavior changes:

- *Make a plan that will stick.*
  Your plan is a map that will guide you on this journey of change. You can even think of it as an adventure. When making your plan, be specific. Want to exercise more? Detail the time of day when you can take walks and how long you will walk. Write everything down, and ask yourself if you are confident that these activities and goals are realistic for you. If not, start with smaller steps. Post your plan where you will most often see it as a reminder.
- *Start small.*
  After you've identified realistic short-term and long-term goals, break down your goals into small, manageable steps that are specifically defined and can be measured. Is your long-term goal to lose 20 pounds within the next five months? A good weekly goal would be to lose one pound a week. If you would like to eat healthier, consider as a goal for the week replacing dessert with a healthier option, like fruit or yogurt. At the end of the week, you will feel successful knowing you met your goal.
- *Change one behavior at a time*. Unhealthy behaviors develop over the course of time, so replacing unhealthy behaviors with

healthy ones requires time. Many people run into problems when they try to change too much too fast. To improve your success, focus on one goal or change at a time. As new healthy behaviors become a habit, try to add another goal that works toward the overall change you are striving for.

- *Involve a buddy.*
  Whether it be a friend, co-worker or family member, someone else on your journey will keep you motivated and accountable. Perhaps it can be someone who will go to the gym with you or someone who is also trying to stop smoking. Talk about what you are doing. Consider joining a support group. Having someone with whom to share your struggles and successes makes the work easier and the mission less intimidating.
- *Ask for support.*
  Accepting help from those who care about you and will listen strengthens your resilience and commitment. If you feel overwhelmed or unable to meet your goals on your own, consider seeking help from a psychologist. Psychologists are uniquely trained to understand the connection between the mind and body, as well as the factors that promote behavior change. Asking for help does not mean a lifetime of therapy; even just a few sessions can help you examine and set attainable goals or address the emotional issues that may be getting in your way.

Start with “Why?”

Making changes in habitual behavior requires a deep and abiding belief that change is needed. Your desire to change may be motivated by personal goals, or it may be the result of the impact your improved wellness will have on those you love. Nietzsche said, “He who has a strong enough *why* can bear almost any *how*.”

Once you have a compelling reason to change, develop a plan and commit to that plan. If you experience a moment of weakness, do not waste time on self- condemnation. Revisit your compelling reason and reaffirm your commitment to change. The health, peace, and sense of wellbeing inherent in the highest level of your own personal wellness is more than worth the effort required to change.

For more information about making permanent lifestyle changes, go to the APA website linked below:

LIfestyle Changes That Last

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2.4.1.7: Assessing Your Personal Lifestyle Behaviors

Complete the following lab. Please print, complete, and submit the evaluation linked below to D2L.

Lifestyle Evaluation Lab

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[1]Auburn University. Division of Student Affairs.

[2]Boston University School of Public Health.

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2.4.2.1: Exercise- Not a Passing Fad

The benefits of physical activity and exercise are universally recognized—and have been for far longer than one might think. Our Paleolithic ancestors regularly engaged in physical activity to survive. However, rather than chasing after a soccer ball to win a game or taking a leisurely stroll down a tree-lined path, they "worked out" by chasing after their next meal. For them, no exercise meant no food. How's that for a health benefit?

With the advent of sedentary agriculture some 10,000 years ago, that same level of peak performance was no longer necessary. As our ancestors continued to devise more advanced means of acquiring food, physical activity declined. It wasn't until the fourth century BCE, that the Greek physician Herodicus, recognized the importance of being physically active outside of a hunter-gatherer society. He practiced gymnastic medicine, a branch of Greek medicine that relied on vigorous exercise as a treatment. During that same time period, Hippocrates, who is often referred to as the Father of Modern Medicine, asserted, "If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health." In the 12 century CE, the Jewish philosopher Rabbi Moses ben Maimon, a physician to the Sultan of Egypt, stated, "Anyone who lives a sedentary life and does not exercise, even if he eats good foods and takes care of himself according to proper medical principles, all his days will be painful ones and his strength will wane." The 15th century theologian and scholar Robert Burton went so far as to declare that *not* exercising, or "idleness" as he referred to it in his widely read tome, *The Anatomy of Melancholy*, was the "bane of body and mind." Burton also warned that the lack of exercise was the sole cause of melancholy (the name given depression at that time) and "many other maladies." Burton claimed that idleness was one of the seven deadly, as well as "the nurse of naughtiness," and the "chief author of mischief." For Burton, exercise was not only essential for good health, but a means of avoiding eternal damnation.

By the 16th century, the benefits of exercise were widely accepted, at least among the wealthy and the educated, who had access to leisure. During this time period, H. Mercuralis defined exercise as "the deliberate and planned movement of the human frame, accompanied by breathlessness, and undertaken for the sake of health or fitness." This definition is still widely used today.

Beyond the physical health benefits, there are affective benefits associated with group games and activities. Ancient Mayans organized the first team game called the Ball Game. It consisted of two teams trying to get a ball through a hoop mounted approximately 23 feet on a wall. The rules were to get the ball through the hoop using certain parts of the body. In some cases the captain of the losing team gave himself as a human sacrifice to the winning team, an act that was believed by the Mayans to be a vital part of prosperity.

American Indians are thought to have founded the modern game of lacrosse, as well as other stick games. Lacrosse, which received its name from French settlers, was more than a form of recreation. It was a cultural event used to settle disputes between tribes.



Figure 2.4.2.1.1: *Lacrosse Players. George Catlin. Date*

unknown.

The outcome of the game, as well as the choosing of teams, was thought to be controlled supernaturally. As such, game venues and equipment were prepared ritualistically.

From Ancient History to Modern Times

In retrospect, the perceived benefits of exercise have changed very little since Herodicus or the American Indians. Mounting research supports historical assertions that exercise is vital to sustaining health and quality of life. Culturally, sports play a huge role in growth and development of youth and adults. Physically, there is indisputable evidence that regular exercise promotes healthy functioning of the brain, heart, and the skeletal and muscular systems. Exercise also reduces risk for chronic diseases, such as cancer, diabetes, and obesity. Regular exercise can even improve emotional health and overall wellbeing.

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2.4.2.2: What are Physical Activity and Exercise?

Physical activity is defined as any movement carried out by skeletal muscle that requires energy and is focused on building health. Health benefits include improved blood pressure, blood-lipid profile, and heart health. Acceptable physical activity includes yard work, house cleaning, walking the dog, or taking the stairs instead of the elevator. Physical activity does not have to be done all it once. It can be accumulated through various activities throughout the day. Although typing on a phone or laptop or playing video games does involve skeletal muscle and requires a minimal amount of energy, the amount required is not sufficient to improve health.

Despite the common knowledge that physical activity is tremendously beneficial to one's health, rates of activity among Americans continue to be below what is needed. According to the Center for Disease Control (CDC), only 1 in 5 (21%) of American adults meet the recommended physical activity guidelines from the Surgeon General. Less than 3 in 10 high school students get 60 minutes or more of physical activity per day. Non-Hispanic whites (26%) are more active than their Hispanic (16%) and Black counterparts (18%) as is the case for males (54%) and females (46%). Those with more education and those whose household income is higher than poverty level are more likely to be physically active.1

The word *exercise*, although often used interchangeably with the phrase *physical activity*, denotes a sub-category of physical activity. **Exercise** is a planned, structured, and repetitive movement pattern intended to improve fitness. As a positive side-effect, it significantly improves health as well. Fitness improvements include the heart's ability to pump blood, increased muscle size, and improved flexibility.

Components of Health-Related Fitness

In order to carry out daily activities without being physically overwhelmed, a minimal level of fitness is required. To perform daily activities without fatigue, it is necessary to maintain health in five areas: cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition. These five areas are called the components of health- related fitness. Development of these areas will improve your quality of life, reduce your risk of chronic disease, and optimize your health and well-being. Each of these 5 areas will be explored in depth at a later time. Below is a brief description of each.

- *Cardiorespiratory endurance*Cardiorespiratory endurance is the ability to carry out prolonged, large muscle, dynamic movements at a moderate to high level of intensity. This relates to your heart's ability to pump blood and your lungs' ability to take in oxygen.
- *Muscular strength*
  Muscular strength is the ability of the muscles to exert force over a single or maximal effort.
- *Muscular endurance*
  Muscular endurance is the ability to exert a force over a period of time or repetitions.
- *Flexibility*
  Flexibility is the ability to move your joints through a full range of motion.
- *Body Composition*
  Body composition is the relative amount of fat mass to fat-free mass.

As previously stated, these areas are significant in that they influence your quality of life and overall health and wellness.

Skill-Related Components of Fitness

In addition to the 5 health-related components, there are 6 skill-related components that assist in developing optimal fitness: speed, agility, coordination, balance, power, and reaction time. Although important, these areas do not directly affect a person's health. A person's ability to perform ladder drills (also known as agility drills) is not related to his/her heart health. However, coordination of muscle movements may be helpful in developing muscular strength through resistance training. As such, they may indirectly affect the 5 areas associated with health-related fitness. Skill- related components are more often associated with sports performance and skill development.

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2.4.2: FITNESS PRINCIPLES

By Scott Flynn

Learning Objectives

- Describe the origins of exercise
- Define physical activity and exercise
- Discuss principles of adaptation to stress
- Provide guidelines for creating a successful fitness program
- Identify safety concerns

2.4.2.1: Exercise- Not a Passing Fad

2.4.2.2: What are Physical Activity and Exercise?

2.4.2.3: Principles of Adaptation to Stress

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2.4.2.3: Principles of Adaptation to Stress

The human body adapts well when exposed to stress. The term *stress*, within the context of exercise, is defined as an exertion above the normal, everyday functioning. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. For example, a secretary who sits at a desk all day may push his/her cardiorespiratory system to its limits simply by walking up several flights of stairs. For an avid runner, resistance training may expose the runner's muscles to muscular contractions the athlete is not accustomed to feeling. Although stress is relative to each individual, there are guiding principles in exercise that can help individuals manage how much stress they experience to avoid injury and optimize their body's capacity to adapt. Knowing a little about these principles provides valuable insights needed for organizing an effective fitness plan.

Overload Principle

Consider the old saying, "No pain, no gain." Does exercise really have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even increased sweating for temperature regulation. As these subsequent adaptations occur, the stress previously experienced during the same activity, feels less stressful in future sessions. As a result of the adaptation, more stress must be applied to the system in order to stimulate improvements, a principle known as the **overload principle**.

For example, a beginning weightlifter performs squats with 10 repetitions at 150 pounds. After 2 weeks of lifting this weight, the lifter notices the 150 pounds feels easier during the lift and afterwards causes less fatigue. The lifter adds 20 pounds and continues with the newly established stress of 170 pounds. The lifter will continue to get stronger until his/her maximum capacity has been reached, or the stress stays the same, at which point the lifter's strength will simply plateau. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

FITT

In exercise, the amount of stress placed on the body can be controlled by four variables: **F**requency, **I**ntensity, **T**ime (duration), and **T**ype, better known as FITT. The FITT principle, as outlined by the American College of Sports Medicine (ACSM) falls under the larger principle of overload.

Frequency and Time

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A beginner may determine that 2–3 exercise sessions a week are sufficient enough to stimulate improvements. On the other hand, a seasoned veteran may find that 2–3 days is not enough to adequately stress the system. According to the overload principle, as fitness improves, so must the stress to ensure continued gains and to avoid plateauing.

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon.

Although independent of one another, frequency and time are often combined into the blanket term, **volume**. The idea is that volume more accurately reflects the amount of stress experienced. This can be connected to the **progression principle**. For example, when attempting to create a jogging plan, you may organize 2 weeks like this:

- Week 1: three days a week at 30 minutes per session
- Week 2: four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, the aggressive nature of the progression is revealed. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes, equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burnout, severe fatigue, and injury. The progression principle relates to an optimal overload of the body by finding an amount that will drive adaptation without compromising safety.

Type of Exercise

Simply put, the type of exercise performed should reflect a person's goals. In cardiorespiratory fitness, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. As such, these activities can be used to build lung capacity and improve cellular and heart function.

However, the more specific the exercise, the better. While vigorous ballroom dancing will certainly help develop the cardiorespiratory system, it will unlikely improve a person's 10k time. To improve performance in a 10k, athletes spend the majority of their time training by running, as they will have to do in the actual 10k. Cyclists training for the Tour de France, spend up to six hours a day in the saddle, peddling feverishly. These athletes know the importance of training the way they want their body to adapt. This concept, called the **principle of specificity**, should be taken into consideration when creating a training plan.

In this discussion of type and the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity and requires energy (ATP) to be produced primarily through anaerobic pathways, that is, pathways not requiring oxygen to produce ATP. Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces requires aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter, so the energy systems will adequately adapt.

Likewise, force stress accounts for the amount of force required during an activity. In weightlifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers, which are unable to generate as much force as the fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory systems. As an adaptation to the heat, the amount of sweating increases as does plasma volume, making it much easier to keep the body at a normal temperature during exercise. The only way to adapt is through heat exposure, which can take days to weeks to properly adapt.

In summary, to improve performance, being specific in your training, or training the way you want to adapt, is paramount.

Intensity

Intensity, the degree of difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the other components, intensity drives adaptation. Because of its importance, it is imperative for those beginning a fitness program to quantify intensity, as opposed to estimating it as hard, easy, or somewhere in between. Not only will this numeric value provide a better understanding of the effort level during the exercise session, but it will also help in designing sessions that accommodate individual goals.

How then can intensity be measured? Heart rate is one of the best ways to measure a person's effort level for cardiorespiratory fitness. Using a percentage of maximum lifting capacity would be the measure used for resistance training.

Rest, Recovery, and Periodization

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The **principle of rest and recovery** (**or principle of recuperation**) suggests that rest and recovery from the stress of exercise must take place in proportionate amounts to avoid too much stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without overstressing the athlete. This training principle, called **periodization**, is especially important to serious athletes but can be applied to most exercise plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest.

Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macrocycles, respectively. An example of this might be:

Week	Frequency	Intensity	Time	Type
1	3 days	40% HRR	25 min	walk
2	4 days	40% HRR	30 min	walk
3	4 days	50% HRR	35 min	walk
4	2 days	30% HRR	30 min	other

As this table shows, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be “stress” weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as**overtraining syndrome**. Overtraining syndrome is not well understood. However, experts agree that a decline in performance resulting from psychological and physiological factors cannot be fixed by a few days’ rest. Instead, weeks, months, and sometimes even years are required to overcome the symptoms of overtraining syndrome. Symptoms include the following:

- Weight loss
- Loss of motivation
- Inability to concentrate or focus
- Feelings of depression
- Lack of enjoyment in activities
- Normally considered enjoyable
- Sleep disturbances
- Change in appetite

Reversibility

Chronic adaptations are not permanent. As the saying goes, “Use it or lose it.”
The **principle of reversibility** suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called **detraining**, adaptations will recede.

In cardiorespiratory endurance, key areas, such as VO_{2max}, stroke volume, and cardiac output all declined with detraining while submaximal heat rate increased. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase, VO_{2max} had fallen by 27% and stroke volume and cardiac output had fallen by 25%. The most well-trained subjects in the study had to train for nearly 40 days following bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in the blood after a 2- minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid

was dramatically affected.[2]

Not only is endurance training affected, but muscular strength, muscular endurance, and flexibility all show similar results after a period of detraining.

Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their VO_{2max}, increasing their time to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen was seen by individuals and families. Those who saw the most improvements saw similar percentage improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

In addition to genes, other factors can affect the degree of adaptation, such as a person's age, gender, and training status at the start of a program. As one might expect, rapid improvement is experienced by those with a background that includes less training, whereas those who are well trained improve at a slower rate.

Activity Guidelines

Below are links to the physical activity guidelines provided by the US Department of Health and Human Services and the American College of Sports Medicine (ACSM). As you review these recommendations, notice how closely they follow the FITT pattern described earlier in the chapter.

NIH Recommendations for Physical Activity

ACSM Physical Activity Guidelines

Fitness Guidelines

The recommendations linked above pertain to physical activity only. While they can be applied to fitness, more specific guidelines have been set to develop fitness. As stated previously, physical activity is aimed at improving health; exercise is aimed at improving health and fitness. These guidelines will be referenced often as each health-related component of fitness is discussed.

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2.4.2.4: Creating a Successful Fitness Plan

Often, the hardest step in beginning a new routine is simply starting the new routine. Old habits, insufficient motivation, lack of support, and time constraints all represent common challenges when attempting to begin a new exercise program. Success, in this case, is measured by a person's ability to consistently participate in a fitness program and reap the fitness benefits associated with a long-term commitment.

Think Lifestyle

Beginning a fitness program is a daunting task. To illustrate the concept of lifestyle, consider attendance at fitness centers during the month of January. Attendance increases dramatically, driven by the number 1 New Year's resolution in America: losing weight. Unfortunately, as time marches on, most of these new converts do not. By some estimates, as many as 80% have stopped coming by the second week in February. As February and March approach, attendance continues to decline, eventually falling back to pre-January levels.

Why does this occur? Why aren't these new customers able to persist and achieve their goal of a healthier, leaner body? One possible explanation: patrons fail to view their fitness program as a lifestyle. The beginning of a new year inspires people to make resolutions, set goals, as they envision a new and improved version of themselves. Unfortunately, most of them expect this transformation to occur in a short period of time. When this does not happen, they become discouraged and give up.

Returning to teen level weight and/or fitness may be an alluring, well-intended goal, but one that is simply unrealistic for most adults. The physical demands and time constraints of adulthood must be taken into consideration for any fitness program to be successful. Otherwise, any new fitness program will soon be abandoned and dreams of physical perfection fade, at least until next January.

Like any other lifestyle habit, optimal health and fitness do not occur overnight. Time and, more importantly, consistency, drive successful health and fitness outcomes. The very term *lifestyle* refers to changes that are long term and become incorporated into a person's daily routine. Unlike many fad diets and quick fixes advertised on television, successful lifestyle changes are also balanced and reasonable. They do not leave you feeling depressed and deprived after a few days. Find a balance between what you want to achieve and what you are realistically able to do. Finally, you must do more than simply change your behaviors. You must also modify your mental perception to promote long-term health. Find a compelling reason for incorporating healthier behaviors into your daily routine.

The steps below will guide you through this process. Before beginning a fitness program, you should understand the safety concerns associated with exercise.

Safety First: Assessing Your Risk

The physical challenges of beginning a new exercise program increase the risk of injury, illness, or even death. Results from various studies suggest vigorous activity increases the risk of acute cardiac heart attacks and/or sudden cardiac death.3 While that cautionary information appears contradictory to the previously identified benefits of exercise, the long-term benefits of exercise unequivocally outweigh its risks. In active young adults (younger than 35), incidence of cardiac events are still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 experience a cardiac event. 4

Of those rare cardiac incidents that do occur, the presence of preexisting heart disease is the common thread, specifically, atherosclerosis. **Atherosclerosis** causes arteries to harden and become clogged with plaque, which can break apart, move to other parts of the body, and clog smaller blood vessels. As such, it is important to screen individuals for risk factors associated with heart disease before they begin an exercise program.

The American College of Sports Medicine recommends a thorough pre-screening to identify any risk of heart disease. The 7 major risk factors associated with increased risk of heart disease are identified below.[5]

- *Family history*
  Having a father or first-degree male relative who has experienced a cardiac event before the age of 55, or a mother or first-

degree female relative who has experienced a cardiac event before age 65, could indicate a genetic predisposition to heart disease.
- *Cigarette smoking*
  The risk of heart disease is increased for those who smoke or have quit in the past 6 months.
- *Hypertension*
  Having blood pressure at or above 140 mm/HG systolic, 90 mm/Hg diastolic is associated with increased risk of heart disease.
- *Dyslipidemia*
  Having cholesterol levels that exceed recommendations (130 mg/dL, HDL below 40 mg/dL), or total cholesterol of greater than 200 mg/dL increases risk.
- *Impaired fasting glucose (diabetes)*Blood sugar should be within the recommended ranges.
- *Obesity*
  Body mass index greater than 30, waist circumference of larger than 102 cm for men and larger than 88 cm for women, or waist to hip ratio of less than 0.95 men, or less than 0.86 women increases risk of heart disease.
- *Sedentary lifestyle*
  Persons not meeting physical activity guidelines set by US Surgeon General's Report have an increased risk of heart disease.

In addition to identifying your risk factors, you should also complete a Physical Activity Readiness Questionnaire (PAR-Q) before beginning an exercise program. The PAR-Q asks yes or no questions about symptoms associated with heart disease. Based on your responses on the PAR-Q, you will be placed into a risk category: low, moderate, high.

- Low risk persons include men younger than 45, and women younger than 55, who answer no to all of the PAR-Q questions and have one or no risk factors. Although further screening is a good idea, such as getting physician's approval, it isn't necessary.
- Moderate risk persons are men of or greater than 45, women 55 or those who have two or more risk factors. Because of the connection between cardiac disease, the seven risk factors, and risk during exercise, it is recommended you get a physician's approval before beginning an exercise program.
- High risk persons answer yes to one or more of the questions on the PAR-Q. Physician's approval is required before beginning a program.

Once you have determined your ability to safely exercise, you are ready to take the next steps in beginning your program. Additional safety concerns, such as where you walk and jog, how to be safe during your workout, and environmental conditions, will be addressed at a later time.

As you review the remaining steps, a simple analogy may help to better conceptualize the process.

Imagine you are looking at a map because you are traveling to a particular location and you would like to determine the best route for your journey. To get there, you must first determine your current location and then find the roads that will take you to your desired location. You must also consider roads that will present the least amount of resistance, provide a reasonably direct route, and do not contain any safety hazards along the way. Of course, planning the trip, while extremely important, is only the first step. To arrive at your destination, you must actually drive the route, monitoring your car for fuel and/or malfunction, and be prepared to reroute should obstacles arise.

Preparing yourself for an exercise program and ultimately, adopting a healthier lifestyle, requires similar preparation. You will need to complete the following steps:

- *Assess your current fitness*Where are you on the map?
- *Set goals*
  What is your destination's location?
- *Create a plan*
  What route will you choose?
- *Follow through*Start driving!

Assess Your Condition

To adequately prepare, you will need to take a hard look at your current level of

fitness. With multiple methods of assessing your fitness, you should select the one that most closely applies to you. Obtaining a good estimate will provide you a one-time glance at your baseline fitness and health and provide a baseline measurement for

gauging the efficacy of your fitness program in subsequent reassessments.

Assessments are specific to each health- related component of fitness. You will have the opportunity to assess each one in the near future.

Set Goals

Using the map analogy, now that you know your current location, you must determine your destination and the best route for getting there. You can start by setting goals. In his bestselling book, *The 7 Habits of Highly Effective People*, author Stephen Covey suggests you should "Begin with the end in mind."7 While Covey's words may not be directly aimed at those seeking to complete a fitness program, his advice is useful to anyone making a significant lifestyle change. To be successful, you must develop a clear vision of your destination. Setting specific goals about how you want to feel and look, increases your chances of success. Without specific goals to measure the success of your efforts, you could possibly exceed your target and believe you failed.

The art of setting goals includes stating them in a clearly defined and measurable way. Consider exactly what you would like to accomplish, make certain your goals can be measured, and establish a reasonable timeframe in which to achieve your goals.

Goals that meet these guidelines are referred to as S.M.A.R.T. goals.

- **S**pecific
  Be as specific and detailed as possible in creating your goal.
- **M**easurable: If your goal cannot be measured, you will not know when you have successfully completed the goal.
- **A**ttainable
  Consider whether you have the resources—such as time, family support, and financial means—to obtain your goal.
- **R**ealistic
  While your goal should be challenging, it should not exceed reasonable expectations.
- **T**imeframe
  Set a deadline to accomplish your goal.

A well-stated goal contains all of the SMART components listed above. Take a look at the well-stated example below:

Example 2.4.2.4.1:

I will improve my 12-minute distance by 10% within 2 months of the first assessment.

Note, all the ingredients of a well-stated goal are present. It is specific (improve 12- minute distance by 10%), measurable (10% improvement), attainable and realistic (the degree of improvement is reasonable in that time frame), and includes a time frame (a clear deadline of 2 months).

Less effective goals would be stated like this:

- I will run farther next time I assess my fitness.
- I want to jog faster.
- I will lose weight

And a common one:

- I will exercise 3 days a week at 60% max heart rate for 45 minutes per session for 2 months.

At a closer glance, none of these examples contain all of the ingredients of a well- stated goal. How can "faster" be measured? "Farther" is not specific enough, nor is "lose weight." In the last example, this is not a goal at all. It is a plan to achieve a goal that has not been stated.

In the end, setting up well-stated goals will give you the best chance to convert good intentions into a healthier lifestyle.

To complete this step, write down 2-3 personal goals, stated in the SMART format, and put them in a place you will see them frequently.

Create a Plan

Once you know exactly what you want to achieve, generate a strategy that will help you reach your goals. As you strategize, your goal is to determine the frequency, the intensity, and the duration of your exercise sessions. While doing this, it is imperative to keep in mind a few key principles.

First, use your goals as the foundation for your program. If your goal is related to weight loss, this should drive the frequency, duration, and intensity of your daily workouts as these variables will influence your body's use of fat for fuel and the number of calories burned. If you feel more interested in improving your speed, you will need to dedicate more workout time to achieving those results.

Another key principle is the importance of safety. The importance of designing a program that is safe and effective cannot be overstated. You can minimize any risks by relying on the expert recommendations of the US Department of Health and Human Services and the American College of Sports Medicine previously outlined and linked here. These highly reputable organizations have conducted extensive research to discover the optimal frequency, intensity, and duration for exercise.

Follow Through

Once you have assessed your current fitness levels, set goals using the SMART guidelines, and created your personalized fitness plan, you should feel very proud of yourself! You have made significant progress toward achieving a healthier lifestyle. Now is when the "rubber hits the road." (Literally so, if your plan includes walking or jogging.) Now that you have invested time and energy to develop a thoughtful, well-designed fitness program, it is time to reap the returns of good execution. The assessment, planning and preparation are really the hardest parts. Once you know what to do and how to do it, success is simply a matter of doing it.

Unfortunately, the ability to stick with a program proves difficult for most. To prevent getting derailed from your program, identify barriers that may prevent you from consistently following through. One of the most common challenges cited is a shortage of time. Work schedules, school, child care, and the activities of daily living can leave you with little time to pursue your goals. Make a list of the items that prevent you from regularly exercising and then analyze your schedule and find a time for squeezing in your exercise routine. Regardless of when you schedule your exercise, be certain to exercise consistently. Below are a few additional tips for achieving consistency in your daily fitness program:

- *Think long term; think lifestyle.*
  The goal is to make exercise an activity you enjoy every day throughout your life. Cultivating a love for exercise will not occur overnight and developing your ideal routine will take time. Begin with this knowledge in mind and be patient as you work through the challenges of making exercise a consistent part of your life.
- *Start out slowly.*
  Again, you are in this for the long haul. No need to overdo it in the first week. Plan for low intensity activity, for 2–3 days per week, and for realistic periods of time (20–30 minutes per session).
- *Begin with low Intensity/low volume.*
  As fitness improves, you will want to gradually increase your efforts in terms of quantity and quality. You can do this with more time and frequency (called volume) or you can increase your intensity. In beginning a program, do not change both at the same time.
- *Keep track.*
  Results from a program often occur slowly, subtly, and in a very anti- climactic way. As a result, participants become discouraged when immediate improvements are not visible. Keeping track of your consistent efforts, body composition, and fitness test results and seeing those subtle improvements will encourage and motivate you to continue.
- *Seek support.*
  Look for friends, family members, clubs, or even virtual support using apps and other online forums. Support is imperative as it provides motivation, accountability, encouragement, and people who share a common interest, all of which are factors in your ability to persist in your fitness program.
- *Vary your activities from time to time.*
  Your overall goals are to be consistent, build your fitness, and reap the health benefits associated with your fitness program. Varying your activities occasionally will prevent boredom. Instead of walking, play basketball or ride a bike. Vary the location of your workout by discovering new hiking trails, parks or walking paths.
- *Have fun.*
  If you enjoy your activities, you are far more likely to achieve a lasting lifestyle change. While you cannot expect to be exhilarated about exercising every day, you should not dread your daily exercise regimen. If you do, consider varying your

activities more, or finding a new routine you find more enjoyable.

- *Eat healthier*.
  Nothing can be more frustrating than being consistent in your efforts without seeing the results on the scale. Eating a balanced diet will accelerate your results and allow you to feel more successful throughout your activities.

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2.4.2.5: Additional Safety Concerns

As activity rates among Americans increase, specifically outdoor activities, safety concerns also rise. Unfortunately, the physical infrastructure of many American cities does not accommodate active lifestyles. Limited financial resources and de-emphasis on public health means local and state governments are unlikely to allocate funds for building roads with sidewalks, creating walking trails that surround parks, or adding bike lanes. In addition, time constraints and inconvenience make it challenging for participants to travel to areas where these amenities are available. As a result, exercise participants share roads and use isolated trails/pathways, inherently increasing the safety risks of being active.

A key principle in outdoor safety is to recognize and avoid the extremes. For example, avoid roads that experience heavy traffic or are extremely isolated. Avoid heavy populated areas as well as places where no one is around. Do not exercise in the early morning or late at night, during extreme cold or extreme heat. To minimize safety risks during these types of environmental conditions, do not use headphones that could prevent you from hearing well and remaining alert, do not exercise alone, prepare for adequate hydration in the heat, and use warm clothing in extreme cold to avoid frostbite. Extreme conditions require extra vigilance on your part.

A second key principle, whether outdoor or indoor, is to simply use common sense. While this caveat seems obvious, it gets ignored far too often. Always remember the purpose of your exercise is for enjoyment and improved health. If these objectives could be compromised by going for a run at noon in 95-degree heat, or lifting large amounts of weight without a spotter, you should reconsider your plan. Before exercising in what could be risky conditions, ask yourself, “Is there a safer option available?”

Lastly, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy nature, but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions are additional variables to avoid in order to complete your exercise session without an accident.

The document linked below from the University of Texas at San Antonio Police Department outlines specific safety tips that will help you stay safe in your activities.

Safety Tips for Runners, Walkers, and Joggers

Environmental Conditions

When exercising outdoors, you must consider the elements and other factors that could place you at increased risk of injury or illness.

Heat-Related Illness

Heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, contributed to 7,233 deaths in the United States between 1999 and 2009. A 2013 report released by the Center for Disease Control stated that about 658 deaths from heat-related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.[8]

The number one risk factor associated with heat-related illness is hydration, the starting point of all heat-related illness. Unfortunately, sweat loss can occur at a faster rate than a person can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring hydration levels can assist in preventing illness. One simple method, while not full proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2–3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout (see lab). This is a great way to see firsthand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre- and post-body weight by drinking fluids during and after the workout to restore what was lost. This method, when combined with urine-

monitoring, can provide a fairly accurate assessment of hydration levels.

The best preventative measure for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48–64 oz. per day, per person. In an effort to individualize hydration, experts now recommend basing fluid intake on individual size, gender, activity levels, and climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.[9] For a 150-pound individual, this would mean 75–150 ounces of water per day! While there is still considerable debate over the exact amounts, no one disputes the importance of continually monitoring your hydration using one of the techniques described previously. Insufficient hydration leads to poor performance, poor health, and potentially serious illness.

It should be noted that electrolyte "sport" drinks, such as Gatorade and PowerAde, are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost through sweating during physical activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can create conditions equally as dangerous if you fail to take proper precautions. To minimize the risk of cold-related illness, you must prevent the loss of too much body heat. The three major concerns related to cold- related illnesses are hypothermia, frost-nip, and frost bite.

As with heat-related illness, the objective of preventing cold-related illness is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear, indicating the need to take action. Some of those symptoms include:

- Shivering
- Numbness and stiffness of joints and appendages
- Loss of dexterity and/or poor coordination
- Peeling or blistering of skin, especially to exposed areas
- Discoloration of the skin in the extremities

When walking or jogging in the cold, it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- *Hydration is key*.
  Cold air is usually drier air, which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.
- *Stay dry*.
  Heat loss occurs 25x faster in water than on dry land. As such, keeping shoes and socks dry and clothing from accumulating too much sweat will allow for more effective body temperature regulation.
- *Dress appropriately*.
  Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture-wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin, and any additional layers of clothing, without it becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can breathe.
- *Cover the extremities*.
  Those parts of the body farthest away from the heart (toes, fingers, and ears) tend to get coldest first. Take the appropriate steps to cover those areas by using gloves, moisture-wicking socks, and a winter cap to cover your head.

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2.4.3.1: What is the cardiovascular and respiratory system?

Imagine for a moment climbing to the top of Mt. Everest, a challenging feat very few have accomplished. In the process, you gradually ascend from base camp, which sits at about 17,500 feet above sea level, to the peak at over 29,000 feet. At this elevation, the pressure of oxygen is so low, you struggle to take in a satisfying breath. Although you strive to breathe deeply, you are unable to get enough air. Your heart rate increases and you might even develop nausea and a headache. Unless your body has a chance to acclimate itself to higher elevations or you gain access to supplemental oxygen, your symptoms will persist or worsen.

These are the sensations many people with cardiovascular or respiratory illnesses, such as asthma, chronic bronchitis, or mild cardiovascular disease, experience on a daily basis. Climbing up a flight of steps may leave them gasping for air, as would walking briskly or even breathing in cold air. Regardless of the cause, being unable to take in sufficient air can create a sense of panic and cause serious physical discomfort. The goal of this short narrative is to engender an appreciation for the simple act of breathing and the ensuing satisfaction that comes with each life-sustaining breath. For most people, unless they engage in strenuous physical activity, such as jogging or climbing a flight of stairs, their **cardiovascular and respiratory system** (heart, blood vessels, and lungs) operates efficiently enough to go unnoticed. However, does that mean their cardiorespiratory (CR) system is functioning at optimal capacity, or could it be operating at a minimum level and experiencing problems that go undetected? This chapter defines cardiorespiratory fitness, examines the benefits of a healthy CR system, and explores how to effectively assess and improve the CR system.

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2.4.3.2: The Benefits of Good Cardiorespiratory Health

The link below provides a list of specific benefits:

- List of Benefits

The article linked below describes how exercise protects against Cardiovascular Disease (CVD):

- Preventing CVD

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2.4.3: CARDIORESPIRATORY FITNESS

By Scott Flynn

Learning Objectives

- Define the cardiovascular and respiratory system
- Describe how the cardiorespiratory system works
- Identify the benefits of cardiorespiratory fitness
- What is the importance of this system?
- Identify methods for assessing and improving the CR system

2.4.3.1: What is the cardiovascular and respiratory system?

2.4.3.2: The Benefits of Good Cardiorespiratory Health

2.4.3.3: How the CR System Works

2.4.3.4: The CR System and Energy Production

2.4.3.5: Oxidative Energy System (Aerobic)

2.4.3.6: Immediate/Explosive Energy System

2.4.3.7: Non-Oxidative or Anaerobic Energy System

2.4.3.8: Energy Systems Combine

2.4.3.9: Changes in the CR System

2.4.3.10: Assessing CR Fitness

2.4.3.11: Creating a Plan to Develop CR Fitness

2.4.3.12: Measuring Heart Rate

2.4.3.13: Measuring Intensity

2.4.3.14: Cardiorespiratory Fitness Assessment

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2.4.3.3: How the CR System Works

The cardiorespiratory system operates to obtain and circulate vital compounds throughout the body—specifically, oxygen and nutrients, such as food energy, vitamins, and minerals. Both oxygen and nutrients, which are imperative for cellular energy production, must be taken in from the lungs and digestive system. Because the heart and lungs are so interlocked in this process, the two systems are often labeled together as the cardiorespiratory system. Without a healthy respiratory system, the body would struggle to bring in enough oxygen, release **carbon dioxide** (the chemical waste product of cellular metabolism) and eliminate unwanted particles that enter the respiratory tract when inhaling. Without a healthy heart, transporting oxygen from the lungs and nutrients from the digestive system to the body's cells would be impossible. If the health of the CR system were compromised enough, survival would be impossible. Additionally, both must be healthy or the function of one or the other will be compromised.

Below are several videos explaining how the cardiovascular and respiratory systems operate and function together:

The CR System and Exercise

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

How the Cardiovascular System Works

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Respiratory System Explained in Detail

YouTube Video

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2.4.3.4: The CR System and Energy Production

Clearly the cardiovascular and respiratory systems function as one, but why is the CR system so important? What makes the distribution of oxygen throughout the body so vital to existence? The answer is simple: ENERGY. While oxygen in and of itself does not contain any energy (**calories**), it does combine with fuel extracted from food once it has been introduced into the cell to help produce **adenosine triphosphate** (ATP). ATP is the basic form of cellular energy found in the body. Because the body stores very little ATP, it must constantly be regenerated. For this reason, people must continue eating and breathing to live.

Within the context of fitness, the purpose of the cardiorespiratory system is not only to produce energy but to also adapt in a way so that energy production can be optimized. For example, a high school cross country runner wants to be fit enough to compete in the state cross country meet. Unfortunately, this athlete's current mile times are 6 minutes per mile. In other words, that is the maximum work rate possible for this athlete. However, the goal is to improve to 5 minutes per mile, or improve the maximum work rate. To do so, more energy must be produced. According to the principles of adaptation, it is possible for this athlete to become more efficient at producing energy, enabling him to run a mile in less time. An example of this adaptation comes from the world record mile time of 3 minutes and 43 seconds. The world record marathon time (26.2 miles) is 2 hours, 2 minutes, and 52 seconds. That equates to 4 minutes and 41 seconds per mile over the 26-mile course. That is some serious ATP production!

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2.4.3.5: Oxidative Energy System (Aerobic)

As oxygen and nutrients are delivered to the cells, they are utilized to produce ATP. The workhorses of the cell for oxidative metabolism are the **mitochondria**. This form of energy production is contingent on the ability of the CR system to deliver oxygen and nutrients and the cell's ability to process that oxygen. Because of the importance of oxygen in this particular energy-producing pathway, it is called the oxidative energy system, or **aerobic system**.

Oxidative energy production is the primary means of ATP production during rest and for activities that last for 2 minutes or longer. Although other forms of energy production assist in ATP production at any given time, long duration exercise sessions rely on this aerobic pathway. Also, in contrast to other forms of ATP production, the oxidative energy system uses both carbohydrates and fats for fuel sources.

To consider: What activities would emphasize development of this energy pathway?

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2.4.3.6: Immediate/Explosive Energy System

While the oxidative system is the primary source of ATP production, it does require a few minutes for the system to begin operating at full capacity during exercise. How then could the body immediately produce enough energy to perform a strenuous activity, such as sprinting 50 meters? Clearly, another energy system must drive ATP production. The immediate or explosive energy system utilizes the storage of **creatine phosphate** (CP) and the storage of **adenosine diphosphate**, which is stored in very small amounts, to generate ATP. When needed, this energy system provides enough ATP to sustain a short- duration, explosive activity, approximately 10–20 seconds or less. Once CP is depleted, other energy systems must assist in the ATP generating process.

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2.4.3.7: Non-Oxidative or Anaerobic Energy System

As the name implies, the **non-oxidative energy system** does not require oxygen to generate ATP. Instead, the cells where the ATP is produced require **glucose**(carbohydrates that have been broken down) as the fuel source. Like the immediate energy system, this system is associated with high intensity and short duration movements. While it is possible for some elite athletes to maintain exercise at “anaerobic” levels for several minutes, even they will eventually fatigue as a result of the non-oxidative system’s ability to sustain ATP production for events lasting longer than approximately 2 minutes.

As glucose is processed to produce ATP, the natural byproduct of this process, lactic acid, also begins to accumulate. The result of excessive lactic acid accumulation contributes to muscle fatigue, making it impossible to continue exercise at a high intensity.

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2.4.3.8: Energy Systems Combine

It is important to understand that energy systems do not operate in a compartmental fashion, but rather operate simultaneously, each carrying some of the burden of ATP production. For example, a professional soccer player would spend most of the match “cruising” at a light/moderate intensity level, thus primarily utilizing the oxidative energy system. However, during the match, he or she may sprint for several hundred meters, utilizing the explosive and non-oxidative system, or he or she may jump, requiring use of the explosive system. Thus, both energy systems are utilized simultaneously throughout the match. To improve performance, this player would need to develop the energy system which is utilized the most during the match.

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2.4.3.9: Changes in the CR System

An improvement in CR functioning, or fitness level, requires adaptation of the system. Remember, the point is to more effectively generate ATP so more work can be accomplished. In order to process more oxygen and deliver more oxygenated blood to the cells, the overall system must undergo changes to make this possible. Here is a list of adaptations that occur to the CR system as a result of consistent aerobic exercise:

- Resting heart rate may decrease. The average resting heart rate hovers around 70–75 beats per minute. Elite athletes may have resting heart rates in the high 30s. Generally, resting heart rate may decrease by approximately 10 beats per minute with chronic exercise.
- Pulmonary adaptations, such as increased **tidal volume** (the amount of oxygen entering the lungs with each breath) and increased **diffusion capacity** (the amount of oxygen that enters the blood stream from the lungs). This allows for more oxygen to enter the pulmonary circulation en route to the left side of the heart.
- The heart muscles, specifically the left side of the heart, increase in size making it possible to contract more forcefully. As a result, more blood can be pumped with each beat meaning more oxygen can be routed to the systemic circulation.
- More oxygen is delivered and transported into the cells where ATP production can occur. This is called the **arterial-vein difference** (a-VO_{2diff})

These changes in the system are not permanent because of a process known as the **principle of reversibility**. Following a period of inactivity, the benefits from chronic aerobic exercise will be reversed.

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2.4.3.10: Assessing CR Fitness

To adequately prepare for starting a personal fitness program, it is important to first assess your current level of fitness. There are multiple methods for assessing a person's level of fitness. Each of the walking/jogging assessments discussed here attempts to estimate a key physiological marker of the heart's and lungs' functioning capacity and maximal oxygen consumption. **Maximal oxygen consumption**, or $VO_{2\ max}$, measures the body's maximum ability to take in and utilize oxygen, which directly correlates to overall health and fitness. A good estimate of $VO_{2\ max}$ provides a one- time glance at a person's health and fitness level and a baseline measurement for reassessment at future dates to gauge improvements.

Some of the most common walking/jogging assessments used to estimate $VO_{2\ max}$ include the 12-Minute Walk, 1.5-Mile Run/Walk Test, 3-Minute Step Test, and 1- Mile Walk Test. Unfortunately, these field assessments, although practical and inexpensive, only provide estimations. More accurate assessments require a lab- based VO_{2max} test using equipment that measures the volume of oxygen and carbon dioxide being moved in and out of the air passages during exercise. Although this test is more accurate, the expense and availability make it impractical for most. Unlike the lab test, the field assessments are relatively cost free, user-friendly and require very little expertise to conduct or perform. In addition, the key point of the assessment is measuring differences rather than absolute values, and the field tests accurately meet that objective.

Information on how to safely perform these assessments will be provided at the end of this chapter.

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2.4.3.11: Creating a Plan to Develop CR Fitness

Once the assessments have been completed, the next step is to develop a plan for maintaining or improving your current level of fitness. This fitness plan should include activities that are safe and adapted to meet your personal goals. Once these fitness goals have been identified, the principles of adaptation to change can be utilized to achieve those goals. These principles include **specificity**, targeting specific areas in a workout, and **overload,**the practice of increasing exertion as the body adapts to ensure continued gains in fitness levels. Specifically, you need to apply the FITT principle (**F**itness, **I**ntensity, **T**ime, and **T**ype) described in detail in the previous chapter, “Fitness Principles”:

- **Frequency**: 3–5 days per week for healthy adults.
- **Intensity**: moderate to vigorous intensity, which equals 40–85% of heart rate reserve, or 55–90% of percentage of max heart rate. (More information about intensity will be provided later.)
- **Time/duration**: 20–60 minutes per session or accumulation of 150 minutes per week. Sessions must be continuous for 10 minutes or more.
- **Type/mode**: Use large muscle groups and exercises specific to cardiorespiratory exercise.

Click on the link below for ACSM’s latest recommendations on the quantity and quality of exercise for adults:

ACSM's Official News Release

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2.4.3.12: Measuring Heart Rate

Those starting the VO2max assessments must first measure their heart rate, an important component used in the calculations.

Here is a video describing how to determine heart rate:

YouTube Video

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2.4.3.13: Measuring Intensity

Intensity may be the most important aspect of the FITT principle. Engaging in a “cardio” program that does not stress the CR system to the recommended levels will be ineffective. Engaging in a program that overstresses the system can lead to injury and pose unnecessary risks. So how do you know if you are in the right range?

Heart rate is one of the best ways to measure effort level. Walking and jogging increase a person’s heart rate. Based on the function of the heart, this is no surprise. The heart rate directly correlates with the amount of oxygen being taken in by the lungs. As activity increases in intensity, oxygen demands increase and so does heart rate.

Because of this relationship, heart rate can be used in the design of an effective walking and jogging program by creating target heart rate zones. Heart rate zones represent an intensity range—a low end heart rate and a high end rate—within which a person’s heart rate would fall during a walking or jogging session.

The first step in determining your **target heart rate (THR)**, is to determine your **maximum heart rate (MHR),** both measured in beats per minute (bpm). Generally, MHR is estimated to be your age subtracted from 220 beats per minute. In other words, your heart rate should theoretically stop increasing once it reaches the calculated maximum. While helpful, it is not uncommon to see variances in the laboratory tested maximum heart rate versus the calculated method.

The next step in calculating THR is to calculate a specific percentage of your MHR. This is done using two different methods. Keep in mind, finding the THR is the objective in both methods, even though slightly different numbers are used.

The first method, called Max Heart Rate Method, is more commonly used.

Max Heart Rate Method

1. Calculate MHR;
   MHR = 220 – age.
2. Calculate high and low THR by plugging in a percentage range. In this example, 60 and 80% are being used.
   MHR x .60 = THR_{Low}
   MHR x .80 =THR_{High}
3. The resulting low and high THR numbers represent the range, or target intensity.

The target intensity signifies an optimal training zone for that particular walking or jogging session. By keeping the heart rate within that range, you will drive adaptation specific to that intensity. By using real, but random numbers, and plugging them into the above equation this becomes apparent.

Female, aged 20:

1. MHR = 220 -20
   MHR = 200 bpm;
2. THR_{low} = 200 x .60
   THR_{low} = 120 bpm
   THR_{high} =200 x .80
   THR_{high} = 160 bpm
3. THR=120-160bpm

To achieve her self-established goals, the female in the example above will need to stay within the range of 120 and 160 bpm. If her efforts are intense enough that she begins to exceed 160 bpm during her session, or easy enough that her heart rate falls below 120 bpm, she would need to change her intensity mid-session to get the optimal results.

The Karvonen Formula or Heart Rate Reserve Method

1. Calculate MHR; MHR = 220 – age.

2. Determine your **resting heart rate (RHR)**.
3. Find the **heart rate reserve (HRR)**;

   HRR = MHR – RHR

4. Calculate high and low THR by plugging in a percentage range and then adding in the RHR. In this example, 60 and 80% are being used.

   THR_{low} = HRR x .60 + RHR

   THR_{high} = HRR x .80 + RHR

5. The resulting low and high THR numbers represent the range, or target intensity.

Clearly, the Karvonen formula requires a few more steps, specifically, the incorporation of the resting heart rate. Using the same female in the example above, along with a randomly selected RHR, the THR looks like this:

1. MHR=220–20
   MHR = 200
2. RHR = 72 bpm (randomly selected)
3. HRR=MHR–RHR
   HRR=200–72
   HRR = 128
4. THR_{low}=HRRx.60+RHR
   THR_{low}=128x.60+72
   THR_{low} = 149 bpm
   THR_{high} = HRR x .80 + RHR
   THR_{high}=128x.80+72
   THR_{high} = 174 bpm
5. THR=149–174bpm

A comparison of the two methods, reveals that the low and high end of the Karvonen formula is much higher than the Max Heart Rate method, even though the exact same percentages have been used. If the female in this example used the Karvonen Formula, she would find herself at a much higher intensity, especially at the low end of the range (120 vs. 149 bpm). How can this be? Aren't these formulas supposed to have the same objective?

While it is true that both equations are used to estimate a target heart rate range, only the Karvonen Formula takes into account the RHR, the lowest possible heart rate that can be measured for that individual. The Max Heart Rate method assumes the lowest heart rate possible is "0," a number to be avoided if at all possible! Because of the difference between 0 and the maximum heart rate, the calculated percentages result in a much lower number. In terms of accuracy, the Karvonen method is superior. It simply is a better representation of true target ranges.

Other Ways to Determine Intensity

Since not everyone owns a heart rate monitor, other methods of determining exercise intensity have been developed. One particular method, called the **rating of perceived exertion (RPE)**, uses subjective measurement to determine intensity. The method is as simple as asking the question, Overall, how hard do I feel I am working? The answer is given based on a scale of 6 to 20 with 6 being almost no effort and 20 being maximum effort. Studies have indicated that when subjects are asked to exercise at a moderate or heavy intensity level, subjects can accurately do so, even without seeing their heart rate. As a result, using the RPE scale can be an effective way of managing intensity.

The original RPE scale or **Borg Scale**, designed by Dr. Gunnar Borg, was developed to mimic generalized heart rate patterns. The starting and ending point of the scale are less intuitive than a typical scale of 1-10. By design, the 6 represents a resting heart rate of 60 bpm and the 20 an exercise heart rate of 200 bpm, a beat count someone might experience at maximum effort. Over time, a modified Borg Scale was developed using a simple 1– 10 scale, with 1 being resting effort and 10 being maximum effort. Even though the modified scale is more intuitive, the traditional scale is still used more frequently.

Walking and jogging not only benefit physical health, but many enjoy the social benefits realized by exercising with friends. When

walking or jogging with friends, intensity can easily be measured by monitoring your ability to carry on a conversation. With the **Talk Test**, if you are only able to say short phrases or give one word responses when attempting to converse during an exercise session, this would suggest you are working at a high enough intensity that your breathing rate makes conversation difficult. Certainly, if you can speak in full sentences without getting winded, the intensity would be very light. Just like RPE, the Talk Test is yet another way to subjectively measure intensity, which can then be correlated with heart rates.

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2.4.3.14: Cardiorespiratory Fitness Assessment

Follow the link below to the course lab in which you will be assessing your current level of cardiorespiratory fitness. You will be using the lab labeled:

Assessing Your Cardiorespiratory Fitness Level

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2.4.4: MUSCULAR STRENGTH AND ENDURANCE

By Jonathan Howard

Learning Objectives

- Describe muscular structure and function
- Identify types of muscles
- Describe an effective resistance exercise program
- Assess your muscular strength and endurance
- Understand the dangers of supplements

Muscles are used for movement in the body. The largest portion of energy expenditure in the body happens in muscles while helping us perform daily activities with ease and improving our wellness. Muscular strength is the amount of force that a muscle can produce one time at a maximal effort, and muscular endurance is the ability to repeat a movement over an extended period of time. Resistance training is the method of developing muscular strength and muscular endurance, which in turns improves wellness. This chapter explores many ways to resistance train. However, achieving the best muscular performance requires the assistance of a trained professional. For more information download this pdf on Muscular Strength and Endurance

2.4.4.1: Muscular Physiology

2.4.4.2: Resistance Exercise Programing

2.4.4.3: Supplements

2.4.4.4: Assessing your Muscular Strength and Endurance

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2.4.4.1: Muscular Physiology

Muscles are highly specialized to contract forcefully. Muscles are powered by muscle cells, which contract individually within a muscle to generate force. This force is needed to create movement. There are over 600 muscles in the human body; they are responsible for every movement we make, from pumping blood through the heart and moving food through the digestive system, to blinking and chewing. Without muscle cells, we would be unable to stand, walk, talk, or perform everyday tasks.

Types of Muscle

There are three types of muscle:

- *Skeletal Muscle* - Responsible for body movement.
- *Cardiac Muscle* - Responsible for the contraction of the heart.
- *Smooth Muscle* - Responsible for many tasks, including movement of food along intestines, enlargement and contraction of blood vessels, size of pupils, and many other contractions.

Skeletal Muscle Structure and Function

Skeletal muscles are attached to the skeleton and are responsible for the movement of our limbs, torso, and head. They are under conscious control, which means that we can consciously choose to contract a muscle and can regulate how strong the contraction actually is. Skeletal muscles are made up of a number of **muscle fibers**. Each muscle fiber is an individual muscle cell and may be anywhere from 1 mm to 4 cm in length. When we choose to contract a muscle fiber—for instance we contract our bicep to bend our arm upwards—a signal is sent from our brain via the spinal cord to the muscle. This signals the muscle fibers to contract. Each nerve will control a certain number of muscle fibers. The nerve and the fibers it controls are called a **motor unit**. Only a small number of muscle fibers will contract to bend one of our limbs, but if we wish to lift a heavy weight then many more muscles fibers will be recruited to perform the action. This is called muscle **fiber recruitment**.

Each muscle fiber is surrounded by connective tissue called an **external lamina**. A group of muscle fibers are encased within more connective tissue called the **endomysium**. The group of muscle fibers and the endomysium are surrounded by more connective tissue called the **perimysium.** A group of muscle fibers surrounded by the perimysium is called a muscle **fasciculus**. A muscle is made up of many muscle fasciculi, which are surrounded by a thick collagenous layer of connective tissue called the **epimysium**. The epimysium covers the whole surface of the muscle.

Muscle fibers also contain many mitochondria, which are energy powerhouses that are responsible for the aerobic production of energy molecules, or**ATP molecules**. Muscle fibers also contain glycogen granules as a stored energy source, and **myofibrils**, which are threadlike structures running the length of the muscle fiber. Myofibrils are made up of two types of protein: 1) **Actin myofilaments**, and 2) **myosin myofilaments**. The actin and myosin filaments form the contractile part of the muscle, which is called
the **sarcomere**. Myosin filaments are thick and dark when compared with actin filaments, which are much thinner and lighter in appearance. The actin and myosin filaments lie on top of one another; it is this arrangement of the filaments that gives muscle its striated or striped appearance. When groups of actin and myosin filaments are bound together by connective tissue they make the myofibrils. When groups of myofibrils are bound together by connective tissue, they make up muscle fibers.

The ends of the muscle connect to bone through a tendon. The muscle is connected to two bones in order to allow movement to occur through a joint. When a muscle contracts, only one of these bones will move. The point where the muscle is attached to a bone that moves is called the **insertion**. The point where the muscle is attached to a bone that remains in a fixed position is called the **origin**.

How Muscles Contract

Muscles are believed to contract through a process called the **Sliding Filament Theory**. In this theory, the muscles contract when actin filaments slide over myosin filaments resulting in a shortening of the length of the sarcomeres, and hence, a shortening of the muscle fibers. During this process the actin and myosin filaments do not change length when muscles contract, but instead

they slide past each other.

During this process the muscle fiber becomes shorter and fatter in appearance. As a number of muscle fibers shorten at the same time, the whole muscle contracts and causes the tendon to pull on the bone it attaches to. This creates movement that occurs at the point of insertion.

For the muscle to return to normal (i.e., to lengthen), a force must be applied to the muscle to cause the muscle fibers to lengthen. This force can be due to gravity or due to the contraction of an opposing muscle group.

Skeletal muscles contract in response to an electric signal called an **action potential**. Action potentials are conducted along nerve cells before reaching the muscle fibers. The nerve cells regulate the function of skeletal muscles by controlling the number of action potentials that are produced. The action potentials trigger a series of chemical reactions that result in the contraction of a muscle.

When a nerve impulse stimulates a motor unit within a muscle, all of the muscle fibers controlled by that motor unit will contract. When stimulated, these muscle fibers contract on an all-or-nothing basis. The all- or-nothing principle means that muscle fibers either contract maximally along their length or not at all. Therefore, when stimulated, muscle fibers contract to their maximum level and when not stimulated there is no contraction. In this way, the force generated by a muscle is not regulated by the level of contraction by individual fibers, but rather it is due to the number of muscle fibers that are recruited to contract. This is called **muscle fiber recruitment**. When lifting a light object, such as a book, only a small number of muscle fibers will be recruited. However, those that are recruited will contract to their maximum level. When lifting a heavier weight, many more muscle fibers will be recruited to contract maximally.

When one muscle contracts, another opposing muscle will relax. In this way, muscles are arranged in pairs. An example is when you bend your arm at the elbow: you contract your bicep muscle and relax your tricep muscle. This is the same for every movement in the body. There will always be one contracting muscle and one relaxing muscle. If you take a moment to think about these simple movements, it will soon become obvious that unless the opposing muscle is relaxed, it will have a negative effect on the force generated by the contracting muscle.

A muscle that contracts, and is the main muscle group responsible for the movement, is called the **agonist** or **prime mover**. The muscle that relaxes is called the **antagonist**. One of the effects that regular strength training has is an improvement in the level of relaxation that occurs in the opposing muscle group. Although the agonist/antagonist relationship changes, depending on which muscle is responsible for the movement, every muscle group has an opposing muscle group.

Below are examples of agonist and antagonist muscle group pairings:

AGONIST (Prime Mover)	Antagonist
Latimus Dorsi (upper back)	**Deltoids** (shoulder)
Rectus Abdominus (stomach)	**Erector Spinae** (back muscles)
Quadricepts (top of thigh)	**Hamstrings** (back of thigh)
Gastrocnemius (calf)	**Tibialis Anterior** (front of lower leg)
Soleus (below calf)	**Tibialis Anterior** (front of lower leg)

Smaller muscles may also assist the agonist during a particular movement. The smaller muscle is called the **synergist**. An example of a synergist would be the deltoid (shoulder) muscle during a press-up. The front of the deltoid provides additional force during the press-up; however, most of the force is applied by the pectoralis major (chest). Other muscle groups may also assist

the movement by helping to maintain a fixed posture and prevent unwanted movement. These muscle groups are called **fixators**. An example of a fixator is the shoulder muscle during a bicep curl or tricep extension.

Types of Muscular Contraction

- *Isometric* - This is a static contraction where the length of the muscle, or the joint angle, does not change. An example is pushing against a stationary object such as a wall. This type of contraction is known to lead to rapid rises in blood pressure.
- *Isotonic* - This is a moving contraction, also known as **dynamic contraction**. During this contraction the muscle fattens, and there is movement at the joint.

Types of Isotonic Contraction

- *Concentric*
  This is when the muscle contracts and shortens against a resistance. This may be referred to as the lifting or positive phase. An example would be the lifting phase of the bicep curl.
- *Eccentric*
  This occurs when the muscle is still contracting and lengthening at the same time. This may be referred to as the lowering or negative phase.

Muscle Fiber Types

Not all muscle fibers are the same. In fact, there are two main types of muscle fiber:

- *Type I* - Often called slow-twitch or highly- oxidative muscle fibers
- *Type II* - Often called fast-twitch or low- oxidative muscle fibers

Additionally, Type II muscle fibers can be further split into **Type IIa** and **Type IIb**. Type IIb fibers are the truly fast twitch fibers, whereas Type IIa are in between slow and fast twitch. Surprisingly, the characteristics of Type IIa fibers can be strongly influenced by the type of training undertaken. Following a period of endurance training, they will start to strongly resemble Type I fibers, but following a period of strength training they will start to strongly resemble Type IIb fibers. In fact, following several years of endurance training they may end up being almost identical to slow-twitch muscle fibers.

Type I (Slow-Twitch Muscle Fibers)

Slow-twitch muscle fibers contain more**mitochondria**, the organelles that produce aerobic energy. They are also smaller, have better blood supply, contract more slowly, and are more fatigue resistant than their fast-twitch brothers. Slow-twitch muscle fibers produce energy, primarily, through aerobic metabolism of fats and carbohydrates. The accelerated rate of aerobic metabolism is enhanced by the large numbers of mitochondria and the enhanced blood supply. They also contain large amounts of **myoglobin**, a pigment similar to hemoglobin that also stores oxygen. The myoglobin provides an additional store of oxygen for when oxygen supply is limited. This extra oxygen, along with the slow-twitch muscle fibers' slow rate of contraction, increases their endurance capacity and enhances their fatigue resistance. Slow-twitch muscle fibers are recruited during continuous exercise at low to moderate levels.

Type IIb (Fast-Twitch Low-oxidative Muscle Fibers)

These fibers are larger in size, have a decreased blood supply, have smaller mitochondria and less of them, contract more rapidly, and are more adapted to produce energy **anaerobically** (without the need for oxygen) than slow-twitch muscle fibers. Their reduced rate of blood supply, together with their larger size and fewer mitochondria, makes them less able to produce energy aerobically, and are therefore, not well suited to prolonged exercise. However, their faster rate of contraction, greater levels of glycogen, and ability to produce much greater amounts of energy anaerobically make them much more suited to short bursts of energy. Because of their greater speed of contraction and reduced blood supply, they are far less fatigue resistant than slow-twitch fibers, and they tire quickly during exercise.

Numbers of Slow and Fast-Twitch Fibers

The number of slow and fast-twitch fibers contained in the body varies greatly between individuals and is determined by a person's genetics. People who do well at endurance sports tend to have a higher number of slow-twitch fibers, whereas people who are better at sprint events tend to have higher numbers of fast-twitch muscle fibers. Both the slow twitch and fast-twitch fibers can be influenced by training. It is possible through sprint training to improve the power generated by slow twitch fibers, and through endurance training, it is possible to increase the endurance level of fast-twitch fibers. The level of improvement varies, depending on the individual, and training can never make slow-twitch fibers as powerful as fast- twitch, nor can training make fast-twitch fibers as fatigue resistant as slow-twitch fibers.

Cardiac Muscle Structure and Function

Cardiac muscle cells are only found in the heart. They are elongated and contain actin and myosin filaments, which form**sarcomeres**; these join end to end to form**myofibrils**. The actin and myosin filaments give cardiac muscle a striated appearance. The striations are less numerous than in skeletal muscle. Cardiac muscles contain high numbers of mitochondria, which produce energy through aerobic metabolism. An extensive capillary network of tiny blood vessels supply oxygen to the cardiac muscle cells. Unlike the skeletal muscle cells, the cardiac cells all work as one unit, all contracting at the same time. In short, the sinoatrial node at the top of the heart sends an impulse to the atrioventricular node, which sends a wave of polarization that travels from one heart cell to another causing them all to contract at the same time.

Smooth Muscle Structure and Function

Smooth muscle cells are variable in function and perform numerous roles within the body. They are spindle shaped and smaller than skeletal muscle and contain fewer actin and myosin filaments. The actin and myosin filaments are not organized into sarcomeres, so smooth muscles do not have a striated appearance. Unlike other muscle types, smooth muscle can apply a constant tension. This is called **smooth muscle tone**. Smooth muscle cells have a similar metabolism to skeletal muscle, producing most of their energy aerobically. As such, they are not well adapted to producing energy anaerobically.[1]

For more information on muscle physiology, click on the links below:

Skeletal Muscle Physiology

Fast Twitch versus Slow Twitch Video

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Actin and Myosin: the Romeo and Juliet of Muscle Cells

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Skeletal Muscles

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

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2.4.4.2: Resistance Exercise Programing

Designing a resistance exercise program can seem like a daunting task. However, the basics are very simple. The table below provides instructions for designing an effective resistance exercise program.

Resistance Exercise Program

F	Frequency of Exercise	How Often	Beginner	2–3 days per week Full-body workout of all 6 body areas 48–72 hours of rest in-between workouts	
			Intermediate to High	4–5 days per week; often perform split workouts (example: Monday and Thursday, work chest, shoulders, triceps, abdominals; Tuesday and Friday, work back, legs, biceps) 48–72 hours of rest in-between workouts	
I	Intensity of Exercise	How Hard	Beginner	60%–70% of maximum strength	
			Intermediate to High	70%–90% of maximum strength	
T	Time of Exercise	–How many reps –How many sets –How much time between sets	Beginner	1–3 Sets 8–12 repetitions	30 sec to 1 minute
			Intermediate to High	Endurance – 12–20+ Reps 2–3 Sets	30 sec to 1 minute
				Strength – 2–6 Reps 3–5 Sets	2 to 5 minutes
T	Type of Exercise	Which Exercises	Weight machines, free weights, resistance tubing, medicine ball, own body weight		

Note

Specificity Principle - you must work each muscle group to have strength gains in that particular part of the body

Recommendations for Resistance Training Exercise

- *Perform a minimum of 8 to 10 exercises that train the major muscle groups.*
  - Workouts should not be too long. Programs longer than one hour are associated with higher dropout rates.
  - Choose more compound, or multi-joint exercises, which involve more muscles with fewer exercises.
- *Perform one set of 8 to 12 repetitions to the point of volitional fatigue.*
  - More sets may elicit slightly greater strength gains, but additional improvement is relatively small.
- *Perform exercises at least 2 days per week.*
  - More frequent training may elicit slightly greater strength gains, but additional improvement is relatively small since progress is made during the recuperation between workouts.
- *Adhere as closely as possible to the specific exercise techniques.*
- *Perform exercises through a full range of motion.*
  - Elderly trainees should perform the exercises in the maximum range of motion that does not elicit pain or discomfort.

- *Perform exercises in a controlled manner.*
- *Maintain a normal breathing pattern.*
- *If possible, exercise with a training partner.*
  - Partners can provide feedback, assistance, and motivation.

Position Stand on Progression Models in Resistance Training for Healthy Adults[2]

- *Both concentric and eccentric muscle actions*
- *Both single and multiple joint exercises*
- *Exercise sequence*
  - Large before small muscle group exercises
  - Multiple-joint exercises before single-joint exercises
  - Higher intensity before lower intensity exercises
- *When training at a specific RM load*
  - 2-10% increase in load if one to two repetitions over the desired number
- *Training frequency*
  - 2-3 days per week for novice and intermediate training
  - 4-5 days per week for advanced training
- *Novice training*
  - 8-12 repetition maximum (RM)
- *Intermediate to advanced training*
  - 1-12 RM using periodization* (strategic implementation of specific training phases alternating between phases of stress and phases of rest)
  - Eventual emphasis on heavy loading (1-6 RM)
  - At least 3-min rest periods between sets
  - Moderate contraction velocity
  - 1-2 s concentric, 1-2 s eccentric

* For more information on using periodization for weight training, click on the link below:

Periodization for Weight Training

Details

- *Hypertrophy training*
  - 1-12 RM in periodized fashion, with emphasis on the 6-12 RM zone
  - 1- to 2-min rest periods between sets
  - Moderate contraction velocity
  - Higher volume, multiple-set programs
- *Power training* (two general loading strategies):
  - **Strength training**
    - Use of light loads
    - 30-60% of 1 RM
    - Fast contraction velocity
    - 2-3 min of rest between sets for multiple sets per exercise
    - Emphasize multiple-joint exercises especially those involving the total body
  - **Local muscular endurance training**
    - Light to moderate loads
    - 40-60% of 1 RM
    - High repetitions (> 15)
    - Short rest periods (< 90 seconds)

Recommendations should be viewed within the context of an individual's target goals, physical capacity, and training status.

Six Types of Resistance Training

Each type of resistance training benefits muscles in a different way. While these types of resistance training are not new, they could be unique sources of resistance that you have not considered in your quest to add muscle to your frame. Using these forms of resistance alone, in combination with one another, or in combination with the more traditional resistance apparatus, can enable

you to diversify your efforts to produce valuable and improved results.

In each type of training, you may use an apparatus to create an environment for resistance. The uniqueness of these sources is found in the way they are implemented. You might use a dumbbell for a particular exercise in some of these alternative resistance methods, but the way you use the resistance through a range of motion may be altogether different.

In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

- *Dynamic Constant Training*
  As the name suggests, the most distinctive feature of dynamic constant training (DCT) is that the resistance is constant. A good example of DCT occurs when you use free weights or machines that do not alter resistance, but redirect it instead. The emphasis shifts to different planes along the muscle group being worked. When you work on a shoulder-press machine, for example, the resistance remains constant over the entire range of motion. It is identical from the bottom of the movement to the top and back down again. Only the direction of the resistance varies. The resistance redirects itself through the arc and then redirects itself again when the shoulders let the weight come back down to the starting position.
- *Dynamic Progressive Training*
  In dynamic progressive training (DPT), resistance increases progressively as you continue to exercise. DPT is often used as a rehabilitative measure and offers the sort of resistance that builds gradually while remaining completely within the control of the person using it. Equipment includes rubber bands and tubing, springs, and an apparatus controlled by spring-loaded parts. They are low- cost items that are easily accessible and can be used anywhere. Though commonly employed for rehabilitation of torn ligaments, joints, muscles, and broken bones, it is also convenient for travelers on either vacation or business trips. When combined with traditional forms of resistance, this training creates a better-balanced program and provides the muscles with a welcome alternative from time to time.
- *Dynamic Variable Training*
  This form of resistance exercise takes up where dynamic constant training leaves off. Whereas DCT employs constant resistance, never varying to accommodate the body's mechanics, DVT can be adapted to the varying degrees of strength of a muscle group throughout a range of motion. Though very few machines succeed in this goal, a few have come close.

  Hammer Strength equipment emphasizes common fixed areas of resistance. However, the Strive line of equipment has been able to give the user much more choice in resistance levels during an exercise. Strive equipment uses the DVT principle most effectively because it allows the user to increase resistance at the beginning, middle or end of the range of motion. If your joints are stronger at the end of a movement (the top) or the beginning (the bottom), you can set the resistance accordingly. The Strive line is the most flexible yet of all gym equipment designed to adhere to the DVT principle. It lets you tailor-make your workouts based on your body's mechanics.

- *Isokinetic Training*
  In isokinetic training (IKT), the muscle is contracted at a constant tempo. Speed determines the nature of this resistance training, not the resistance itself; however, the training is based on movement carried out during a condition of resistance. IKT can be performed with the body's own weight.

  In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

- *Isometric Training*
  Familiar to most people, isometric training (IMT) is an excellent way to build strength with little adverse effect on joints and tendons commonly associated with strength training and lifting heavy weights. Though it appears simple in comparison to traditional resistance training, IMT should not be underrated in its effectiveness. IMT is a method in which the force of contraction is equal to the force of resistance. The muscle neither lengthens nor shortens. You may be wondering how any training occurs without lengthening and shortening the muscles. In IMT, the muscles act against each other or against an immovable object.

  Isometric training is what you see swimmers do when they press their hands against a solid wall, forcing all their bodyweight

into the wall. Another common IMT exercise is pressing the hands together to strengthen the pectorals and biceps. Pressing against the wall can involve muscles in the front deltoid, chest and biceps. Isometric training has been proven very effective for gaining strength, but this method usually strengthens only the muscles at the point of the isometric contraction. If the greatest resistance and force are acting upon the mid-portion of the biceps, that is where most of the benefit will occur. A comprehensive isometric routine can serve to increase strength in certain body parts.

- *Isotonic Training*
  This method demands constant tension, typically with free weights. Though this approach may sound a lot like dynamic constant training, it differs because it does not necessarily redirect the resistance through a range of motion, but rather, keeps tension constant as in the negative portion of an exercise. Complete immobility of the muscle being worked is required. For example, in the preacher curl, the biceps are fixed against the bench. They lift (positive), then release the weight slowly downward (negative), keeping the same tension on the muscles in both directions. This is one reason that free-weight exercise is considered the best form of isotonic training. Merely lifting a dumbbell or barbell, however, is not necessarily enough to qualify as isotonic. The true essence of isotonic training is keeping resistance constant in both the positive and negative portions of each repetition.

Exercise Order for Resistance Training

The general guidelines for exercise order when training all major muscle groups in a workout is as follows:

- Large muscle group exercises (i.e., squat) should be performed before smaller muscle group exercises (i.e., shoulder press).
- Multiple-joint exercises should be performed before single-joint exercises.
- For power training, total body exercises (from most to least complex) should be performed before basic strength exercises. For example, the most complex exercises are the snatch (because the bar must be moved the greatest distance) and related lifts, followed by cleans and presses. These take precedence over exercises such as the bench press and squat.
- Alternating between upper and lower body exercises or opposing (agonist–antagonist relationship) exercises can allow some muscles to rest while the opposite muscle groups are trained. This sequencing strategy is beneficial for maintaining high training intensities and targeting repetition numbers.
- Some exercises that target different muscle groups can be staggered between sets of other exercises to increase workout efficiency. For example, a trunk exercise can be performed between sets of the bench press. Because different muscle groups are stressed, no additional fatigue would be induced prior to performing the bench press. This is especially effective when long rest intervals are used.[3]

Resistance Training Conclusion

The most effective type of resistance- training routine employs a variety of techniques to create a workout program that is complete and runs the gamut, from basic to specialized. Learning different methods of training, different types of resistance, and the recommended order can help you acquire a balanced, complete physique. That does not mean that these training methods will help everybody to win competitions, but they will help you learn how to tune in to your body and understand its functions through resistance and movement. This knowledge and understanding develops a valuable skill, allowing you to become more adept at finding what works best for you on any given day.

For additional information on resistance exercises, click on the links below:

Exercise and Muscle Directory

Muscular Strength and Endurance Activity

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2.4.4.3: Supplements

Many active people use nutritional supplements and drugs in the quest for improved performance and appearance. Most of these substances are ineffective and expensive, and many are dangerous. A balanced diet should be your primary nutritional strategy.

Below are links that provide additional information about the use of supplements during exercise:

Benefits and Side Effects of Steroid Use

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Claims versus actual effects of performance aids

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2.4.4.4: Assessing your Muscular Strength and Endurance

Functional Leg Strength Tests

The following tests assess functional leg strength using squats. Most people do squats improperly, increasing their risk of knee and back pain. Before you add weight- bearing squats to your weight-training program, you should determine your functional leg strength, check your ability to squat properly, and give yourself a chance to master squatting movements. The following leg strength tests will help you in each of these areas.

These tests are progressively more difficult, so do not move on to the next test until you have scored at least a 3 on the current test. On each test, give yourself a rating of 0, 1, 3, or 5, as described in the instructions that follow the last test.

Chair Squat

Instructions

1. Sit up straight in a chair with your back resting against the backrest and your arms at your sides. Your feet should be placed more that shoulder-width apart so that you can get them under your body.
2. Begin the motion of rising out of the chair by flexing (bending) at the hips-not the back. Then squat up using a hip hinge movement (no spine movement). Stand without rocking forward, bending your back, or using external support, and keep your head in a neutral position.
3. Return to the sitting position while maintaining a straight back and keeping your weight centered over your feet. Your thighs should abduct (spread) as you sit back in the chair. Use your rear hip and thigh muscles as much as possible as you sit.

   Do five repetitions.
   Your rating _____

Un-weighted Squat

Instructions

1. Stand with your feet placed slightly more than shoulder-width apart, toes pointed out slightly, hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
2. Squat down, keeping your weight centered over your arches and actively flexing (bending) your hips until your legs break parallel. During the movement, keep your back straight, shoulders back, and chest out, and let your thighs part to the side so that you are squatting between your legs.
3. Push back up to the starting position, hinging at the hips and not with the spine, maximizing a straight back and neutral head position.

   Do five repetitions.
   Your rating _____

Single-Leg Lunge-Squat with Rear-Foot Support

Instructions

1. Stand about 3 feet in front of a bench (with your back to the bench).
2. Place the instep of your left foot on the bench, and put most of your weight on your right let (your left leg should be bent), with your hands at your sides.
3. Squat on your right leg until your thigh is parallel with the floor. Keep your back straight, chest up, shoulders back, and head neutral.
4. Return to the starting position. Do three repetitions for each leg. Your rating: _____

Rating Your Functional Leg Strength Test Results

- *5 POINTS*
  Performed the exercise properly with good back and thigh position, weight centered over the middle or rear of the foot,

chest out, and shoulders back; good use of hip muscles on the way down and on the way up, with head in a neutral position throughout the movement; maintained good form during all repetitions; abducted)spread) the thighs on the way down during chair squats and double-leg squats; for single-let exercises, showed good strength on both sides; for single-leg lunge-squat with rear-foot support, maintained straight back, and knees stayed behind toes.

- *3 POINTS:*
  Weight was forward on the toes, with some rounding of the back; used thigh muscles excessively, with little use of hip muscles; head and chest were too far forward; showed little abduction of the thighs during double-leg squats; when going down for single-leg exercises, one side was stronger than the other; form deteriorated with repetitions; for single-leg lunge-squat with rear-foot support and single-leg squat from a bench, could not reach parallel (thigh parallel with floor).
- *1 POINT*
  Had difficulty performing the movement, rocking forward and rounding back badly; used thigh muscles excessively, with little use of hip muscles on the way up or on the way down; chest and head were forward; on un-weighted squats, had difficulty reaching parallel; and showed little abduction of the thighs on single-leg exercises, one leg was markedly stronger than the other; could not perform multiple repetitions.
- *0 POINTS*
  Could not perform exercise.

Using Your Results

Are you at all surprised by your rating for muscular strength?

What factors , if any, influenced your ability to perform these assessments?

Are you satisfied with your current level of muscular strength as evidenced in your daily life? For example, are you happy with your ability to lift objects, climb stairs, and engage in sports and recreational activities?

Muscle Endurance Assessment

For best results, do not do any strenuous weight training within 48 hours of any test.

The 60-Second Sit-Up Test

- *Equipment*
  1. Stopwatch, clock, or watch with a second hand
  2. Partner

Warning

DO NOT TAKE THIS TEST IF YOU SUFFER FROM LOW-BACK PAIN.

To prepare, try a few sit-ups to get used to the proper technique and warm up your abdominal muscles.

1. Lie flat on your back on the floor with knees bent, feet flat on the floor, and your fingers interlocked behind your neck and your elbows wide. Your partner should hold your ankles firmly so that your feet stay on the floor as you do the sit-ups.
2. When your partner signals you to begin, raise your head and chest off the floor until your chest touches your knees or thighs, keeping your elbows wide, then return to the starting position. Keep your neck neutral. Do not force your neck forward, and stop if you feel any pain.
3. Perform as many sit-ups as you can in 60 seconds.

   Number of sit-ups: _____

To rank your results, please see the chart on page 16.

Ratings for 60-second Sit-up Test:

Number of Sit-Ups						
Men	*Very Poor*	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: Under 20	Below 36	36 - 40	41 -46	47 - 50	51 - 61	Above 61
20 - 29	Below 33	33 -37	38 - 41	42 - 46	47 - 54	Above 54
30 - 39	Below 30	30 - 34	35 - 38	39 - 42	43 - 50	Above 50
40 - 49	Below 24	24 - 28	29 - 33	34 - 38	39 - 46	Above 46
50 - 59	Below 19	19 - 23	24 - 27	28 - 34	35 - 42	Above 42
60 and over	Below 15	15 - 18	19 - 21	22 - 29	30 - 38	Above 38

Number of Sit-Ups						
Women	*Very Poor*	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: Under 20	Below 28	28 - 31	32 - 35	36 - 45	46 - 54	Above 54
20 - 29	Below 24	24 - 31	32 - 37	38 - 43	44 - 50	Above 50
30 - 39	Below 20	20 - 24	25 - 28	29 - 34	35 - 41	Above 41
40 - 49	Below 14	14 - 19	20 - 23	24 - 28	29 - 37	Above 37
50 - 59	Below 10	10 - 13	14 - 19	20 - 23	24 - 29	Above 29
60 and over	Below 3	3 - 5	6 - 10	11 - 16	17 - 27	Above 27

The Push-Up Test

- *Equipment*:
  Mat or towel (optional)

In this test, you will perform either standard push-ups, or modified push-ups, in which you support yourself with your knees. The Cooper Institute developed the ratings for this test with men performing push-ups and women performing modified push-ups. Biologically, males tend to be stronger than females; the modified technique reduces

the need for upper-body strength in a test of muscular endurance. Therefore, for an accurate assessment of upper-body endurance, men should perform standard push-ups and women should perform modified push-ups. (However, in using push-ups as part of a strength-training program, individuals should choose the technique most appropriate for increasing their level of strength and endurance, regardless of gender.)

Instructions

1. For push-ups: Start in the push-up position with your body supported by your hands and feet. For the modified push-ups: Start in the modified push-up position with your body supported by your hand and knees. For both positions, your arms and your back should be straight and your fingers pointed forward.
2. Lower your chest to the floor with your back straight, and then return to the starting position.
3. Perform as many push-ups as you can without stopping.

   Number of push-ups: _____

   Number of modified push-ups: _____

Rating Your Push-Up Test Result

Your score is the number of completed push-ups or modified push-ups. Refer to the appropriate portion of the table on page 19 for a rating of your upper-body endurance.

Record your rating below and in the chart at the end of this lab.

Rating: _____

Ratings for the Push-Up and Modified Push-Up Test:

Men	Number of Modified Push-Ups					
	Very Poor	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: 18 - 29	Below 22	22 - 28	29 - 36	37 - 46	47 - 61	Above 61
30 - 39	Below 17	17 - 23	24 - 29	30 - 38	39 - 51	Above 51
40 - 49	Below 11	11 - 17	18 - 23	24 - 29	30 - 39	Above 39
50 - 59	Below 9	9 - 12	13 - 18	19 - 24	25 - 38	Above 38
60 and over	Below 6	6 - 9	10 - 17	18 - 22	23 - 27	Above 27
Women	**Number of Modified Push-Ups**					
	Very Poor	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: 18 - 29	Below 17	17 - 22	23 - 29	30 - 35	36 - 44	Above 44
30 - 39	Below 11	11 - 18	19 - 23	24 - 30	31 - 38	Above 38
40 - 49	Below 6	6 - 12	13 - 17	18 - 23	24 - 32	Above 32
50 - 59	Below 6	6 - 11	12 - 16	17 - 20	21 - 27	Above 27
60 and over	Below 2	2 - 4	5 - 11	12 - 14	15 - 19	Above 19

SOURCE: Based on norms from the Cooper Institute for Aerobic Research, Dallas, Texas; from the Physical Fitness Specialist Manual, Revised 2002.
Used with permission.

The Squat Endurance Test

Instructions

1. Stand with your feet placed slightly more than shoulder width apart, toes pointed out slightly, hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
2. Squat down, keeping your weight centered over your arches, until your thighs are parallel with the floor. Push back up to the starting position, maintaining a straight back and neutral head position.
3. Perform as many squats as you can without stopping.

Number of squats: _____

Rating your Squat Endurance Test Result

Your score is the number of completed squats. Refer to the appropriate portion of the table for a rating of your leg muscular endurance. Record your rating below and in the summary at the end of this lab.

Rating: _____

Ratings for the Squat-Endurance Test:

Number of Squats Performed

Men	*Very Poor*	*Poor*	*Below Average*	*Average*	*Above Average*	*Good*	*Excellent*
Age: 18-25	<25	25-30	31-34	35-38	39-43	44-49	>49
26-35	<22	22-28	29-30	31-34	35-39	40-45	>45
36-45	<17	178-22	23-26	27-29	30-34	35-41	>41
46-55	<9	13-17	18-21	22-24	25-38	29-35	>35
56-65	<9	9-12	13-16	187-20	21-24	25-31	>31
65 +	<7	7-10	11-14	15-18	19-21	22-28	>28
Women	*Very Poor*	*Poor*	*Below Average*	*Average*	*Above Average*	*Good*	*Excellent*
Age: 18-25	*<18*	*18-24*	*25-28*	*29-32*	*33-36*	*37-43*	*>43*
26-35	*<20*	*13-20*	*21-24*	*25-28*	*29-32*	*33-39*	*>39*
36-45	*<7*	*7-14*	*15-18*	*19-22*	*23-26*	*27-33*	*>33*
46-55	*<5*	*5-9*	*10-13*	*14-17*	*18-21*	*22-27*	*>27*
56-65	*<3*	*3-6*	*7-9*	*10-12*	*13-17*	*18-24*	*>24*
65 +	*<2*	*2-4*	*5-10*	*11-13*	*14-16*	*17-23*	*>23*

SOURCE: Top End Sports. www.topendsports.com/testing/tests/home-squat.htm

Summary of Results

Test	Number Performed	Rating
Sit-up Test		
Push-up Test		
Squat Endurance Test		

Using Your Results

1. Are you at all surprised by your ratings for muscular endurance?
2. What factors, if any, influenced your scores?
3. Are you satisfied with your current level of muscular endurance as evidenced in your daily life, for example, your ability to carry groceries or your books, hike, and do yard work?

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2.4.5.1: The Benefits of Flexibility and Stretching

There are many benefits to regular stretching with the most important of those being simple: being flexible will help you move freely and complete activities with greater ease.

Healthy Joints and Pain Management

As many as 28 percent of all adults report pain and stiffness in joints. That number increases dramatically with age and women are more likely to develop joint symptoms. For adults, arthritis is one of the most common conditions with 54% of people 75 years and older having been diagnosed with arthritis. Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching increases joint mobility and function, and decreases joint stiffness and pain.

Pain can also be related to imbalances in the muscles. For example, if the front of your thighs and hips get too tight from a lack of flexibility, the tension will pull on the hips (where the muscles are attached). The result is the pelvis may be pulled forward and cause greater sway in your lower back. This affects your posture and can eventually lead to pain and stiffness in the neck, shoulders and lower back. Stretching regularly, for all major muscle groups/joint areas, promotes good alignment and balance.

Muscle Relaxation and Stress Relief

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots (also called trigger points). Regular stretching decreases anxiety, blood pressure, and breathing rate which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea (painful menstruation) and to relieve muscle cramps during participation of exercise/sports.

Other Benefits

In addition to the benefits listed above, several other benefits have been researched and characterized as good reasons maintain a regular routine of stretching:

- Increased blood flow- Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched which may help them recover from exercise faster.
- Reduction of Future Lower Back Pain-Most experts agree (while research is still inconclusive) that counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging with muscle fitness and stretching exercises can reduce your risk of developing lower- back pain.

Flexibility and Aging

For many young adults, the thought of long term flexibility can be taken for granted. For example, how hard is it to bend over and tie your shoes? How difficult is it to walk around campus with a backpack? As young adults, most of those activities are likely encountered with little pain or resistance. However, ROM declines with age. Simple things like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can be painful. Therefore, flexibility is critical to maintaining a high quality of life in older years.

The Inactivity-Mobility Cycle

If you have ever been injured to the point that required immobilization of a joint, you realize how important mobility is in relation to your overall health. Unfortunately, as joints ROM is restricted from arthritis or other injuries, activity declines. As activity declines, the ROM likely continues to suffer as a result of inactivity and the vicious cycle ensues. A simple stretching program can help alleviate this problem and help break out of the cycle.

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2.4.5.2: Improving the Range of Motion

Joint ROM results from a combination of factors which could be classified as internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include environmental temperature, gender, age, excess fat mass, muscle mass, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions such as muscular contractions and stretching are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

Joint Structure

A joint is a location on the body in which two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits the ROM. For example, the shoulder joint which is structurally a ball-in-socket joint, can rotate in multiple directions. In other words, it has a wide range of motion. However, the knee joint is a modified hinge joint which is limited to essentially a forward-backward direction of movement. Additionally, excessive fat mass surrounding a joint or even large muscle mass may limit the ROM for a particular joint. Although weight loss could affect amounts of fat mass surrounding a joint, or loss of muscle, joint structure cannot be altered. As a result, little can be done in this area to improve flexibility.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. In other words, you can't stretch your hamstring and expect your shoulders to improve. Likewise, you can be flexible in your shoulder but very "stiff" in your fingers or ankles. So, a complete stretching program must include multiple stretches for various joints.

Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. For example, the head of the humerus fits into a small cavity to create the shoulder joint. However, those bones can only remain in place as a result of the muscles, tendons, and ligaments that keep the joint tight an in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through it's normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed isn't well understood, it does appear to be related to the elastic and plastic properties of the connective tissue. Elasticity is defined as the ability to return to resting length after **passive stretching** (i.e. elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. Plasticity is the tendency to assume a greater length after passive stretching (i.e. plastic deformation). In other words, taking that stretchy spring and changing the resting position to a new longer length. The goal of a flexibility program, is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Several studies have suggested that a slow, sustained stretch of 30-90 seconds is necessary to produce chronic plastic deformation.

Neuromuscular System

Modern cars come equipped with a central computer and sensors throughout to troubleshoot problems with the vehicle. Sensors in the engine determine temperature. Sensors on the wheels determine tire pressure while sensors in the gas tank tell you when the gas tank is low in fuel. Much like car, our bodies are equipped with sensors, called proprioceptors, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These proprioceptors are called muscle spindles and Golgi tendon organs (GTO's).

Muscles spindles, lie parallel to the regular muscle and help determine the length of muscles when they are being stretched. When a muscle is stretched, they send signals to the central nervous system causing the stretched muscle to contract. In other words, there is some resistance to the stretch generated by the nervous system's reflexive stimulus sent to the stretching muscle. This

is called the myotatic or stretch reflex. Additionally, that same signal also causes the antagonist (the opposing) muscle to relax, called reciprocal inhibition. So, when you stretch your upper thigh (quadriceps) your hamstrings (antagonist to the quadriceps) are relaxed.

The GTOs are located near the musculotendon junction, the end points of the muscle, and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, these signals will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called autogenic inhibition or the inverse myotatic reflex. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, to effectively stretch, movements must be sustained for long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will not be overridden and lengthening cannot occur. Whether signaling the muscles to contract or relax, the neuromuscular system manipulates the stretched muscle, presumably as a protective mechanism to prevent injury.

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2.4.5: FLEXIBILITY

Learning Objectives

- Define flexibility
- Examine the benefits of flexibility
- Identify ways to increase flexibility
- Create an effective stretching program
- Assess your own flexibility

One of the five health related components of fitness is flexibility. Flexibility relates to the ability to move a joint through it's full range of motion (ROM). To develop a complete fitness program, you should take time to emphasize this component in your routine by stretching. Unfortunately, "...most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention." (American Council on Exercise)

Flexibility is classified into two types: static and dynamic. **Static flexibility** is a measure of the limits of a joints overall range of motion. It's measured by stretching and holding a joint in the position of it's maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, passive forces are required (force generated from an external source). **Dynamic flexibility** is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production (your own muscles contracting). Because it's difficult to quantify "stiffness," dynamic flexibility is measured more subjectively. For example, how easy is it to swing a tennis racket, climb steps, or get in and out of a car? The target of any good stretching program is to improve static and dynamic flexibility so that normal ROM can be achieved. The term "normal" relates to population studies that have measured various areas of the body and established an average degree of movement for a particular joint.

2.4.5.1: The Benefits of Flexibility and Stretching

2.4.5.2: Improving the Range of Motion

2.4.5.3: Ways to Improve Flexibility

2.4.5.4: Creating and Effective Stretching Program

2.4.5.5: Assessing Your Flexibility, Laboratory Exercises

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2.4.5.3: Ways to Improve Flexibility

Stretching Techniques

Multiple stretching techniques have been researched with results showing they can be beneficial in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using two basic modes: active or passive. **Active stretching**, also called unassisted stretching, suggests that the actual stretch is done individually without an external stimulus.**Passive stretching**, or assisted stretching is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques mentioned below.

Static Stretching

The most commonly prescribed and most commonly used technique for improving flexibility is the static stretch. A static stretch involves slow, gradual and controlled movements. The muscle group is stretched toward the end of the joint ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a "static" position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be in Yoga routines or stretching after a workout or athletic event.

Some of the major advantages for static stretching is that it is generally considered safe (see Stretches to Avoid), it is simple to perform and effective at increasing ROM. The only major disadvantage comes from when it is done too much which can reduce strength and may make joints unstable. Of course this could apply to any of the techniques.

Ballistic Stretching

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch, and ballistic movements that can be forceful, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many athletic coaches feel ballistic stretching is unsafe. Also, many researchers feel it is less effective at improving ROM. Nonetheless, the ACSM still recommends ballistic as one method to effectively increase flexibility.

Synamic Stretching

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that don't involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is that it will target and improve dynamic flexibility which in turn may improve performance. A disadvantage comes from the type of movements which often require good balance and coordination. So, learning correct form and being able to perform dynamic stretches may take a little time to learn or may not be applicable to certain populations.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching

This type of exercise usually involves a partner. The partner will passively stretch the muscle, immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contrac- tion, also describing the sequence of movements involved but adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two things to happen, the stretch reflex and reciprocal inhibition (the antagonist muscle to relax). After 5 seconds, the GTO's then override the muscle

spindle's signals causing autogenic inhibition. Because the muscle is relaxed, it can more easily be stretched. In other words, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself to relax as a result of the contraction.

While many experts feel that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF is that it generally requires a knowledgeable partner, it's somewhat complicated, and can cause some soreness from the contractions.

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2.4.5.4: Creating and Effective Stretching Program

The ACSM has made recommendations on how to design a flexibility program. However, before getting into the design, you should know your current flexibility status by assessing various joint's ROM. Specifically, performing the sit- and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

Set Goals

Once you learn where you are most and least flexible, you should make some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, "I want to increase my flexibility," you will want to state the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal may be, "I will improve my sit-and-reach score by 4 cm by the end of the semester." Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of actually achieving it.

Apply the FITT Principle

As mentioned previously, the ACSM has made recommendations for carrying out a flexibility program based on the FITT Principle (Frequency, Intensity, Time and Type). As you select the areas you want to stretch, keep in mind it is recommended that multiple stretching exercises should be performed to target all major joints including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles. (insert link to specific exercise here). After selecting your exercises, follow the below recommendations when performing your routine.

- ***Frequency***-Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.
- ***Intensity***-Stretch to the point of tightness or mild discomfort.
- ***Time (or duration of each stretch)***-a minimum of 10 seconds for very tight muscles with an emphasis to progress to 30-90 seconds. Two to four repetitions of each stretch should be done.
- ***Type (mode)***-Select from either of the above techniques mentions that best suit your circumstances (Static, Dynamic, Ballistic, or Proprioceptive Neuromuscular Facilitation).

When to Stretch

Although stretching can be done at any time of the day, the ACSM has traditionally recommended that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies have provided evidence against stretching before exercise session suggesting that stretching will compromise the force- producing capabilities of muscles. Therefore, it is recommended that stretching take place only after the body temperature and of the muscles has increased, i.e. after the warm up or after the workout. Additional confirming evidence of this concept has shown that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. As you can see, temperature also plays a significant role in muscle ROM.

http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance

Stretching Safely

In addition to warming the muscle before performing stretching exercises, there are other things that can be done to make your flexibility routine safe. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

In addition, some stretches are not recommended, or contraindicated. Researchers have determined that some stretching exercises may not be beneficial at all or may cause injury. A list of contraindicated stretches and alternative stretches can be

found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. It is important to understand personal limitations before or during a stretch exercise to avoid injury.

Contraindicated Stretches

https://www.unm.edu/~lkravitz/Teaching%20Aerobics/YoungExercise3.pdf

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2.4.5.5: Assessing Your Flexibility, Laboratory Exercises

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below to understand how you can perform these assessements. Those that may be most helpful include sections 5.1, 5.2, and 5.3.

https://wpscms.pearsoncmg.com/bc_hopson_health_2/214/54825/14035385.cw/index.html

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Biomechanics of Stretching

medind.nic.in/jau/t06/jaut06p3.pdf

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2.4.6.1: Body Weight versus Body Composition

According to surveys, the top reason American females exercise is for weight control. For males, the top reason is to improve muscle tone while weight control ranks as the fourth most important reason.[1] Levels of attractiveness based on weight and visible musculature are significant points of emphasis in American culture. As such, individuals with well-toned muscles and low body weight are marketed as *superior* within the context of attractiveness, financial success, and multiple other traits. Unfortunately, this emphasis, as seen in mainstream media, can result in unrealistic ideals and potentially harmful behaviors, such as eating disorders.

Unlike the mainstream outlets, which focus on the association between fat levels and physical attractiveness, this chapter focuses on the health-related consequences related to good and bad body composition. **Body composition** is defined as the body's relative amount of fat-free mass (FFM) and fat mass (FM) and is generally expressed as a percentage of total body weight. FFM includes bones, muscles, ligaments, body fluids and other organs, while FM is limited to fat tissue.

The Importance of Measuring Body Composition Rather Than Just Tracking Body Weight

Tracking weight can be helpful, but body composition measurements help separate a person's actual weight from the weight that could be unhealthy.

For example, an individual who weighs 200 pounds and has 8% body fat, such as an athlete, only carries around 16 pounds of FM. However, a 200-pound person who has a sedentary lifestyle and a body composition of 20%, carries 40 pounds of FM. Weight alone, in this case, does not distinguish between FFM and FM and would suggest both individuals have similar health. As body fat percentage increases, the potential for various diseases also increases significantly.

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2.4.6.2: Diseases Associated with Excessive Body Fat

According to the National Institute of Health (NIH), a wide array of diseases can be linked to excessive body fat.[2] Some of them are:

- Type II Diabetes Mellitus
- Hypertension
- Cancer
- Cerebrovascular Disease (Stroke)
- Cardiovascular Disease
- Metabolic Syndrome
- Lung Disorders
  - Sleep Apnea
  - Asthma
- Musculoskeletal Diseases
  - Osteoarthritis
  - Gout
- Gallbladder Disease
- Pancreatitis
- Non-Alcohol Fatty Liver Disease
- Dementia
- Psychological Problems and Quality of Life
- Kidney Disease
- Pregnancy Problems

An explanation of how being overweight relates to each disease (those highlighted) can be viewed by clicking on the following link.

NIH-Explanation of Disease Risk Associated with Overweight

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2.4.6.3: How Much Fat is Needed?

Fat is a necessary component of daily nutrition. It is needed for healthy cellular function, energy, cushioning for vital organs, insulation, and for food flavor.

Fat storage in the body consists of two types of fat: essential and nonessential fat.**Essential fat** is the minimal amount of fat necessary for normal physiological function. For males and females, essential fat values are typically considered to be 3% and 12%, respectively. Fat above the minimal amount is referred to as **nonessential fat**. It is generally accepted that an overall range of 10-22 percent for men and 20-32 percent for women is considered satisfactory for good health. A body composition within the recommended range suggests a person has less risk of developing obesity-related diseases, such as diabetes, high blood pressure, and even some cancers.

A woman's essential fat range is naturally greater than a man's because of fat deposits in breasts, uterus and sex-specific sites. In both males and females, non- essential fat reserves can be healthy, especially in providing substantial amounts of energy.

Excessive body fat is categorized by the terms overweight and obesity. These terms do not implicate social status or physical attractiveness, but rather indicate health risks. **Overweight** is defined as the accumulation of non-essential body fat to the point that it adversely affects health. According to the American College of Sports Medicine (ACSM), the threshold for being characterized as overweight is having a body composition of FM greater than 32% and 19% for females and males, aged 20-39, respectively.[3]

Obesity is characterized by excessive accumulation of body fat and can be defined as a more serious degree of being overweight. Classifications of obesity begin at body composition of FM greater than 39% and 25% in females and males ages 20- 39, respectively. [4]

Other Health Risks

Diseases are not the only concern with an unhealthy body fat percentage. Several others are listed below.

- *Performance of physical activity*
  An important component of a healthy lifestyle and weight management is regular physical activity and exercise. To the contrary, those who live a sedentary lifestyle will find it more difficult to maintain a healthy body weight or develop adequate musculature, endurance, and flexibility. Unfortunately, additional body weight makes it more difficult to be active because it requires more energy and places a higher demand on weak muscles and the cardiovascular system. The result is a self-perpetuating cycle of inactivity leading to more body weight, which leads to more inactivity.
- *Emotional wellness*
  Studies indicate obesity is associated with a 25% increase in anxiety and mood disorders, regardless of age or gender. Other studies suggest increases in BMI significantly increase the incidence of personality disorders and anxiety and mood disorders. Additional studies have been able to associate a higher incidence of psychological disorders and suicidal tendencies in obese females compared with obese males.[5]
- *Pre-mature death*
  The association between obesity and diseases, such as cancer, CVD, and diabetes, suggests that people with more body fat generally have shorter lifespans. The Center for Disease Control (CDC) estimates up to 365,000 deaths each year can be linked with obesity, representing nearly 15% of all deaths. Other studies have tied the Years of Life Lost to body mass index measurements, estimating anywhere from 2 to 20 years can be lost, depending on ethnicity, age at time of obese classification, and gender.[6]
- *Economic impact*
  The physical harm caused by obesity and overweight is mirrored by its economic impact on the health care system. The CDC has estimated the medical costs to be about $147 billion in 2008, which includes preventative, diagnostic, and treatments. Overweight and obesity also contribute to loss of productivity at work through absenteeism and *presenteeism*, defined as being less productive while working. The annual nationwide productive costs fall within the range of from $3.38 to $6.38 billion.[7]

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2.4.6: BODY COMPOSITION

By Scott Flynn

Learning Objectives

- What is body composition?
- How does body composition affect a person's health?
- What are the health risks and costs associated with overweight and obesity?
- What is the significance of body fat distribution?
- What is Body Mass Index (BMI) and why is it important?

2.4.6.1: Body Weight versus Body Composition

2.4.6.2: Diseases Associated with Excessive Body Fat

2.4.6.3: How Much Fat is Needed?

2.4.6.4: Body Fat Distribution

2.4.6.5: Body Mass Index

2.4.6.6: How to Measure Body Composition

2.4.6.7: Weighing in on the U.S.

2.4.6.8: What Can Be Done?

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2.4.6.4: Body Fat Distribution

Body composition measurements can help determine health risks and assist in creating an exercise and nutrition plan to maintain a healthy weight. However, the presence of unwanted body fat is not the only concern associated with an unhealthy weight. Where the fat is stored, or fat distribution, also affects overall health risks.

Non-essential fat is primarily stored in**adipose tissue**, or fat cells, located on the surface of the body and surrounding the body's organs. Surface fat, located just below the skin, is called **subcutaneous fat**. Fat that lies deeper in the body surrounding the body's organs is called **visceral fat**. Unlike subcutaneous fat, visceral fat is more often associated with abdominal fat. Researchers have found that excessive belly fat decreases insulin sensitivity, making it easier to develop type II diabetes. It may also negatively impact blood lipid metabolism, contributing to more cases of cardiovascular disease and stroke in patients with excessive belly fat.[8]

Body fat distribution can easily be determined by simply looking in the mirror. The outline of the body, or body shape, would indicate the location of where body fat is stored. Abdominal fat storage patterns are generally compared to the shape of an apple, called the **android shape**. This shape is more commonly found in males and post- menopausal females. In terms of disease risk, this implies males and post- menopausal females are at greater risk of developing health issues associated with excessive visceral fat. Individuals who experience chronic stress tend to store fat in the abdominal region.

A pear-shaped body fat distribution pattern, or **gynoid shape**, is more commonly found in pre-menopausal females. Gynoid shape is characterized by fat storage in the lower body such as the hips and buttocks. This shape may be connected to females' child-bearing abilities as enzymes associated with fat-storage and mobilization are activated during certain times of pregnancy and post- partum.

Besides looking in the mirror to determine body shape, people can use an inexpensive tape measure to measure the diameter of their hips and waist. Many leading organizations and experts currently believe a waist circumference of 40 or greater for males and 35 or greater for females significantly increases risk of disease.[9]

In addition to measuring waist circumference, measuring the waist and the hips and using a waist-to-hip ratio (waist circumference divided by the hip circumference) is equally effective at predicting body fat-related health outcomes. According to the National Heart, Lung, and Blood Institute, a ratio of greater than 0.82 for females and 0.94 for males is associated with a higher risk of developing heart disease, diabetes, and hypertension.[10]

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In addition to body composition and waist/hip circumferences, measuring body mass has also been used as an effective method to assess health risks. **Body mass index (BMI)** is a measurement of height (m2) and weight (kg) suggesting that a person's body's weight should be proportional to his or her height. For example, based on the BMI scale, a female with a height of 5'6" should not weigh more than 155 lbs. If her weight exceeded 155 lbs., she would be categorized as "overweight."

$$BMI = \frac{Weight(kg)}{Height(m^2)} \tag{2.4.6.5.1}$$

Among several criticisms, the BMI method has been faulted for not distinguishing between FM and FFM, since only the overall weight is taken into account. For athletes, who may be more massive as a result of larger muscles, this criticism holds true. For example, a professional football player who weighs 215 pounds and stands at 6'3" would have the exact same BMI as a relatively sedentary arm-chair quarterback who also weighs 215 pounds with the same height. This discrepancy also exists when applying BMI to the senior population. As age increases, muscle mass declines. Seniors who have experienced years of muscle mass decline but increased body fat may maintain a constant weight despite having a very different body composition.

Other criticisms of using BMI as a health risk assessment tool include its failure to take age or gender into account. As discussed previously, females naturally have more body fat yet are classified in the same context as males. Because this measurement is so widely used by physicians, patients continue to express concerns about the validity of BMI as an indication of fatness.

Regardless of the criticisms, BMI as used for the general population, has been shown to be a reasonable predictor of health outcomes. At its core, it is not intended to be an estimate of body composition, i.e., measure FM and FFM. Instead, it is intended to be used as an estimate of healthy/unhealthy levels of body fat. When used as a means of tracking weight changes over time it can be a valuable tool in predicting health and for recommending lifestyle modifications.[11]

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2.4.6.6: How to Measure Body Composition

Multiple methods exist to estimate body composition. Remember, body composition is the ration of FM and FFM used to help determine health risks. Of the other methods already mentioned (waist, waist- to-hip ratio, and BMI), none provide estimates of body composition but do provide measurements of other weight- related health markers, such as abdominal fat. Experts have designed several methods to estimate body composition. While they are not flawless, they do provide a fairly accurate representation of body composition. The most common are:

- *Hydrostatic Weighing (Underwater Weighing)*
  At one time, hydrostatic weighing (also and maybe more accurately called **hydrodensitometry**) was considered the criterion for measuring body composition. Many other methods are founded on this model, in one form or another. This method attempts to measure the density of the body by applying Archimedes' principle: density = mass/volume. The mass and volume components are measured by using dry weight and then weight while being submerged in a water tank. Since fat is less dense than muscle tissue, a person with more body fat will weigh less in the water than a similar person with more lean mass. Using the measurements, the density can be determined and converted into body fat percentage. With a small margin of error (around 1-2%) this method is very accurate. Unfortunately, the expense and practicality of building and maintaining a water tank limits access for most. Also, for those with a fear of water, this would obviously not be the preferred method.
- *Dual Energy X-Ray Absorptiometry (DEXA)*
  Replacing underwater weighing as the new "gold standard," is DEXA. While underwater weighing accurately compartmentalizes FM and FFM, DEXA adds a third compartment by using low-radiation X-rays to distinguish bone mineral. This addition slightly increases the accuracy of DEXA by eliminating some of the guess work associated with individual differences, such as total body water and bone mineral density.

  Originally, DEXA scanners were designed to determine and help diagnose bone density diseases. As a result, they can be found in many physicians' offices. However, a full body scan, which takes only a few minutes, is all that is needed to also determine body fat percentage. Major disadvantages to this method are its high cost and the need for a well-trained professional to operate the equipment and analyze the results.

- *Air Displacement (Plethysmography)*
  A good alternative to more expensive methods, air displacement determines body density using the same principle as underwater weighing, by measuring mass and volume. Clearly, the main difference is that mass and volume are being determined by air displacement rather than water displacement. Using a commercial device (the Bod Pod is most commonly referenced), a person sits in a chamber that varies the air pressure allowing for body volume to be assessed. Air displacement provides a viable alternative for those with a fear of water.

  Like many other methods, the expense, availability, and training of personnel Air Displacement requires limit accessibility. Additionally, its accuracy is slightly less than underwater weighing.

- *Bio-electrical Impedance Analysis (BIA)*
  BIA takes a slightly different approach to measuring FFM. The premise behind BIA is that FFM will be proportional to the electrical conductivity of the body. Fat-tissue contains little water, making it a poor conductor of electricity; whereas, lean tissue contains mostly water and electrolytes, making it an excellent conductor. BIA devices emit a low-level electrical current through the body and measure the amount of resistance the current encounters. Based on the level of impedance, a pre-programed equation is used to estimate body fat percentage.

  The most accurate BIA devices use electrodes on the feet and hands to administer the point-to-point electrical current. The margin of error for these devices falls in the range of 3–5%. Portable or handheld BIA devices that only measure lower or upper body conductivity have a higher margin of error (4–8%).

  Because BIA devices primarily measure hydration, circumstances that may influence hydration status at the time of measurement must be taken into account. Recent exercise, bladder content, hydration habits, and meal timing can cause wide measurement variations and influence accuracy. However, this method is generally inexpensive, often portable, and requires limited training to use, making it a very practical option.

- *Skinfold Analysis*
  Skinfold analysis is a widely used method of assessing body composition because of its simplicity, portability, and

affordability. It is also fairly accurate when administered properly. Margins of error are about 4–7%, depending on the quality of the skinfold calipers and skill of the administrator/technician. The assumption of skinfold measurement is that the amount of subcutaneous fat is proportionate to overall body fat. As such, a technician pinches the skin at various sites and uses calipers to measure and record the diameter of the skin folds. These numbers can then be plugged into an equation to generate an estimate of body fat percentage.

The proportionality of subcutaneous fat and overall body fat depends on age, gender, ethnicity, and activity rates. As such, technicians should use the skinfold technique specific to the equation that accounts for those variables to improve accuracy.

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2.4.6.7: Weighing in on the U.S.

Despite the well-known health concerns implicated in overweight and obesity and the availability of multiple methods for assessment and tools to improve body composition, current trends in the United States and around the world are moving in the wrong direction. The unprecedented number of obese Americans has led experts to label it an epidemic, much like they would a disease in a developing country. According to the CDC, the number of American adults (>20 years) that fall into the overweight classification based on BMI are 70.7%. Of those, 37.9% fall within the obese classification. In 1962, the overweight and obesity rates for adults in the U.S. were 32% and 13%, respectively. In other words, overweight trends have more than doubled and obesity rates have almost tripled over the past 50+ years.[12]

Of more concern are the increasing number of obese children ages 6-11 and adolescents ages 12-19, amounting to 17.4% and 20.6%, respectively.[13] While those numbers have stabilized over the past decade, this has led to a dramatic increase in insulin resistance, a form of diabetes formerly known as adult onset diabetes.

With such a diverse population in the U.S. and with an understanding of how BMI is calculated, it is only natural to question the high number of overweight and obese citizens based on BMI alone. However, it is generally believed this is an accurate portrayal of weight status. In a study attempting to compare BMI measurements to actual body fat percentage, it was determined that the total number of obese citizens may be underestimated, and its current prevalence may be worse than is currently being reported.

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- 11: How Genes Are Controlled has no license indicated.

2.4.6.8: What Can Be Done?

With the available tools to identify health risks associated with body fat, anyone concerned about their health should gather as much data about body composition and body fat distribution as possible. Compiling multiple measurements and analyzing them provides a better idea of a person's current health status and will help determine the next course of action. For example, BMI alone can be beneficial. But when combined with waist circumference, a greater understanding of risk can be achieved. Likewise, when combining BMI and waist circumference with body fat percentage, an ideal conclusion of health status can be made.

In the lab accompanying this chapter, you will be guided through the process of assessing your BMI, waist circumference, waist-to-hip ratio, and body fat percentage.

The next course of action is to set goals and formulate a plan to get to a healthy range of weight and body fat percentage. Where weight loss is needed, the plan should include a balance of calorie restriction and physical activity/exercise. This might also include tracking your current eating and activity habits. More specific information on weight management strategies will be discussed in a later chapter.

Low Body Composition

Because more people experience excess body fat, the focus up to this point has been on health concerns related to overweight and obesity. However, fat is an essential component to a healthy body, and in rare cases, individuals have insufficient fat reserves, which can also be a health concern. The range of essential body fat for males is 3-5% and 8-12% for females. Attempting to, or intentionally staying in those ranges, through excessive exercise or calorie restriction is not recommended. Unfortunately, low body fat is often associated with individuals struggling with eating disorders, the majority of whom are females.

The main concern of low body fat relates to the number and quality of calories being consumed. Foods not only provide energy but also provide the necessary nutrients to facilitate vital body functions. For example, low amounts of iron from a poor diet can result in anemia. Potassium deficiencies can cause hypokalemia leading to cardiovascular irregularities. If adequate calcium is not being obtained from foods, bone deficiencies will result. Clearly, having low body fat, depending on the cause, can be equally as detrimental to health as having too much.

The health concerns most often linked to low body fat are:

- Reproductive disorders
  - Infrequent or missing menstrual cycles
- Respiratory disorders
- Immune System disorders
- Circulatory disorders
- Premature death

In some cases, despite attempts to gain weight, individuals are unable to gain the pounds needed to maintain a healthy weight. In these cases, as in the case of excess fat, a holistic approach should be taken to determine if the low levels of body fat are adversely affecting health. These individuals should monitor their eating habits to assure they are getting adequate nutrition for their daily activity needs. Additionally, other lifestyle habits should be monitored or avoided, such as smoking, which may suppress hunger.

Additional reading on low body fat and its impact can be found on the Livestrong.com website, on this page: At what body fat percent do you start losing your period?.

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2.4.7.1: The Basics of Nutrition

Nutrition can be defined as the science of the action of food, beverages, and their components in biological systems. A nutrient is a compound that provides a needed function in the body. Nutrients can be further classified based on the amount needed in the body. **Macronutrients** are the nutrients the body needs in larger amounts. **Micronutrients** are also important nutrients, but ones the body needs in smaller amounts.

Macronutrients	Micronutrients
Carbohydrate	Vitamins
Protein	Minerals
Lipids	
Water	

Macronutrients

- *Carbohydrates:* The word carbohydrate literally means "hydrated carbon," or carbon with water. Thus, it is no surprise that carbohydrates are made up of carbon, hydrogen, and oxygen. Sucrose (table sugar) is an example of a commonly consumed carbohydrate. Some dietary examples of carbohydrates are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta.
- *Proteins:* Like carbohydrates, proteins are comprised of carbon, hydrogen, and oxygen, but they also contain nitrogen. Several dietary sources of proteins include nuts, beans/legumes, skim milk, egg whites, and meat.
- *Lipids:* Lipids consist of fatty acids, triglycerides, phospholipids, and sterols (cholesterol). Lipids are also composed of carbon, hydrogen, and oxygen. Some dietary sources of lipids include, oils, butter, and egg yolks.
- *Water:* Water is made up of hydrogen and oxygen and is the only macronutrient that provides no energy.

Micronutrients

- *Vitamins:* These compounds are essential for normal physiologic processes in the body.
- *Minerals:* Minerals are the elements (think periodic table) that are essential for normal physiologic processes in the body.

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2.4.7: NUTRITION

Learning Objectives

- Summarize the basics of nutrition
- Define macronutrients and micronutrients
- Categorize and describe the body's sources of energy
- Analyze intake of nutrition and make appropriate changes

2.4.7.1: The Basics of Nutrition

2.4.7.2: Calories (Food Energy)

2.4.7.3: References and Links

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2.4.7.2: Calories (Food Energy)

Food energy is measured in kilocalories (kcals), commonly referred to as calories. Although technically incorrect, this terminology is so familiar that it will be used throughout this course. A kilocalorie is the amount of energy needed to raise 1 kilogram of water 1 degree Celsius. A food's kilocalories are determined by putting the food into a bomb calorimeter and determining the energy output: Energy = Measurement of Heat Produced. Below is a picture of a bomb calorimeter and a link to a video showing how one is used.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

https://www.youtube.com/watch?v=YXo9B2AbH0s

The number of kilocalories per gram for each nutrient is shown below:

Nutrient	**Energy (kcal/g)**
Carbohydrate	4
Protein	4
Lipids	9
Water	0
Vitamins	0
Minerals	0

As the table above illustrates, only carbohydrates, protein, and lipids provide energy. However, there is another dietary energy source that is not a nutrient— alcohol. To emphasize, alcohol is *not* a nutrient, but it does provide 7 kilocalories of energy per gram.

Knowing the number of calories in each nutrient allows a person to calculate/estimate the amount of calories contained in any food consumed.

Carbohydrates

Carbohydrates have become, surprisingly, quite controversial. Some people passionately extol the merits of carbohydrates, while others berate them as nutritional assassins. However, it is important to understand that carbohydrates are a diverse group of compounds that have a multitude of effects on bodily functions. Thus, trying to make blanket statements about carbohydrates is not a good idea.

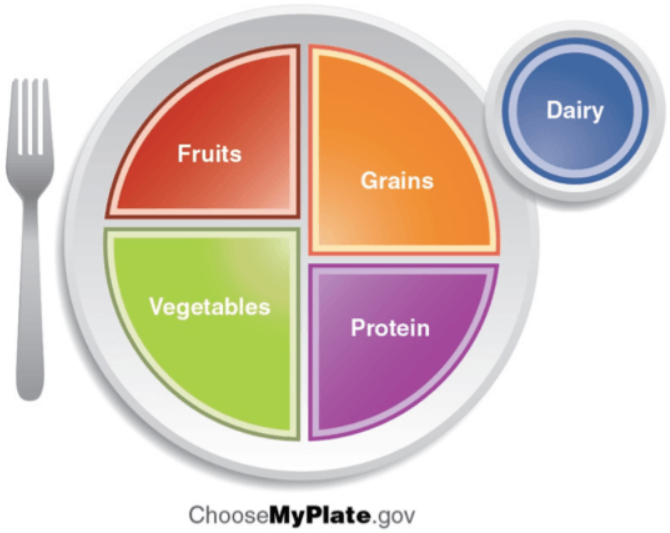
My Plate

Derived from OpenStax

On average, a person needs 1500 to 2000 calories per day to sustain (or carry out) daily activities. The total number of calories needed by one person is dependent on their body mass, age, height, gender, activity level, and the amount of exercise per day. If exercise is regular part of one's day, more calories are required. As a rule, people underestimate the number of calories ingested and overestimate the amount they burn through exercise. This can lead to ingestion of too many calories per day. The accumulation of an extra 3500 calories adds one pound of weight. If an excess of 200 calories per day is ingested, one extra pound of body weight will be gained every 18 days. At that rate, an extra 20 pounds can be gained over the course of a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns almost 100 calories.

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. In fact, the breakdown of carbohydrates requires the least amount of energy, whereas the processing of proteins demands the most energy. In general, the amount of calories ingested and the amount of calories burned determines the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything you ingest, so when considering calorie intake, beverages must also be considered.

To help provide guidelines regarding the types and quantities of food that should be eaten every day, the USDA has updated their food guidelines from MyPyramid to MyPlate. They have put the recommended elements of a healthy meal into the context of a place setting of food. MyPlate categorizes food into the standard six food groups: fruits, vegetables, grains, protein foods, dairy, and oils. The accompanying website gives clear recommendations regarding quantity and type of each food that you should consume each day, as well as identifying which foods belong in each category. The accompanying graphic (Figure) gives a clear visual with general recommendations for a healthy and balanced meal. The guidelines recommend to "Make half your plate fruits and vegetables." The other half is grains and protein, with a slightly higher quantity of grains than protein. Dairy products are represented by a drink, but the quantity can be applied to other dairy products as well.



MyPlate. The U.S. Department of Agriculture developed food guidelines called MyPlate to help demonstrate how to maintain a healthy lifestyle. Derived from OpenStax- You can download material: http://cnx.org/contents/14fb4ad7-39a...482e3e22@8.108.

High-Fructose Corn Syrup

Food manufacturers are always searching for cheaper ways to produce their products. One extremely popular method for reducing costs is the use of high-fructose corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose, which is the same as sucrose. Nevertheless, because increased consumption of high-fructose corn syrup has coincided with increased obesity in the United States, a lot of controversy surrounds its use.

Alternative sweeteners are simply alternatives to sucrose and other mono- and disaccharides that provide sweetness.

Below are several links that provide additional information about glucose, corn syrup, and sugar.

The New York Times article linked below discusses the growing popularity of sugar compared to high fructose corn syrup: "Sugar is Back on Food Labels, This Time as a Selling Point"

The website linked below provides a wealth of information about all things sweet, such as corn syrup, sugar substitutes, sugar supplements, and granulated fructose.

Corn Syrup

The article linked below explains why the Corn Refiners Association has asked for permission to change the name of high fructose corn syrup to corn sugar and why the US Food and Drug Administration rejected that request:

"No New Name for High Fructose Corn Syrup"

Protein

Protein is another major macronutrient that, like carbohydrates, consists of small repeating units. But instead of sugars, proteins are made up of amino acids.

Proteins can be classified as either complete or incomplete. Complete proteins provide adequate amounts of all nine essential amino acids. Animal proteins, such as meat, fish, milk, and eggs, are good examples of complete proteins. Incomplete proteins do not contain adequate amounts of one or more of the essential amino acids. For example, if a protein does not provide enough of the essential amino acid leucine it would be considered incomplete. Leucine would be referred to as the **limiting amino acid** because there is not enough of it for the protein to be complete. Most plant foods are incomplete proteins, with a few exceptions, such as soy. The table below shows the limiting amino acids in some plant foods.

Self Magazine's Nutrition Data website is a useful resource for determining protein quality and identifying complementary proteins. To use the site, go to www.nutritiondata.com, type the name of the food you want information on in the search bar and hit Enter. When you have selected your food from the list of possibilities, you will be given information about this food. Included in this information is the Protein Quality section. This will give you an amino acid score and a figure that illustrates which amino acid(s) is limiting. If your food is an incomplete protein, you can click "Find foods with a complementary profile." This will take you to a list of dietary choices that will provide complementary proteins for your food.

The chapter linked below is from a book published by the National Academies of Sciences, Engineering, and Medicine and provides an exhaustive examination of the role protein and amino acids play in human health.

Protein and Amino Acids

Fat

There is neither bad nor good cholesterol, despite the common use of these descriptions in reference to LDL and HDL, respectively. Cholesterol is cholesterol. HDL and LDL contain cholesterol but are actually lipoproteins that will be described later. It is not necessary to include cholesterol in your diet because our bodies have the ability to synthesize the required amounts. The figure below gives you an idea of the cholesterol content of a variety of foods.

www.webmd.com/cholesterol- management/foods-to-avoid-for-high- cholesterol

Fiber

The simplest definition of fiber is indigestible matter. Indigestible means that it survives digestion in the small intestine and reaches the large intestine.
There are the three major fiber classifications:

- *Dietary fiber:* This type of fiber contains both nondigestible carbohydrates and lignin and is always intrinsic and intact in plants.
- *Functional fiber:* This type of fiber contains nondigestible carbohydrates only and can be isolated, extracted, or synthesized. Functional fiber can be from plants or animals and produces beneficial physiological effects in humans.
- *Total Fiber:* Fiber that contains both dietary fiber and functional fiber.

Vitamins

Derived from OpenStax-

Vitamins are organic compounds found in foods and are a necessary part of the biochemical reactions in the body. They are involved in a number of processes, including mineral and bone metabolism, and cell and tissue growth, and they act as cofactors for energy metabolism. The

B vitamins play the largest role of any vitamins in metabolism (Table and Table).

You get most of your vitamins through your diet, although some can be formed from the precursors absorbed during digestion. For example, the body synthesizes vitamin A from the β-carotene in orange vegetables like carrots and sweet potatoes. Vitamins are either fat-soluble or

water-soluble. Fat-soluble vitamins A, D, E, and K, are absorbed through the intestinal tract with lipids in chylomicrons. Vitamin D is also synthesized in the skin through exposure to sunlight. Because they are carried in lipids, fat-soluble vitamins can accumulate in the lipids stored in the body. If excess vitamins are retained in the lipid stores in the body, hypervitaminosis can result.

Water-soluble vitamins, including the eight B vitamins and vitamin C, are absorbed with water in the gastrointestinal tract.
These vitamins move easily through bodily fluids, which are water based, so they are not stored in the body. Excess water- soluble vitamins are excreted in the urine. Therefore, hypervitaminosis of water- soluble vitamins rarely occurs, except with an excess of vitamin supplements.

Derived from OpenStax-

Minerals

Minerals in food are inorganic compounds that work with other nutrients to ensure the body functions properly. Minerals cannot be made in the body; they come from the diet. The amount of minerals in the body is small—only 4 percent of the total body mass—and most of that consists of the minerals that the body requires in moderate quantities: potassium, sodium, calcium, phosphorus, magnesium, and chloride.

The most common minerals in the body are calcium and phosphorous, both of which are stored in the skeleton and necessary for the hardening of bones. Most minerals are ionized, and their ionic forms are used in physiological processes throughout the body. Sodium and chloride ions are electrolytes in the blood and extracellular tissues, and iron ions are critical to the formation of hemoglobin. There are additional trace minerals that are still important to the body's functions, but their required quantities are much lower.

Like vitamins, minerals can be consumed in toxic quantities (although it is rare). A healthy diet includes most of the minerals your body requires, so supplements and processed foods can add potentially toxic levels of minerals. Table and Table provide a summary of minerals and their function in the body.

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2.4.8.1: Weight Management Through Diet

Achieving one's ideal weight can be a real challenge. But like most endeavors in life, knowledge is power. The more people know about their diet, the better equipped they will be to manage their weight. Most people focus on the number of calories consumed. However, it is also important for them to know how many macronutrients are in the foods they eat. The most effective way to do this is performing a 10-day nutritional intake analysis. These analyses are best done on consecutive days to account for the habitual ebb and flow of one's daily food intake.

Remaining healthy during any weight loss program is paramount. Fad diets that promise quick results do not consider the effects of rapid weight loss on the body. Restricting weight loss to 1 to 2 pounds a week is a far healthier approach. Slow weight also prevents the body from burning lean muscle since the body can only burn a certain amount of fat in a week. Dieters who experience steady declines in weight are more likely to keep the weight off. The term "diet" is often synonymous with strict routines that require drastic changes in one's eating habits. In reality, the term "diet" simply describes the intake of food.

To lose weight, dieters need a clear understanding of how weight loss occurs. One pound of fat loss is going to require a reduction in caloric intake of 3,500 calories. When viewed in terms of daily food intake, to lose a pound a week, a dieter needs to reduce their daily food intake by 500 calories a day: 3,500 calories/7 days= 500 calories per day. To successfully lose 2 pounds per week, that reduction would have to be doubled to 1,000 calories per day. Attempting to lose 2 pounds or more per week would require a calorie reduction too drastic to be maintained and too restrictive to be healthy. Thus the recommendation of combining diet and exercise is the most effective method for experiencing weight loss. Subtracting 500 calories of food intake and exerting 500 calories in exercise will provide that same 1000 calorie reduction, but in a manner that is far easier to maintain, and certainly more enjoyable.

No matter what your weight loss goal is, even a modest weight loss, such as 5 to 10 percent of your total body weight, is likely to produce health benefits, such as improvements in blood pressure, blood cholesterol, and blood sugars.[1]

Getting Started with Weight Loss

The Centers for Disease Control and Prevention (CDC) recommends following the step-by-step guide published on its website, on this page: Healthy Weight: Losing Weight. Getting Started. The same information is also reprinted below:

Step 1: Make a commitment

Making the decision to lose weight, change your lifestyle, and become healthier is a big step to take. Start simply by making a commitment to yourself. Many people find it helpful to sign a written contract committing to the process. This contract may include things like the amount of weight you want to lose, the date you would like to lose the weight by, the dietary changes you will make to establish healthy eating habits, and a plan for getting regular physical activity.
Writing down the reasons why you want to lose weight can also help. It might be because you have a family history of heart disease, or because you want to see your kids get married, or simply because you want to feel better in your clothes. Post these reasons where they serve as a daily reminder of why you want to make this change.

Step 2: Take stock of where you are

Consider talking to your health care provider. He or she can evaluate your height, weight, and explore other weight- related risk factors you may have. Ask for a follow-up appointment to monitor changes in your weight or any related health conditions.

Keep a "food diary" for a few days, in which you write down everything you eat. By doing this, you become more aware of what you are eating and when you are eating. This awareness can help you avoid mindless eating.

Next, examine your current lifestyle. Identify things that might pose challenges to your weight loss efforts. For example, does your work or travel schedule make it difficult to get enough physical activity? Do you find yourself eating sugary foods because that is what you buy for your kids? Do your coworkers frequently bring high- calorie items, such as doughnuts, to the workplace to share with everyone? Think through things you can do to help overcome these challenges.

Finally, think about aspects of your lifestyle that can help you lose weight. For example, is there an area near your workplace where you and some coworkers can take a walk at lunchtime? Is there a place in your community, such as a YMCA, with exercise facilities for you and child care for your kids?

Step 3: Set realistic goals

Set some short-term goals and reward your efforts along the way. If your long-term goal is to lose 40 pounds and to control your high blood pressure, some short-term eating and physical activity goals might be to start eating breakfast, taking a 15-minute walk in the evenings, or having a salad or vegetable with supper.

Focus on two or three goals at a time. Great, effective goals are —

- Specific
- Realistic
- Forgiving (less than perfect)

For example, "Exercise more" is not a specific goal. But if you say, "I will walk 15 minutes, 3 days a week for the first week," you are setting a specific and realistic goal for the first week.

Remember, small changes every day can lead to big results in the long run. Also, remember that realistic goals are achievable goals. By achieving your short- term goals day by day, you will feel good about your progress and be motivated to continue. Setting unrealistic goals, such as losing 20 pounds in 2 weeks, can leave you feeling defeated and frustrated.

Being realistic also means expecting occasional setbacks. Setbacks happen when you get away from your plan for whatever reason—maybe the holidays, longer work hours, or another life change. When setbacks happen, get back on track as quickly as possible. Also, take some time to think about what you would do differently if a similar situation happens, to prevent setbacks.

Keep in mind everyone is different—what works for someone else might not be right for you. Just because your neighbor lost weight by taking up running, doesn't mean running is the best option for you. Try a variety of activities: walking, swimming, tennis, or group exercise classes, to see what you enjoy most and can fit into your life. These activities will be easier to stick with over the long term.

Step 4: Identify resources for information and support

Find family members or friends who will support your weight loss efforts. Making lifestyle changes can feel easier when you have others you can talk to and rely on for support. You might have coworkers or neighbors with similar goals, and together you can share healthful recipes and plan group exercise. Joining a weight loss group or visiting a health care professional, such as a registered dietitian, can help.

Step 5: Continually "check in" with yourself to monitor your progress

Revisit the goals you set for yourself in Step 3, and evaluate your progress regularly. If you set a goal to walk each morning but are having trouble fitting it in before work, see if you can shift your work hours or if you can get your walk in at lunchtime or after work. Evaluate which parts of your plan are working well and which ones need tweaking. Then rewrite your goals and plan accordingly.

If you are consistently achieving a particular goal, add a new goal to help you continue on your pathway to success.

Reward yourself for your successes! Recognize when you are meeting your goals and be proud of your progress. Use non- food rewards, such as a bouquet of freshly picked flowers, a sports outing with friends, or a relaxing bath. Rewards help keep you motivated on the path to better health.[2]

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2.4.8.2: The Importance of Physical Activity in Maintaining a Healthy Weight

On its website, the CDC explains the importance of including physical activity as part of any weight loss program. You can find information about the benefits of physical activity, recommended levels of physical activity, and the number of calories burned during common activities by clicking on this link to webpage: Healthy Weight: Physical Activity for a Health Weight. That same information is reprinted below.

Why is physical activity important?

Regular physical activity is important for good health, and it is especially important if you are trying to lose weight or to maintain a healthy weight.

- When losing weight, more physical activity increases the number of calories your body uses for energy or "burns off." The burning of calories through physical activity, combined with reducing the number of calories you eat, creates a "calorie deficit" that results in weight loss.
- Most weight loss occurs because of decreased caloric intake. However, evidence shows the only way to maintain weight loss is to be engaged in regular physical activity.
- Most importantly, physical activity reduces risks of cardiovascular disease and diabetes beyond that produced by weight reduction alone.

Physical activity also helps to–

- Maintain weight.
- Reduce high blood pressure.
- Reduce risk for type 2 diabetes, heart attack, stroke, and several forms of cancer.
- Reduce arthritis pain and associated disability.
- Reduce risk for osteoporosis and falls.
- Reduce symptoms of depression and anxiety.

How much physical activity do I need?

When it comes to weight management, people vary greatly in how much physical activity they need. Here are some guidelines to follow:

To maintain your weight.

Work your way up to 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous- intensity aerobic activity, or an equivalent mix of the two each week. Strong scientific evidence shows that physical activity can help you maintain your weight over time. However, the exact amount of physical activity needed to do this is not clear since it varies greatly from person to person. It is possible that you may need to do more than the equivalent of 150 minutes of moderate-intensity activity a week to maintain your weight.

To lose weight and keep it off.

You will need a high amount of physical activity unless you also adjust your diet and reduce the amount of calories you are eating and drinking. Getting to and staying at a healthy weight requires both regular physical activity and a healthy eating plan.

What do moderate- and vigorous-intensity mean?

Moderate: While performing the physical activity, if your breathing and heart rate is noticeably faster but you can still carry on a conversation, it is probably moderately intense.

Examples include:

- Walking briskly (a 15-minute mile).
- Light yard work (raking/bagging leaves or using a lawn mower).
- Light snow shoveling.
- Actively playing with children.
- Biking at a casual pace.

Vigorous: If your heart rate is increased substantially, and you are breathing too hard and fast to have a conversation, it is probably vigorously intense.

Examples include:

- Jogging/running.
- Swimming laps.
- Rollerblading/inline skating at a brisk pace.
- Cross-country skiing.
- Most competitive sports (football, basketball, or soccer). • Jumping rope.[3]

The table below provides a list of common physical activities and the average calories expended during those activities.

Calories Used per Hour in Common Physical Activities		
Moderate Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person[1]	Approximate Calori
Hiking	185	370
Light gardening/yard work	165	330
Dancing	165	330
Golf (walking and carrying clubs)	165	330
Bicycling (<10 mph)	145	290
Walking (3.5 mph)	140	280
Weight lifting (general light workout)	110	220
Stretching	90	180

Vigorous Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person[1]	Approximate Calori
Running/jogging (5 mph)	295	590
Bicycling (>10 mph)	295	590
Swimming (slow freestyle laps)	255	510
Aerobics	240	480
Walking (4.5 mph)	230	460
Heavy yard work (chopping wood)	220	440
Weightlifting (vigorous effort)	220	440
Basketball (vigorous)	220	440

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh les

Source: Adapted from Dietary Guidelines for Americans 2005, page 16, Table 4.

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh less.

Source: Adapted from Dietary Guidelines for Americans 2005, page 16, Table 4.

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2.4.8.3: Keeping the Weight Off

On its website the CDC admonishes that permanent weight loss is a result of making changes to eating habits that become a long-term part of a healthier lifestyle. You may access that section on their website by clicking Healthy Weight: Improving Your Eating Habits. It is also reprinted below.

Reflect, Replace, Reinforce: A process for improving your eating habits

- Create a list of your eating habits. Keeping a food diary for a few days, in which you write down everything you eat and the time of day you ate it, will help you uncover your habits. For example, you might discover that you always seek a sweet snack to get you through the mid- afternoon energy slump. Use thisdiary to help. It's good to note how you were feeling when you decided to eat, especially if you were eating when not hungry. Were you tired? Stressed out?
- Highlight the habits on your list that may be leading you to overeat. Common eating habits that can lead to weight gain are:
  - Eating too fast
  - Always cleaning your plate
  - Eating when not hungry
  - Eating while standing up (may lead to eating mindlessly or too quickly)
  - Always eating dessert
  - Skipping meals (or maybe just breakfast)
- Look at the unhealthy eating habits you have highlighted. Be sure you have identified all the triggers that cause you to engage in those habits. Identify a few you would like to work on improving first. Don't forget to pat yourself on the back for the things you are doing right. Maybe you almost always eat fruit for dessert, or you drink low-fat or fat- free milk. These are good habits! Recognizing your successes will help encourage you to make more changes.
- Create a list of "cues" by reviewing your food diary to become more aware of when and where you are "triggered" to eat for reasons other than hunger. Note how you are typically feeling at those times. Often an environmental "cue," or a particular emotional state, is what encourages eating for non-hunger reasons.
- Common triggers for eating when not hungry are:
  - Opening up the cabinet and seeing your favorite snack food.
  - Sitting at home watching television.
  - Before or after a stressful meeting or situation at work.
  - Coming home after work and having no idea what's for dinner.
  - Having someone offer you a dish they made "just for you!"
  - Walking past a candy dish on the counter.
  - Sitting in the break room beside the vending machine.
  - Seeing a plate of doughnuts at the morning staff meeting.
  - Swinging through your favorite drive-through every morning.
  - Feeling bored or tired and thinking food might offer a pick-me-up.

Circle the "cues" on your list that you face on a daily or weekly basis. Going home for the Thanksgiving holiday may be a trigger for you to overeat, and eventually, you want to have a plan for as many eating cues as you can. But for now, focus on the ones you face more often.

Ask yourself these questions for each "cue" you have circled:

Is there anything I can do to avoid the cue or situation? This option works best for cues that don't involve others. For example, could you choose a different route to work to avoid stopping at a fast food restaurant on the way? Is there another place in the break room where you can sit so you are not next to the vending machine?

For things I cannot avoid, can I do something differently that would be healthier? Obviously, you cannot avoid all situations that trigger your unhealthy eating habits, like staff meetings at work. In these situations, evaluate your options. Could you suggest or bring healthier snacks or beverages? Could you offer to take notes to distract your attention? Could you sit farther away from the food so it won't be as easy to grab something? Could you plan ahead and eat a healthy snack before the meeting?

Replace unhealthy habits with new, healthy ones. For example, in reflecting upon your eating habits, you may realize that you eat

too fast when you eat alone. So, make a commitment to share a lunch each week with a colleague, or have a neighbor over for dinner one night a week. Other strategies might include putting your fork down between bites or minimizing other distractions (i.e., watching the news during dinner) that might keep you from paying attention to how quickly—and how much— you are eating.

Here are more ideas to help you replace unhealthy habits:

Eat more slowly. If you eat too quickly, you may "clean your plate" instead of paying attention to whether your hunger is satisfied.

Eat only when you are truly hungry instead of when you are tired, anxious, or feeling an emotion besides hunger. If you find yourself eating when you are experiencing an emotion besides hunger, such as boredom or anxiety, try to find a non-eating activity to do instead. You may find a quick walk or phone call with a friend helps you feel better.

Plan meals ahead of time to ensure that you eat a healthy well-balanced meal.

Reinforce your new, healthy habits and be patient with yourself. Habits take time to develop. It doesn't happen overnight. When you do find yourself engaging in an unhealthy habit, stop as quickly as possible and ask yourself: Why do I do this? When did I start doing this? What changes do I need to make?

Be careful not to berate yourself or think that one mistake "blows" a whole day's worth of healthy habits. You can do it! It just takes one day at a time![4]

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2.4.8.4: Health Risks of Being Underweight

The 2003–2006 National Health and Nutrition Examination Survey (NHANES) estimated that 1.8 percent of adults and 3.3 percent of children and adolescents in the United States are underweight. Centers for Disease Control and Prevention. “NCHS Health E-Stat. Prevalence of Underweight among Children and Adolescents: United States, 2003–2006.” Accessed October 8, 2011. http://www.cdc.gov/nchs/data/hestat/underweight/underweight_children.htm. Being underweight is linked to nutritional deficiencies, especially iron-deficiency anemia, and to other problems such as delayed wound healing, hormonal abnormalities, increased susceptibility to infection, and increased risk of some chronic diseases such as osteoporosis. In children, being underweight can stunt growth. The most common underlying cause of underweight in America is inadequate nutrition. Other causes are wasting diseases, such as cancer, multiple sclerosis, tuberculosis, and eating disorders. People with wasting diseases are encouraged to seek nutritional counseling, as a healthy diet greatly affects survival and improves responses to disease treatments. Eating disorders that result in underweight affect about eight million Americans (seven million women and one million men).

Anorexia Nervosa

Anorexia nervosa, more often referred to as “anorexia,” is a psychiatric illness in which a person obsesses about their weight and about food that they eat. Anorexia results in extreme nutrient inadequacy and eventually to organ malfunction. Anorexia is relatively rare—the National Institute of Mental Health (NIMH) reports that 0.9 percent of females and 0.3 percent of males will have anorexia at some point in their lifetime, The National Institute of Mental Health. “Eating Disorders among Adults: Anorexia Nervosa.” Accessed October 8, 2011. http://mentalhealth.gov/statistics/1EAT_ADULT_ANX.shtml. but it is an extreme example of how an unbalanced diet can affect health. Anorexia frequently manifests during adolescence and it has the highest rate of mortality of all mental illnesses. People with anorexia consume, on average, fewer than 1,000 kilocalories per day and exercise excessively. They are in a tremendous caloric imbalance. Moreover, some may participate in binge eating, self-induced vomiting, and purging with laxatives or enemas. The very first time a person starves him- or herself may trigger the onset of anorexia. The exact causes of anorexia are not completely known, but many things contribute to its development including economic status, as it is most prevalent in high-income families. It is a genetic disease and is often passed from one generation to the next. Pregnancy complications and abnormalities in the brain, endocrine system, and immune system may all contribute to the development of this illness.

The primary signs of anorexia are fear of being overweight, extreme dieting, an unusual perception of body image, and depression. The secondary signs and symptoms of anorexia are all related to the caloric and nutrient deficiencies of the unbalanced diet and include excessive weight loss, a multitude of skin abnormalities, diarrhea, cavities and tooth loss, osteoporosis, and liver, kidney, and heart failure. There is no physical test that can be used to diagnose anorexia and distinguish it from other mental illnesses. Therefore, a correct diagnosis involves eliminating other mental illnesses, hormonal imbalances, and nervous system abnormalities. Eliminating these other possibilities involves numerous blood tests, urine tests, and x-rays. Coexisting organ malfunction is also examined. Treatment of any mental illness involves not only the individual, but also family, friends, and a psychiatric counselor. Treating anorexia also involves a dietitian, who helps to provide dietary solutions that often have to be adjusted over time. The goals of treatment for anorexia are to restore a healthy body weight and significantly reduce the behaviors associated with causing the eating disorder. Relapse to an unbalanced diet is high. Many people do recover from anorexia, however most continue to have a lower-than-normal bodyweight for the rest of their lives (see Note 11.33 "Video 11.3").

What I Gained in Recovery from Anorexia

On a more positive note, watch this personal account of what can be gained from anorexia recovery.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Bulimia

Bulimia, like anorexia, is a psychiatric illness that can have severe health consequences. The NIMH reports that 0.5 percent of females and 0.1 percent of males will have bulimia at some point in their lifetime. The National Institute of Mental Health. "Eating Disorders among Adults: Bulimia Nervosa." Accessed October 8, 2011. http://mentalhealth.gov/statistics/1EAT_ADULT_RBUL.shtml. Bulimia is characterized by episodes of eating large amounts of food followed by purging, which is accomplished by vomiting and with the use of laxatives and diuretics. Unlike people with anorexia, those with bulimia often have a normal weight, making the disorder more difficult to detect and diagnose. The disorder is characterized by signs similar to anorexia such as fear of being overweight, extreme dieting, and bouts of excessive exercise. Secondary signs and symptoms include gastric reflux, severe erosion of tooth enamel, dehydration, electrolyte imbalances, lacerations in the mouth from vomiting, and peptic ulcers. Repeated damage to the esophagus puts people with bulimia at an increased risk for esophageal cancer. The disorder is also highly genetic, linked to depression and anxiety disorders, and most commonly occurs in adolescent girls and young women. Treatment often involves antidepressant medications and, like anorexia, has better results when both the family and the individual with the disorder participate in nutritional and psychiatric counseling.

Binge-Eating Disorder

Similar to those who experience anorexia and bulimia, people who have a binge-eating disorder have lost control over their eating. Binge-eating disorder is not currently diagnosed as a distinct psychiatric illness, although there is a proposal from the American Psychiatric Association to categorize it more specifically. People with binge-eating disorder will periodically overeat to the extreme, but their loss of control over eating is not followed by fasting, purging, or compulsive exercise. As a result, people with this disorder are often overweight or obese, and their chronic disease risks are those linked to having an abnormally high body weight such as hypertension, cardiovascular disease, and Type 2 diabetes. Additionally, they often experience guilt, shame, and depression. Binge-eating disorder is commonly associated with depression and anxiety disorders. According to the NIMH, binge-eating disorder is more prevalent than anorexia and bulimia, and affects 3.5 percent of females and 2.0 percent of males at some point during their lifetime. The National Institute of Mental Health. "Eating Disorders among Adults: Binge Eating Disorder." Accessed October 8, 2011. http://www.nimh.nih.gov/statistics/1EAT_ADULT_RB.shtml. Treatment often involves antidepressant medication as well as nutritional and psychiatric counseling.

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2.4.8: WEIGHT MANAGEMENT

By Lisa Jellum

Learning Objectives

- Discuss how to manage weight through diet
- Provide steps for starting a weight loss plan
- Reinforce the importance of physical activity in weight management
- Explain how to keep the weight off

The majority of Americans are unhappy with their current weight. Almost everyone would like to lose at least 5 pounds. A growing percentage of Americans are carrying enough excess weight to put them at risk for many diseases and even death. Few people, however, know enough about their own bodies to successfully manage their weight. Anyone planning to start a weight loss program should begin by carefully considering the following factors:

- How many calories are being consumed daily?
- How many calories are being expended?
- How much fluids are being consumed?
- How well are electrolytes being managed?

2.4.8.1: Weight Management Through Diet

2.4.8.2: The Importance of Physical Activity in Maintaining a Healthy Weight

2.4.8.3: Keeping the Weight Off

2.4.8.4: Health Risks of Being Underweight

2.4.8.5: References

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2.4.9.1: What is Stress and How Does it Affect Wellness?

Stress is defined as the body's physical, mental, and emotional response to a particular stimulus, called a **stressor**. This adaption/coping-response helps the body prepare for challenging situations. It is the level of a person's response to a stressor that determines whether the experience is positive or negative. As a hardworking college student, you may feel as if you know the meaning of stress all too well. You may dream of a future where the demands on your time are diminished, so you can escape the high levels of stress you are feeling now. Unfortunately, regardless of their situation, everyone experiences stress on a regular basis. The good news is, not all stress is bad! Small levels of stress can enhance cognitive brain function. Stress may provide the motivation and concentration you need to write an essay, practice a speech, or prepare for a job interview. For most people, these types of stressors are manageable and not harmful. Stressors that have the potential for harm include the sudden loss of a loved one, the unexpected ending of a romantic relationship, or the unfair demands of an unreasonable boss.

Defining Stress

Stress, then, is more than simply the tension and apprehension generated by problems, obstacles, or traumatic events. Stress is the body's automatic response (physical, mental, and emotional) to any stressor. It is a natural and unavoidable part of life, and it can be empowering and motivating, or harmful and potentially dangerous.

For more information on stress click on the links below:

What is Stress?
Understanding and Dealing with Stress

Below is a video on stress.

YouTube Video

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View this YouTube Video online

Effects of Stress on Wellness

As stated previously, not all stress is bad. In fact, the stress associated with riding a roller coaster, watching a scary movie, or scaling a cliff can enhance these experiences. Regardless of whether the stress experienced is negative or positive, the effects on the body are identical.

When a person senses that a situation demands action, the body responds by releasing chemicals into the blood. The hypothalamus signals the adrenal glands to release a surge of hormones that include adrenaline and cortisol. The physiological effects of those chemicals—enhanced focus, quicker reaction time, and increased heart rate, energy, and strength—are quite beneficial when faced with a potentially dangerous situation that is temporary.

Unfortunately, most of the stressors people face—work, school, finances, relationships—are a part of everyday life, and thus, inescapable. Experiencing ongoing, unavoidable stress can result in some very unpleasant and harmful effects, both mental and physical. Chronic stress can cause upset stomach, headaches, sleep problems, and heart disease. It can also cause depression, anxiety, and even memory loss.

To watch a video that describes the effects of stress in detail, click on the link below:

YouTube Video

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2.4.9.2: What Are the Strategies for Managing Stress?

Although stress in everyday life is unavoidable, there are ways to cope with it that will minimize or eliminate its harmful effects.

The Anxiety and Depression Association of America (ADAA) provides a list of effective strategies for coping with stress. That document is linked here: Tips: Coping Strategies. For your convenience, it is also reprinted below with the ADAA's permission.

When you are feeling anxious or stressed, these strategies will help you cope:

- **Take a time-out.** Practice yoga, listen to music, meditate, get a massage, or learn relaxation techniques. Stepping back from the problem helps clear your head.
- **Eat well-balanced meals.** Do not skip any meals. Do keep healthful, energy-boosting snacks on hand.
- **Limit alcohol and caffeine**, which can aggravate anxiety and trigger panic attacks.
- **Get enough sleep.** When stressed, your body needs additional sleep and rest.
- **Exercise daily** to help you feel good and maintain your health. Check out the fitness tips below.
- **Take deep breaths**. Inhale and exhale slowly.
- **Count to 10 slowly**. Repeat, and count to 20 if necessary.
- **Do your best**. Instead of aiming for perfection, which isn't possible, be proud of however close you get.
- **Accept that you cannot control everything**. Put your stress in perspective: Is it really as bad as you think?
- **Welcome humor**. A good laugh goes a long way.
- **Maintain a positive attitude**. Make an effort to replace negative thoughts with positive ones.
- **Get involved.** Volunteer or find another way to be active in your community, which creates a support network and gives you a break from everyday stress.
- **Learn what triggers your anxiety.** Is it work, family, school, or something else you can identify? Write in a journal when you're feeling stressed or anxious and look for a pattern.
- **Talk to someone.** Tell friends and family you're feeling overwhelmed, and let them know how they can help you. Talk to a physician or therapist for professional help.
- **Get help online.** Lantern offers online programs guided by professional coaches to help you turn healthy anxiety management into a habit. *(Sponsored)*
  - **Listen to podcasts on a wide range of topics**
  - **Watch recorded webinars on topics ranging from how to worry less, coping with panic attacks, treatments for children, and helping suicidal families, and many more.**

Fitness Tips: Stay Healthy, Manage Stress

To receive the greatest benefits from exercising, try to include at least 21/2 hours of moderate-intensity physical activity (e.g., brisk walking) each week, 11/4 hours of a vigorous-intensity activity (such as jogging or swimming laps), or a combination of the two.

- **5 X 30:** Jog, walk, bike, or dance three to five times a week for 30 minutes.
- **Set small daily goals** and aim for daily consistency rather than perfect workouts. It is better to walk every day for 15–20 minutes than to wait until the weekend for a three-hour fitness marathon. Lots of scientific data suggests that frequency is most important.
- **Find forms of exercise** that are fun or enjoyable. Extroverted people often like classes and group activities. People who are more introverted often prefer solo pursuits.
- **Distract yourself** with an iPod or other portable media player to download audiobooks, podcasts, or music. Many people find it is more fun to exercise while listening to material they enjoy.
- **Recruit** an "exercise buddy." It is often easier to stick to your exercise routine when you have to stay committed to a friend, partner, or colleague.
- **Be patient** when you start a new exercise program. Most sedentary people require about four to eight weeks to feel coordinated and sufficiently in shape so that exercise feels easier.

Additional strategies for coping with stress are linked below:

YouTube Video

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Stress Management

10 Tips to Manage Stress This is a link to WebMD with a video on how to manage stress

To hear the world's most relaxing sound (according to research), click on the link below:

YouTube Video

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2.4.9.3: Assess Your Stress Level

Are you more or less stressed than your peers? The website linked below contains a stress test. On the website, scroll down to the “Quiz: Are You Stressed?”

How Stressed Are You?

Below is a link to the Lab for this chapter on stress. Please be certain to get a PDF of your results and submit it in D2L:

Lab for Chapter on Stress

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2.4.10.1: What Is Cardiovascular Disease?

Cardiovascular disease (CVD) generally refers to conditions that involve narrowed or blocked blood vessels. The term is often used interchangeably with heart disease. However, heart disease is just one type of cardiovascular disease. Other types of CVD include stroke, high blood pressure, angina (chest pain), and rheumatic heart disease. This chapter will focus on heart disease and strokes.

Heart Disease

Heart disease is a disorder of the blood vessels that can lead to heart failure. This disorder can be congenital and/or the result of lifestyle. Most people associate heart disease with heart attacks. A heart attack, also known as a **myocardial infarction**, happens when an artery becomes blocked, preventing oxygen and nutrients from getting to the heart. When a person is experiencing a heart attack, they will have crushing chest pains, profound shortness of breath, left arm pain, radiating jaw pain or middle back pain. These signs and symptoms indicate that a person should seek immediate medical assistance.

Click on the link below for more information about how to recognize and respond to a heart attack victim:

Recognizing and Responding to a Heart Attack

Other types of heart disease include:

- Coronary artery disease: damage or disease in the heart's major blood vessels
- High blood pressure: A condition in which the force of the blood against the artery walls is too high.
- Cardiac Arrest: Sudden, unexpected loss of heart function, breathing, and consciousness.
- Congestive heart failure: A chronic condition in which the heart does not pump blood as well as it should.
- Arrhythmia: Improper beating of the heart, whether irregular, too fast, or too slow.
- Peripheral artery disease: A circulatory condition in which narrowed blood vessels reduce blood flow to the limbs.
- Congenital heart disease: An abnormality in the heart that develops before birth.

Many people believe incorrectly that heart disease can be cured with surgery and medication. This is a myth. Heart disease is a lifelong condition. Although procedures, such as bypass surgery, can increase blood flow to the heart, the arteries remain damaged. Additionally, this condition will steadily worsen without major lifestyle changes.

Combating America's Number 1 Killer

Heart disease remains the leading cause of death in America, and in most other countries worldwide. However, the death toll from this disease has been declining steadily for decades, falling 60% since its peak in the mid 1960s. In addition, the death rate from stroke, the third most common cause of death, has declined by about 75 percent since the early 1960s (NIH, 2017). The death rates from these diseases have fallen as awareness about the devastating effects of smoking, high cholesterol, high blood pressure, and obesity has increased. Researchers believe that heart disease in America will continue to decline if more people begin to eat healthier diets, exercise more, and stop smoking.

Click on the link below to watch a video about the study in the 1960s that first revealed the root causes of heart disease:

The Hidden Epidemic: Heart Disease in America

YouTube Video

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View this YouTube Video online

Stroke

Strokes are the fifth leading cause of death and a leading cause of disability in the United States. This type of CVD affects the arteries leading to the brain and blood vessels within the brain. A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked by a clot or ruptures. When that happens, part of the brain cannot get the blood and oxygen it needs and as a result, brain cells begin to die.

A stroke that occurs as the result of a blockage is called an **ischemic stroke**. A**hemorrhagic stroke** is the result of a rupture and accounts for only 20% of all strokes.

The Cincinnati Stroke Scale provides early warning signs of a stroke:

- **F = Face:** Is one side of the face drooping down?
- **A = Arm:** Can the person raise both arms, or is one arm weak?
- **S = Speech:** Is speech slurred or confusing?
- **T = Time:** If the conditions listed above are present call 9-1-1 immediately! Time is critical!

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2.4.10.2: What Causes CVD?

The 4 conditions listed below, all of which are beyond a person's control, can be linked to cardiovascular disease:

- *Age*
  There is a strong correlation between CVD and age. As a person ages, the risk for CVD increases also. Although, with males, the risk seems to be when they are younger and females seem to be at higher risk post-menopausal.

- *Sex*
  Males have a higher risk for CVD, especially at younger ages. Women experience higher risk later in their lives. Click on the link below to learn more about The Heart Truth Program, a program focused on raising awareness about women's risk for heart disease and ways for reducing that risk: The Heart Truth Program

- *Race*
  African Americans have the highest risk factor for CVD.

- *Family History/ Race*
  A person's genes can be one of the strongest predictors of CVD, but also has the smallest correlation to to CVD overall.

  The 4 conditions listed below are also linked to cardiovascular disease but *are* within a person's power to change:

- *Tobacco use*
  The strongest predictor of CVD is the use of tobacco. The use of tobacco accounts for 30% of CVD risk. There is a significant reduction in risk for those who do not use tobacco.

- *Obesity*
  Those that have a BMI greater than 30 have a higher than normal risk than those that do not have a BMI greater than 30. "The "obesity epidemic" experienced by the United States over the past several decades threatens to reverse important progress against heart disease. The NIH has undertaken several efforts to prevent or reduce obesity in children and young adults, including a set of randomized trials to identify effective approaches in individuals and a large project to evaluate community approaches to reduce obesity in children (NIH, 2017)"

- *Diet*
  CVD can be correlated to high intake of saturated fat and cholesterol. Risk of dietary cholesterol intake can be correlated to atherosclerosis.

- *Diabetes*
  This condition is viewed as seriously as any of the other factors, such as smoking, high blood pressure, and high blood cholesterol, that a person can control. In fact, those with

  Type II diabetes have the same level of risk for a heart attack as those who have already had a heart attack.

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2.4.9: STRESS

By Jonathan Howard

Learning Objectives

- Define stress
- Describe the effects of stress on wellbeing
- Identify effective strategies for managing stress
- Assess your own levels of stress

In today's fast-paced society, most people complain about being stressed. However, when they use the term *stress*, they rarely know its true meaning. The word carries many negative connotations and is associated with an unpleasant or traumatic event. As such, people mistakenly believe that stress is simply the nervousness and tension experienced prior to, during, or after a negative event. In fact, the effects of stress are physiological, emotional, *and* psychological. Additionally, not all levels of stress are detrimental. The stress athletes experience right before a big game or college students feel right before an exam can enhance focus and increase their ability to concentrate. Stress is either good or bad depending on how long it persists and how it is perceived by the individual. This chapter will provide a deeper understanding of what stress is and provide effective strategies for managing stress.

2.4.9.1: What is Stress and How Does it Affect Wellness?

2.4.9.2: What Are the Strategies for Managing Stress?

2.4.9.3: Assess Your Stress Level

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2.4.10: CARDIOVASCULAR DISEASE

By Lisa Jellum

Learning Objectives

- Define cardiovascular disease
- Identify the types of cardiovascular disease
- Identify risk factors that predispose for heart disease and stroke
- Assess personal risk of Cardiovascular Disease

2.4.10.1: What Is Cardiovascular Disease?

2.4.10.2: What Causes CVD?

2.4.10.3: How to Respond to a Heart Attack

2.4.10.4: Personal Risk Assessment

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2.4.10.3: How to Respond to a Heart Attack

Different types of CVD

Coronary heart disease—often simply called heart disease—is the main form of heart disease. It is a disorder of the blood vessels of the heart that can lead to heart attack. A heart attack happens when an artery becomes blocked, preventing oxygen and nutrients from getting to the heart. Heart disease is one of several cardiovascular diseases, which are diseases of the heart and blood vessel system. Other cardiovascular diseases include stroke, high blood pressure, angina (chest pain), and rheumatic heart disease. (NIH, 2017)

Heart Attack

A Myocardial Infarction is otherwise known as a heart attack. This MI can be seen with the symptoms of Angina Pectoris (crushing chest pains, profound shortness of breath, left arm pain, radiating jaw pain or middle back pain. These signs and symptoms of heart attack are very serious and should be recognized as soon as possible and should be taken care of ASAP.

What to do if you suspect someone having a heart attack. (Mayo Clinic)

- **Call 911 or your local medical emergency number.** Don't ignore or attempt to tough out the symptoms of a heart attack for more than five minutes. If you don't have access to emergency medical services, have a neighbor or a friend drive you to the nearest hospital. Drive yourself only as a last resort, and realize that it places you and others at risk when you drive under these circumstances.
- **Chew and swallow an aspirin,** unless you are allergic to aspirin or have been told by your doctor never to take aspirin. But seek emergency help first, such as calling 911.
- **Take nitroglycerin,** if prescribed. If you think you're having a heart attack and your doctor has previously prescribed nitroglycerin for you, take it as directed. Do not take anyone else's nitroglycerin, because that could put you in more danger.
- **Begin CPR if the person is unconscious.** If you're with a person who might be having a heart attack and he or she is unconscious, tell the 911 dispatcher or another emergency medical specialist. You may be advised to begin cardiopulmonary resuscitation (CPR). If you haven't received CPR training, doctors recommend skipping mouth-to-mouth rescue breathing and performing only chest compressions (about 100 per minute). The dispatcher can instruct you in the proper procedures until help arrives.
- **If an automated external defibrillator (AED) is available** and the person is unconscious, begin CPR while the device is retrieved and set up. Attach the device and follow instructions that will be provided by the AED after it has evaluated the person's condition.

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2.4.10.4: Personal Risk Assessment

What Is Your Number?

The following screening tests are used to a assess a person's risk for developing CVD

- **What:** A blood test that measures total cholesterol, LDL "bad" cholesterol, HDL "good" cholesterol, and triglycerides (another form of fat in the blood). The test is given after a 9- to 12-hour fast.

  Why: To find out if you have any of the following: high blood cholesterol (high total and LDL cholesterol), low HDL cholesterol, or high triglyceride levels. All affect your risk for heart disease.

  When: All healthy adults should have a lipoprotein profile done at least once every 5 years. Depending on the results, your doctor may want to repeat the test more frequently.

- *Blood Pressure*
  What: A simple, painless test using an inflatable arm cuff.

  Why: To find out if you have high blood pressure (also called hyper- tension) or prehypertension. Both are risk factors for heart disease.

  When: At least every 2 years, or more often if you have high blood pressure or prehypertension.

- *Fasting Plasma Glucose*
  What: The preferred test for diagnosing diabetes. After you have fasted overnight, you will be given a blood test the following morning.

  Why: To find out if you have diabetes or are likely to develop the disease. Fasting plasma glucose levels of 126 mg/dL or higher in two tests on different days mean that you have diabetes. Levels between 100 and 125 mg/dL mean that you have an increased risk of developing diabetes and may have prediabetes. Diabetes is an important risk factor for heart disease and other medical disorders.

  When: At least every 3 years, beginning at age 45. If you have risk factors for diabetes, you should be tested at a younger age and more often.

Online Risk Calculator

If you know your cholesterol levels and your blood pressure, you can use one of the calculators linked below to assess your risk of developing cardiovascular disease:

American College of Cardiology Risk Calculator

Framingham Heart Study Risk Calculator

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2.4.11.1: What Is Cancer?

Cancer is the name given to a collection of related diseases in which the body's cells begin to divide without stopping and spread into surrounding tissues.

Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place.

When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old or damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may form growths called **tumors**.

Many cancers form solid tumors, which are masses of tissue. Cancers of the blood, such as leukemias, generally do not form solid tumors.

Cancerous tumors are **malignant**, which means they can spread into, or invade, nearby tissues. In addition, as these tumors grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumors far from the original tumor.

Unlike malignant tumors, **benign tumors** do not invade nearby tissues. However, some benign tumors can be quite large. When removed, they usually do not grow back, whereas malignant tumors sometimes do. Unlike most benign tumors elsewhere in the body, benign tumors in the brain can be life threatening.

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2.4.11.2: How Cancer Arises

Cancer is a genetic disease—that is, it is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Genetic changes that cause cancer can be inherited. They can also be the result of errors that occur as cells divide or environmental exposures that cause damage to **DNA**, the molecules inside cells that carry genetic information and pass it on from one generation to the next. Cancer- causing environmental exposures include substances, such as the chemicals in tobacco smoke; and radiation, such as ultraviolet rays from the sun.

Each person's cancer has a unique combination of genetic changes. As the cancer continues to grow, additional changes will occur. Even within the same tumor, different cells may have different genetic changes.

In general, cancer cells have more genetic changes, such as mutations in DNA, than normal cells. Some of these changes may be the result of the cancer, rather than its cause.

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- 14: How Biological Diversity Evolves has no license indicated.

2.4.11.3: Cancer Statistics

Cancer severely impacts Americans and societies throughout the world. Cancer statistics describe what happens in large groups of people and provide a picture in time of the burden of cancer on society. Statistics indicate how many people are diagnosed with and die from cancer each year, the number of people who are currently living after a cancer diagnosis, and the average age at diagnosis. They also reveal differences among groups defined by age, sex, racial/ethnic group, geographic location, and other categories.

Although statistical trends are usually not directly applicable to individual patients, they are essential for governments, policymakers, health professionals, and researchers to understand the impact of cancer on the population and to develop strategies to address the challenges that cancer poses to society. Statistical trends are also important for measuring the success of efforts to control and manage cancer.

Statistics at a Glance: The Burden of Cancer in the United States

Updates can be found at https://www.cdc.gov/cancer/uscs/index.htm

- In 2016, an estimated 1,685,210 new cases of cancer will be diagnosed in the United States, and 595,690 people will die from the disease.
- The most common cancers in 2016 are projected to be breast cancer, lung and bronchus cancer, prostate cancer, colon and rectum cancer, bladder cancer, melanoma of the skin, non-Hodgkin lymphoma, thyroid cancer, kidney and renal pelvis cancer, leukemia, endometrial cancer, and pancreatic cancer.
- The number of new cases of cancer (**cancer incidence**) is 454.8 per 100,000 men and women per year (based on 2008–2012 cases).
- The number of cancer deaths (**cancer mortality**) is 171.2 per 100,000 men and women per year (based on 2008–2012 deaths).
- Cancer mortality is higher among men than women (207.9 per 100,000 men and 145.4 per 100,000 women). It is highest in African American men (261.5 per 100,000) and lowest in Asian/Pacific Islander women (91.2 per 100,000) per year (based on 2008–2012 deaths).
- The number of people living beyond a cancer diagnosis reached nearly 14.5 million in 2014 and is expected to rise to almost 19 million by 2024.
- Approximately 39.6 percent of men and women will be diagnosed with cancer during their lifetimes (based on 2010-2012 data).
- In 2014, an estimated 15,780 children and adolescents, aged from 0 to 19, were diagnosed with cancer and 1,960 died of the disease.
- National expenditures for cancer care in the United States totaled nearly $125 billion in 2010 and could reach $156 billion in 2020.

The following video explores cancer incidence and mortality through 2020:

YouTube Video

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2.4.11.4: Types of Cancer

There are more than 100 types of cancer. Types of cancer are usually named for the organs or tissues where the cancers form. For example, lung cancer starts in cells of the lung and brain cancer starts in cells of the brain. Cancers may also be described by the type of cell that formed them, such as an epithelial cell or a squamous cell.

Some types of cancer are:

Breast Cancer

The breast is made up of glands called **lobules**that can make milk and thin tubes called ducts that carry the milk from the lobules to the nipple. Breast tissue also contains fat and connective tissue, lymph nodes, and blood vessels.

The most common type of breast cancer is ductal carcinoma, which begins in the cells of the ducts. Breast cancer can also begin in the cells of the lobules and in other tissues in the breast. Ductal carcinoma in situ is a condition in which abnormal cells are found in the lining of the ducts but have not spread outside the duct. Breast cancer that has spread from where it began in the ducts or lobules to surrounding tissue is called **invasive breast cancer**. In inflammatory breast cancer, the breast looks red and swollen and feels warm because the cancer cells block the lymph vessels in the skin.

In the United States, breast cancer is the second most common cancer in women after skin cancer. It can occur in both men and women, but it is rare in men. Each year there are about 100 times more new cases of breast cancer in women than in men.

Some screening tests for breast cancer include:

- *Clinical breast exams and regular breast self-exams*
  Routine examinations of the breasts by health care providers or by women themselves have not been shown to reduce deaths from breast cancer. However, if a woman or her health care provider notices a lump or other unusual change in the breast, it is important for her to get it checked out.

  The following link explains how to perform a Breast Self-Exam:

  Breast Self-Exam (BSE)

- *Mammography*
  This screening method for breast cancer has been shown to reduce mortality from the disease among women aged from 40 to 74, especially those aged 50 or older.
- *Breast MRI*
  This imaging test is often used for women who carry a harmful mutation in the *BRCA1* gene or the*BRCA2*gene; such women have a high risk of developing breast cancer, as well as increased risk for other cancers.

Cervical Cancer

The cervix is the lower, narrow end of the **uterus,** the organ where a fetus grows. The cervix leads from the uterus to the vagina, also known as the **birth canal**.

The main types of cervical cancer are squamous cell carcinoma and adenocarcinoma. Squamous cell carcinoma begins in the thin, flat cells that line the cervix. Adenocarcinoma begins in cervical cells that make mucus and other fluids.

Long-lasting infections with certain types of human papillomavirus (HPV) cause almost all cases of cervical cancer. Vaccines that protect against infection with these types of HPV can greatly reduce the risk of cervical cancer.

Screening tests:

- *Pap test and human papillomavirus (HPV) testing*
  Having a Pap test to check for abnormal cells in the cervix, or a test to check for HPV, can find cells that may become cervical

cancer. These cells can be treated before cancer forms. Testing is generally recommended to begin at age 21 and to end at age 65, as long as recent results have been normal.

Colorectal Cancer

Colorectal cancer is cancer that starts in the colon or rectum. The colon and the rectum are parts of the large intestine, which is the lower part of the body's digestive system. During digestion, food moves through the stomach and small intestine into the colon. The colon absorbs water and nutrients from the food and stores waste matter called **stool.** Stool moves from the colon into the rectum before it leaves the body.

Most colorectal cancers are **adenocarcinomas**, cancers that begin in cells that make and release mucus and other fluids. Colorectal cancer often begins as an abnormal colon growth called a **polyp**, which may form on the inner wall of the colon or rectum. Some polyps may develop into cancer over time. Finding and removing polyps can prevent colorectal cancer.

Colorectal cancer is the third most common type of cancer in men and women in the United States.

Screening tests:

- *Colonoscopy, sigmoidoscopy, and high-sensitivity fecal occult blood tests (FOBTs)*
  Deaths from colorectal cancer have decreased with the use of colonoscopies and fecal occult blood tests, which check for blood in the stool. Colonoscopy and sigmoidoscopy also help prevent colorectal cancer because they can detect polyps that can be removed before they develop into cancer. Expert groups generally recommend that people who are at average risk for colorectal cancer have screening beginning at age 50 through age 75.

Lung Cancer

Most lung cancer diagnoses are either non- small cell lung cancer or small cell lung cancer, depending on the way the cells look under a microscope. Non-small cell lung cancer is much more common than small cell lung cancer.

Most cases of lung cancer are caused by smoking. Lung cancer is the leading cause of death from cancer in the United States.

For most patients with lung cancer, current treatments do not cure the cancer.

Screening test:

- *Low-dose helical computed tomography*
  This test, which is used to screen for lung cancer, has been shown to reduce lung cancer deaths among heavy smokers aged from 55 to 74.

Prostate Cancer

The prostate gland makes fluid that forms part of semen. The prostate lies just below the bladder in front of the rectum. It surrounds the **urethra**, the tube that carries urine and semen through the penis and out of the body.

Prostate cancer is the most common cancer in men in the United States, after skin cancer, and the second leading cause of death. Prostate cancer occurs more often in African-American men than in white men. African-American men with prostate cancer are more likely to die from the disease than white men with prostate cancer.

Almost all prostate cancers are adenocarcinomas, cancers that begin in cells that make and release mucus and other fluids. Prostate cancer often has no early symptoms. Advanced prostate cancer can cause men to urinate more often or have a weaker flow of urine, but these symptoms can also be caused by benign prostate conditions.

Prostate cancer usually grows very slowly. Most men with prostate cancer are older than 65 years and do not die from the disease. Finding and treating prostate cancer before symptoms occur may not improve a patient's health or help him live longer. Men are advised to consult their doctor about their risk of prostate cancer and whether they need screening tests.

Screening test:

- *PSA test*
  This blood test, which is often done along with a digital rectal exam, is able to detect prostate cancer at an early stage. However, expert groups no longer recommend routine PSA testing for most men because studies have shown that it has little or no effect on prostate cancer deaths and leads to overdiagnosis and overtreatment.

Skin Cancer

Skin cancer is the most common type of cancer. It usually forms in skin that has been exposed to sunlight but can occur anywhere on the body.

Skin consists of several layers. Skin cancer begins in the **epidermis**, or outer layer, which is made up of squamous cells, basal cells, and melanocytes.

There are several different types of skin cancer. Squamous cell and basal cell skin cancers are sometimes called nonmelanoma skin cancers.

Nonmelanoma skin cancer usually responds to treatment and rarely spreads to other parts of the body.

Melanoma is more aggressive than most other types of skin cancer. Unless melanoma is diagnosed early, it is likely to invade nearby tissues and spread to other parts of the body. The number of cases of melanoma increases each year. Only 2 percent of all skin cancers are melanoma, but it causes the most deaths from skin cancer.

Screening test:

- *Skin exams*
  Doctors often recommend that people who are at risk for skin cancer examine their skin regularly or have a health care provider do so. Such exams have not been shown to decrease the risk of dying from skin cancer, and they may lead to overtreatment. However, people should be aware of changes in their skin, such as a new mole or a change to an existing mole, and report these to their doctor promptly.

Testicular Cancer

The testicles are two glands inside the **scrotum**, a sac of loose skin below the penis. The testicles make sperm and the hormone testosterone.

Testicular cancer is the most common cancer in men aged from 15 to 34 years. The two main types of testicular tumors are seminoma and nonseminoma. Nonseminomas tend to grow and spread more quickly than seminomas.

The most common sign of testicular cancer is a lump or swelling in the testicle. Most testicular cancers can be cured, even if they are diagnosed at an advanced stage.

Treatment for testicular cancer can cause infertility by decreasing the amount of sperm made by the body. Men who want to have children may want to use sperm banking to store sperm before they begin treatment.

Screening test:

- *There is no standard or routine screening test for testicular cancer.*Most often, testicular cancer is first found by men themselves, either by chance or during self-exam. Sometimes the cancer is found by a doctor during a routine physical exam.

The following video explains how to perform a testicular self-exam:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Leukemia

Leukemia is cancer of the blood cells. Most blood cells form in the bone marrow. In leukemia, immature blood cells become cancer. These cells do not work the way they should and crowd out the healthy blood cells in the bone marrow.

Different types of leukemia depend on the type of blood cell that becomes cancer. For example, lymphoblastic leukemia is a cancer of the **lymphoblasts**, white blood cells that fight infection. White blood cells are the most common type of blood cell to become cancer. But **red blood cells**, cells that carry oxygen from the lungs to the rest of the body, and **platelets**, cells that clot the blood, may also become cancerous.

Leukemia occurs most often in adults older than 55 years, but it is also the most common cancer in children younger than 15 years.

Leukemia can be either acute or chronic. Acute leukemia is a fast-growing cancer that usually gets worse quickly. Chronic leukemia is a slower-growing cancer that gets worse slowly over time. The treatment and prognosis for leukemia depend on the type of blood cell affected and whether the leukemia is acute or chronic.

Lymphoma

Lymphoma is cancer that begins in cells of the lymph system. The lymph system is part of the immune system, which helps the body fight infection and disease. Because lymph tissue is found all through the body, lymphoma can begin almost anywhere.

The two main types of lymphoma are Hodgkin lymphoma and non-Hodgkin lymphoma (NHL). These can occur in both children and adults. The treatment and probability of a cure depend on the stage and the type of lymphoma.

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2.4.11: CANCER DEVELOPMENT

By Althea Moser

Learning Objectives

- Define cancer and how cancer arises
- Describe different types of cancer
- Identify cancer risks and methods for cancer prevention
- Assess personal cancer risk

2.4.11.1: What Is Cancer?

2.4.11.2: How Cancer Arises

2.4.11.3: Cancer Statistics

2.4.11.4: Types of Cancer

2.4.11.5: Risk Factors for Cancer

2.4.11.6: Assessing Your Personal Risk of Cancer

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2.4.11.5: Risk Factors for Cancer

It is usually impossible to know why one person develops cancer and another does not. But research has shown that certain risk factors may increase a person's chances of developing cancer. There are also factors—called protective risk factors, or just protective factors—that are linked to a lower risk of cancer.

Cancer risk factors include exposure to chemicals or other substances, as well as certain behaviors. They also include circumstances that people cannot control, like age and family history. A family history of certain cancers can be a sign of a possible inherited cancer syndrome.

Most cancer risks, as well as protective factors, are initially identified in epidemiology studies. In these studies, scientists look at large groups of people and compare those who develop cancer with those who do not. These studies may show that those who develop cancer are more or less likely to behave in certain ways, or to be exposed to certain substances, than those who do not develop cancer.

On their own, such studies cannot prove that a behavior or substance causes cancer. For example, the finding could be a result of chance, or the true risk factor could be something other than the suspected risk factor. But findings of this type sometimes get attention in the media, and this can lead to false beliefs about how cancer starts and spreads.

When many studies all point to a similar association between a potential risk factor and an increased risk of cancer, and when a possible mechanism exists that could explain how the risk factor could actually cause cancer, scientists can be more confident about the relationship between the two.

Although some risk factors can be avoided, others—such as growing older—cannot. Limiting exposure to avoidable risk factors may lower a person's risk of developing certain cancers.

Some of the most studied risk factors for cancer are listed below.

Age

Advancing age is the most important risk factor for cancer overall, and for many specific types of cancer. According to the most recent statistical data from the National Cancer Institute's Surveillance, Epidemiology, and End Results program, the median age of a cancer diagnosis is 66 years. This means that half of cancer cases occur in people below this age and half in people above this age. One-quarter of new cancer cases are diagnosed in people aged from 65 to 74.

But the disease can occur at any age. For example, bone cancer is most frequently diagnosed among people under age 20, with more than one-fourth of cases occurring in this age group. And 10 percent of leukemias are diagnosed in children and adolescents under 20 years of age, whereas only 1 percent of cancer overall is diagnosed in that age group.

Alcohol

Drinking alcohol can increase a person's risk of cancer of the mouth, throat, esophagus, larynx (voice box), liver, and breast. The more a person consumes alcohol, the higher his or her risk. The risk of cancer is much higher for those who drink alcohol and also use tobacco.

Doctors advise people who drink to do so in moderate amounts. The federal government's Dietary Guidelines for Americans defines moderate alcohol drinking as up to one drink per day for women and up to two drinks per day for men.

It has been suggested that certain substances in red wine, such as resveratrol, have anticancer properties. However, no evidence exists that drinking red wine reduces the risk of cancer.

Cancer-Causing Substances in the Environment

Cancer is caused by changes to certain genes that alter the way our cells function. Some of these genetic changes occur naturally

when DNA is replicated during the process of cell division. But others are the result of environmental exposures that damage DNA. These exposures may include substances known as **carcinogens**, any substance that causes cancer, such as the chemicals in tobacco smoke; and radiation, such as ultraviolet rays from the sun. People can avoid some cancer-causing exposures, such as tobacco smoke and the sun's rays. But others are harder to avoid, especially if they are found in the air, water, and food, or the materials people use to do their jobs. Scientists are studying which exposures may cause or contribute to the development of cancer. Understanding which exposures are harmful, and where they are found, may help people avoid them.

Simply because a substance has been designated as a carcinogen, however, that does not mean that the substance will necessarily cause cancer. Many factors influence whether a person exposed to a carcinogen will develop cancer, including the amount and duration of the exposure and the individual's genetic background.

Diet

Many studies have looked at the possibility that specific dietary components ornutrients are associated with increases or decreases in cancer risk. Studies of cancer cells in the laboratory and of animal models have sometimes provided evidence that isolated compounds may be carcinogenic, or have anticancer activity.

But with few exceptions, studies of human populations have not yet shown definitively that any dietary component causes or protects against cancer. Sometimes the results of epidemiologic studies, which compare the diets of people with and without cancer have indicated that people with and without cancer differ in their intake of a particular dietary component.

However, these results show only that the dietary component is associated with a change in cancer risk, not that the dietary component is responsible for, or causes, the change in risk. For example, participants with and without cancer could differ in other ways besides their diet, and it is possible that some other difference accounts for the variance in cancer risk.

Hormones

Estrogens, a group of female sex hormones, are known human carcinogens. Although these hormones have essential physiological roles in both females and males, they have also been associated with an increased risk of certain cancers. For instance, taking combined menopausal hormone therapy (estrogen plus progestin, which is a synthetic version of the female hormone progesterone) can increase a woman's risk of breast cancer. Menopausal hormone therapy with estrogen alone increases the risk of endometrial cancer and is used only in women who have had a hysterectomy.

A woman who is considering menopausal hormone therapy should discuss the possible risks and benefits with her doctor.

Studies have also shown that a woman's risk of breast cancer is related to the estrogen and progesterone made by her ovaries, known as endogenous estrogen and progesterone. Being exposed for a long time and/or to high levels of these hormones has been linked to an increased risk of breast cancer. Increases in exposure can be caused by starting menstruation early, going through menopause late, being older at first pregnancy, and never having given birth. Conversely, having given birth is a protective factor for breast cancer.

Obesity

People who are obese may have an increased risk of several types of cancer, including cancers of the breast (in women who have been through menopause), colon, rectum, esophagus, kidney, pancreas, gallbladder, and the lining of the uterus, called the **endometrium**.

Conversely, eating a healthy diet, being physically active, and maintaining a healthy weight may reduce the risk of some cancers. These healthy behaviors also lessen the risk of other illnesses, such as heart disease, type II diabetes, and high blood pressure.

Sunlight

The sun, sunlamps, and tanning booths all give off ultraviolet (UV) radiation. Exposure to UV radiation causes early aging of the skin and skin damage that can lead to skin cancer.

People of all ages should limit the amount of time they spend in the sun, especially between mid-morning and late afternoon, and

avoid other sources of UV radiation, such as tanning beds. It is important to keep in mind that UV radiation is reflected by sand, water, snow, and ice and can go through windshields and windows.

The best way to lessen UV damage when spending time in the sun is to wear long sleeves, long pants, a hat with a wide brim, and sunglasses with lenses that absorb UV radiation. Sunscreen with a sun protection factor (SPF) of at least 15 may help prevent skin cancer but does not work as well as staying out of the sun and wearing protective clothing.

Tobacco

Tobacco use is a leading cause of cancer and of death from cancer. People who use tobacco products, or are regularly exposed to environmental tobacco smoke (called **secondhand smoke**), have an increased risk of cancer because tobacco products and secondhand smoke have many chemicals that damage DNA.

Tobacco use causes many types of cancer, including cancer of the lung, larynx, mouth, esophagus, throat, bladder, kidney, liver, stomach, pancreas, colon and rectum, and cervix, as well as acute myeloid leukemia. People who use smokeless tobacco, such as snuff or chewing tobacco, have increased risks of cancers of the mouth, esophagus, and pancreas.

No level of tobacco use is safe. People who use any type of tobacco product are strongly urged to quit. People who quit smoking, regardless of their age, have substantial gains in life expectancy compared with those who continue to smoke. Also, quitting smoking at the time of a cancer diagnosis reduces the risk of death.

Cancer Prevention Overview

Cancer prevention is action taken to lower the chance of getting cancer. In addition to the physical problems and emotional distress caused by cancer, the high costs of care are also a burden to patients, their families, and to the public. Preventative measures can lower the number of new cases and cancer deaths, and reduce the burden of cancer on society.

Scientists are studying ways to prevent cancer, including the following:

- Avoiding or controlling factors known to cause cancer
- Improving diet and adopting a healthier lifestyle
- Finding precancerous conditions early
- Incorporating chemoprevention: the use of medicines that treat precancerous conditions or prevent cancer from starting

Cancer Treatment

Patients and their doctors must choose from a plethora of cancer treatments. The types of treatment a patient receives depend on the type of cancer a person has and how advanced it is. Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotherapy and/or radiation therapy. They may also undergo immunotherapy, targeted therapy, or hormone therapy.

Clinical trials are also an option for some patients. Clinical trials are research studies that involve people. Understanding what they are and how they work can help patients decide if taking part in a trial is a good option.

When seeking treatment for cancer, patients have a lot to learn and consider. It is normal for them to feel overwhelmed and confused. Talking with their doctor and learning all they can about their treatment options, including clinical trials, can help them make a decision they feel good about.

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2.4.11.6: Assessing Your Personal Risk of Cancer

Complete the following Lab to assess your personal risk of cancer, and submit it per your instructor's directions:

Assess Your Risk of Cancer

Complete the Lab to assess your personal risk of cancer, and submit it per your instructor's directions

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2.4.12.1: Drug Abuse and Addiction

What is drug addiction?

Addiction is defined as a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences. It is considered a brain disease because drugs change the brain by changing its structure and how it works. These brain changes can be long- lasting and can lead to the harmful behaviors seen in people who abuse drugs.

Addiction is a lot like other diseases, such as heart disease. Both disrupt the normal, healthy functioning of the underlying organ, have serious harmful consequences, and are preventable and treatable, but if left untreated, can last a lifetime.

Why do people use drugs?

In general, people begin taking drugs for a variety of reasons:

- *To feel good*
  Most abused drugs produce intense feelings of pleasure. This initial sensation of euphoria is followed by other effects, which differ depending on the type of drug used. For example, with stimulants such as cocaine, the “high” is followed by feelings of power, self-confidence, and increased energy. In contrast, the euphoria caused by opiates, such as heroin, is followed by feelings of relaxation and satisfaction.
- *To feel better*
  Some people who suffer from social anxiety, stress-related disorders, and depression begin abusing drugs in an attempt to lessen feelings of distress. Stress can play a major role in initial drug use, continuing drug abuse, or relapse in patients recovering from addiction.
- *To do better*
  Some people feel pressure to chemically enhance or improve their cognitive or athletic performance, which can play a role in initial experimentation and continued abuse of drugs, such as prescription stimulants or anabolic/androgenic steroids.
- *To satisfy their curiosity and "because others are doing it"*
  In this respect, adolescents are particularly vulnerable because of the strong influence of peer pressure. Teens are more likely than adults to engage in risky or daring behaviors to impress their friends and express their independence from parental and social rules.

If taking drugs makes people feel good or better, what's the problem?

When they first use a drug, people may perceive what seem to be positive effects. They may also believe that they can control their use. However, drugs can quickly take over a person’s life. Over time, if drug use continues, other pleasurable activities become less pleasurable and taking the drug becomes necessary for the user just to feel *normal*. They may then compulsively seek and take drugs even though doing so causes tremendous problems for themselves and their loved ones. Some people may start to feel the need to take higher or more frequent doses, even in the early stages of their drug use. These are the telltale signs of an addiction.

Even relatively moderate drug use poses dangers. Consider how a social drinker can become intoxicated, get behind the wheel of a car, and quickly turn a pleasurable activity into a tragedy that affects many lives.

Is continued drug abuse a voluntary behavior?

The initial decision to take drugs is typically voluntary. However, with continued use, a person’s ability to exert self-control can become seriously impaired; this impairment in self-control is the hallmark of addiction. Brain imaging studies of people with addiction show physical changes in areas of the brain that are critical to judgment, decision making, learning and memory, and behavior control. Scientists believe that these changes alter the way the brain works and may help explain the compulsive and destructive behaviors of addiction.

Why do some people become addicted to drugs while others do not?

As with any other disease, vulnerability to addiction differs from person to person, and no single factor determines whether a person will become addicted to drugs. In general, the more **risk factors** a person has, the greater the chance that taking drugs will lead to abuse and addiction. **Protective factors**, on the other hand, reduce a person's risk of developing addiction. Risk and protective factors may be either environmental, such as conditions at home, at school, and in the neighborhood, or biological, for instance, a person's genes, his or her stage of development, and even a person's gender or ethnicity.

Risk and Protective Factors for Drug Abuse and Addiction	
Risk Factors	**Protective Factors**
Aggressive behavior in childhood	Good self-control
Lack of parental supervision	Parental monitoring and support
Poor social skills	Positive relationships
Drug experimentation	Academic competence
Availability of drugs at school	School anti-drug policies
Community poverty	Neighborhood pride

What environmental factors increase the risk of addiction?

- *Home and family*
  The influence of the home environment, especially during childhood, is a very important factor. Children with parents or older family members who abuse alcohol or drugs or engage in criminal behavior, have an increased risk of developing their own drug problems.
- *Peers and school*
  Friends and acquaintances can have an increasingly strong influence during adolescence. Drug-using peers can sway even those without risk factors to try drugs for the first time. Academic failure or poor social skills can put a child at further risk for using or becoming addicted to drugs.

What biological factors increase risk of addiction?

- *Genetics*
  Scientists estimate that genetic factors account for between 40 and 60 percent of a person's vulnerability to addiction. This includes the effects of environmental factors on the function and expression of a person's genes. A person's stage of development and other medical conditions a person may have are also factors. Adolescents and people with mental disorders are at greater risk of drug abuse and addiction than the general population.
- *Dramatic changes in brain development that occur during adolescence*
  One of the brain areas still maturing during adolescence is the prefrontal cortex—the part of the brain that enables us to

assess situations, make sound decisions, and keep our emotions and desires under control. The fact that this critical part of the adolescent brain is a work in progress puts teenagers at increased risk for making poor decisions, such as trying drugs or continuing to take them. Also, introducing drugs during this period of development may cause brain changes that have profound and long-lasting consequences.

What other factors increase the risk of addiction?

- *Early use*
  Although taking drugs at any age can lead to addiction, research shows that the earlier a person begins to use drugs, the more likely he or she is to develop serious problems. This increased risk may reflect the harmful effects that drugs can have on the developing brain. It may result from a mix of early social and biological vulnerability factors, including unstable family relationships, exposure to physical or sexual abuse, genetic susceptibility, or mental illness. Still, the fact remains that early use is a strong indicator of problems ahead, including addiction.
- *Method of administration*
  Smoking a drug or injecting it into a vein increases its addictive potential. Both smoked and injected drugs enter the brain within seconds, producing a powerful rush of pleasure. However, this intense “high” can fade within a few minutes, taking the abuser down to lower, more normal levels. Scientists believe this starkly felt contrast drives some people to repeated drug usage in an attempt to recapture the fleeting pleasurable state.

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2.4.12.2: Types of Drugs, Possible Health Effects, and Treatment Options

Click on the link below and review the information on commonly abused drugs. Make sure to explore the material, including possible health effects and treatment options when applicable, for the following substances:

- Alcohol
- GHB
- Inhalants
- Marijuana
- Methamphetamine
- Cocaine
- Heroin
- LSD
- MDMA/Molly
- Tobacco

Commonly Abused Drugs

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2.4.12.3: Alcohol, Nicotine, e-cigarettes, and Prescription Drugs

Click on the following links to learn more about alcohol and alcohol abuse:

- Alcohol Abuse FAQs
- College Drinking

Click on the following link for information about nicotine addiction:

- Nicotine Addiction

Watch the video linked below to learn about the consequences of teens using e- cigarettes:

YouTube Video

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View this YouTube Video online

Transcript

Watch the video linked below to learn more about prescription drug abuse in teens:

YouTube Video

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Transcript

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2.4.12.4: Assessing Your Personal Risk Factors for Substance Use and Abuse-

Complete **one** of the following Labs to assess your personal risk factors for substance use and abuse. Choose the Lab most relevant for you. Submit the Lab per your Instructor's directions.

If you drink alcohol complete the following Lab:

1. Alcohol Use Lab

If you smoke cigarettes, complete the following Lab:

2. Cigarette Use Lab

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2.4.12: SUBSTANCE USE AND ABUSE

By Althea Moser

Learning Objectives

- Address addiction and risk factors for addiction
- Define types of drugs, possible health effects, and treatment options
- Explore the abuse of alcohol, nicotine, e-cigarettes, and prescription drugs and their role in addiction
- Assess personal risk for substance use and abuse

2.4.12.1: Drug Abuse and Addiction

2.4.12.2: Types of Drugs, Possible Health Effects, and Treatment Options

2.4.12.3: Alcohol, Nicotine, e-cigarettes, and Prescription Drugs

2.4.12.4: Assessing Your Personal Risk Factors for Substance Use and Abuse-

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2.4.13: SEXUALLY TRANSMITTED DISEASES/INFECTIONS (STDS/STIS)

By Althea Moser

Learning Objectives

- Define STDs, explain how they are transmitted, and identify the most common STDs/STIs
- Identify the incidence, prevalence, and cost of STIs in the United States
- Learn prevention techniques and treatment options
- Develop a personal plan for STI prevention

2.4.13.1: What are STDs?

2.4.13.2: What are the Most Common Types of STIs?

2.4.13.3: Prevention Techniques for STIs/STDs

2.4.13.4: What is the Incidence, Prevalence, and Cost of STIs?

2.4.13.5: STI Treatment Options-

2.4.13.6: Developing a Personal Plan for STI Prevention

2.4.13.7: Helpful Resources

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2.4.13.1: What are STDs?

The following information about STDs is published by the Office of Disease Prevention and Health Promotion on the website Healthy People.gov., and is found on the page "Sexually Transmitted Diseases":

STDs refer to more than 25 infectious organisms that are transmitted primarily through sexual activity. STD prevention is an essential primary care strategy for improving reproductive health.[1]

Despite their burdens, costs, and complications, and the fact that they are largely preventable, STDs remain a significant public health problem in the United States. This problem is largely unrecognized by the public, policymakers, and health care professionals. STDs cause many harmful, often irreversible, and costly clinical complications, such as:

- Reproductive health problems
- Fetal and perinatal health problems
- Cancer
- Facilitation of the sexual transmission of HIV infection[2]

How are STDs Transmitted?

Ejaculation does not have to occur for an STD/STI to be passed from person to person. Sharing contaminated needles used to inject drugs or using contaminated body piercing and tattooing equipment also can transmit some infections, such as HIV or hepatitis B and C

Anyone who has had or is having sexual intercourse or oral sex, or who has participated or is participating in sex play, is at risk for acquiring an STD/STI

Fortunately, it is possible for a person to decrease his or her risk by having protected sex and knowing his or her STD/STI status and that of his or her partner.

Still, the Centers for Disease Control and Prevention (CDC) estimates nearly 20 million new cases of these reportable STDs/STIs (gonorrhea, chlamydia, syphilis) occur each year in the United States— almost half of them among young people 15 to 24 years of age.1

While not the most common STD/STI, HIV/AIDS is one of the most devastating and most well known. Recent data from the CDC indicate that 1.1 million Americans haveHIV[2]:

- One in five is unaware that they have the virus.
- Approximately 50,000 Americans become infected with HIV each year.
- 15,529 people with AIDS died in 2010.

Click on the following link to learn more about reported STDs in the United States:

CDC Fact Sheet

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2.4.13.2: What are the Most Common Types of STIs?

The following information about the most common STIs is published by the US Department of Health and Human Services and found on the NIH's website on the page "What are some types of sexually transmitted diseases or sexually transmitted infections (STDs/STIs)?":

Approximately 20 different infections are known to be transmitted through sexual contact. Here are descriptions of some of the most common and well known:

Chlamydia

Chlamydia[1] (pronounced *kla-MID-ee-uh*) is a common STD/STI caused by the bacterium*Chlamydia trachomatis*. Chlamydia can be transmitted during vaginal, oral, or anal sexual contact with an infected partner. While many individuals will not experience symptoms, chlamydia can cause fever, abdominal pain, and unusual discharge of the penis or vagina.

In women, whether or not they are having symptoms and know about their infection, chlamydia can cause pelvic inflammatory disease (PID). In PID, the untreated STD/STI progresses and involves other parts of the woman's reproductive system, including the uterus and fallopian tubes. This progression can lead to permanent damage to the woman's reproductive organs. This damage may lead to ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

Additionally, if the woman is pregnant, her developing fetus is at risk, because chlamydia can be passed on during her pregnancy or delivery and could lead to eye infections or pneumonia in the infant. If chlamydia is detected early, it can be treated easily with an antibiotic taken by mouth.

Gonorrhea

Gonorrhea[2](pronounced *gon-uh-REE-uh*) is caused by the bacterium Neisseria gonorrhoeae, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract. The most common symptoms of gonorrheal infection are a discharge from the vagina or penis and painful or difficult urination.

As with chlamydial infection, the most common and serious complications of gonorrhea occur in women and include pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and the potential spread to the developing fetus if acquired during pregnancy. Gonorrhea also can infect the mouth, throat, eyes, and rectum and can spread to the blood and joints, where it can become a life-threatening illness.

In addition, people with gonorrhea can more easily contract HIV, the virus that causes AIDS. HIV-infected people with gonorrhea are also more likely to transmit the virus to someone else.[3]

Genital Herpes

Genital herpes[4] is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2.[5] When symptomatic, HSV-1 usually appears as fever blisters or cold sores on the lips, but it can also infect the genital region through oral-genital or genital-genital contact. Symptomatic HSV-2 typically causes painful, watery skin blisters on or around the genitals or anus. However, substantial numbers of people who carry these viruses have no or only minimal signs or symptoms.

Neither HSV-1 nor HSV-2 can be cured, and even during times when an infected person has no symptoms, the virus can be found in the body's nerve cells. Periodically, some people will experience outbreaks in which new blisters form on the skin in the genital area; at those times, the virus is more likely to be passed on to other people.

Pregnant women, especially those who acquire genital herpes for the first time during pregnancy, may pass the infection to their newborns, causing life-threatening neonatal HSV, an infection affecting the infant's skin, brain, and other organs.[6]

HIV/AIDS

HIV, or the human immunodeficiency virus,[7] is the virus that causes AIDS (acquired immunodeficiency syndrome). HIV destroys the body's immune system by killing the blood cells that fight infection. Once HIV destroys a substantial proportion of these cells, the body's ability to fight off and recover from infections is compromised. This advanced stage of HIV infection is known as AIDS.

People whose HIV has progressed to AIDS are very susceptible to opportunistic infections that do not normally make people sick and to certain forms of cancer. AIDS can be prevented by early initiation of antiretroviral therapy in those with HIV infection. Transmission of the virus primarily occurs during unprotected sexual activity and by sharing needles used to inject intravenous drugs, although the virus also can spread from mother to infant during pregnancy, delivery, and breastfeeding.

In 2013, NIH-supported researchers reported that a 2-year-old child who was born with HIV and was treated starting in the first few days of life has had her HIV infection go into remission. This appears to be the first case of functional cure of HIV.

Human Papillomavirus (HPV)

HPV[8] is the most common STD/STI. More than 40 HPV types exist, and all of them can infect both men and women. The types of HPVs vary in their ability to cause genital warts; infect other regions of the body, including the mouth and throat; and cause cancers of the cervix, vulva, penis, and mouth.

Although no cure exists for HPV infection once it occurs, regular screening with a Pap smear test can prevent or detect at an early stage most cases of HPV-caused cervical cancer. (A Pap smear test involves a health care provider taking samples of cells from the cervix during a standard gynecologic exam; these cells are examined under a microscope for signs of developing cancer). A newly available vaccine protects against most (but not all) HPV types that cause cervical cancer. The American Academy of Pediatrics recommends this vaccine for school-aged boys and girls.[9]

Syphilis

Syphilis[10] infections, caused by the bacterium Treponema pallidum, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres. Between 2001 and 2009, the Centers for Disease Control and Prevention (CDC) data show that the syphilis rate increased each year. Those people at highest risk for syphilis include men having sex with both men and women and people residing in the south.[10] The first sign of syphilis is a chancre, a painless genital sore that most often appears on the penis or in and around the vagina. Beyond being the first sign of a syphilis infection, chancres make a person two to five times more likely to contract an HIV infection. If the person is already infected with HIV, chancres also increase the likelihood that the virus will be passed on to a sexual partner.[3] These sores typically resolve on their own, even without treatment. However, the body does not clear the infection on its own, and, over time, syphilis may involve other organs, including the skin, heart, blood vessels, liver, bones, and joints in secondary syphilis. If the illness is still not treated, tertiary syphilis can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.

Expectant mothers harboring the bacterium are at an increased risk of miscarriage and stillbirth, and they can pass the infection on to their fetuses during pregnancy and delivery. Infants that acquire congenital syphilis during pregnancy may suffer from skeletal deformity, difficulty with speech and motor development, seizure, anemia, liver disease, and neurologic problems.

Bacterial Vaginosis

Bacterial vaginosis[11] is a common, possibly sexually transmitted, vaginal infection in women of reproductive age. While it is healthy and normal for a vagina to have bacteria, just like the skin, mouth, or gastrointestinal (GI) tract, sometimes changes in the balance of different types of bacteria can cause problems.

Bacterial vaginosis occurs when problematic bacteria that are normally present only in small amounts increase in number,

replace normal vaginal lactobacilli bacteria, and upset the usual balance. This situation becomes more likely if a woman douches frequently or has new or multiple sexual partners. The most common sign of a bacterial vaginosis infection is a thin, milky discharge that is often described as having a "fishy" odor. However, some women will have no symptoms at all.

Regardless of symptoms, having bacterial vaginosis increases the risk of getting other STDs/STIs and is also associated with pelvic inflammatory disease (PID), an infection of the female reproductive organs, including the uterus and the fallopian tubes (which carry eggs to the uterus), and postoperative infections. Preterm labor and birth are also possibly more common in women with bacterial vaginosis.

Trichomoniasis

Trichomoniasis[12] (pronounced *trik-uh-muh- NAHY-uh-sis*) infection is caused by the single-celled protozoan parasite Trichomonas vaginalis and is common in young, sexually active women. The parasite also infects men, though less frequently. The parasite can be transmitted between men and women as well as between women whenever physical contact occurs between the genital areas. Although*Trichomonas*infections do not always cause symptoms, they can cause frequent, painful, or burning urination in men and women as well as vaginal discharge, genital soreness, redness, or itching in women.

Because the infection can occur without symptoms, a person may be unaware that he or she is infected and continue to re- infect a sexual partner who is having recurrent signs of infection. As with bacterial STDs/STIs, all sexual partners should be treated at the same time to avoid re-infection.

NICHD-sponsored research has shown that during pregnancy, Trichomonas infection is associated with an increased risk of premature birth and infants with low birth weight. Moreover, infants born to mothers with Trichomonas infection are more than twice as likely as infants born to uninfected women to be stillborn or to die as newborns.[13]

Viral Hepatitis

Viral hepatitis is a serious liver disease that can be caused by several different viruses, which can be transmitted through sexual contact.

- Hepatitis A virus (HAV) causes a short-term or self-limited liver infection that can be quite serious, although it does not result in chronic infection. While there are other ways the virus can be transmitted, HAV can be spread from person to person during sexual activity through oral-rectal contact. Vaccination can prevent HAV infection.[13]
- Hepatitis B virus (HBV) causes a serious liver disease that can result in both immediate illness and lifelong infection leading to permanent liver scarring (cirrhosis), cancer, liver failure, and death. HBV spreads through both heterosexual and homosexual contact as well as through contact with other bodily fluids, such as blood, through shared contaminated needles used for injecting intravenous (IV) drugs, tattooing, and piercing. Pregnant women with HBV can transmit the virus to their infants during delivery. HBV infection is preventable through vaccination.[1]
- Hepatitis C virus (HCV) can cause an immediate illness affecting the liver, but it more commonly becomes a silent, chronic infection that leads to liver scarring (cirrhosis), cancer, liver failure, and death. HCV is most commonly transmitted through sharing needles or exposure to infected blood. However, it can spread through sexual contact or from mother to fetus during pregnancy and delivery. There is no vaccine for HCV, and treatments are not always effective.[15] [2]

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2.4.13.3: Prevention Techniques for STIs/STDs

Click on the following link to learn how to prevent STIs:

How You Can Prevent STDs

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2.4.13.4: What is the Incidence, Prevalence, and Cost of STIs?

2021 The Center for Disease Control (CDC) analyses[1,2] provide the clearest picture to date of how common and costly sexually transmitted infections (STIs) are in the United States. CDC's latest estimates indicate that 20% of the U.S. population – approximately one in five people – had an STI on any given day in 2018, and STIs acquired that year cost the American healthcare system nearly $16 billion in direct medical costs alone.

CDC's analyses included eight common STIs, four of which are easily treated and cured if diagnosed early: chlamydia, gonorrhea, syphilis, and trichomoniasis. Also included in the analyses are four sexually transmitted viruses: human papillomavirus (HPV), herpes simplex virus type 2 (HSV-2), human immunodeficiency virus (HIV), and hepatitis B virus (HBV). Many of these infections go undetected because they often have no symptoms and can have serious health consequences.

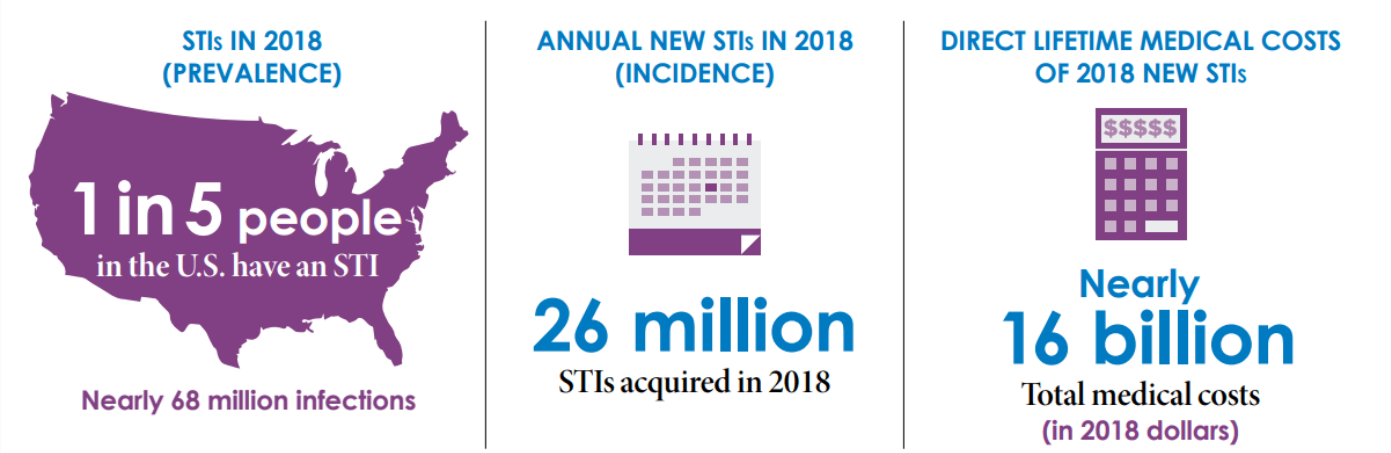


Figure 1: STIs remain common and costly to the nation's health. (Public Domain; CDC)

Fighting STIs: prevention, diagnosis, and prompt treatment

Because STIs are preventable, significant reductions in new infections are not only possible, they are urgently needed. Prevention can minimize the negative, long-term consequences of STIs and reduce healthcare costs. To do this, prevention efforts should:

- Focus on hard-hit populations. Young people and women face some of the biggest impacts and most significant consequences of STIs.
- Consider the social, cultural & economic conditions that make it more difficult for some sexually active people to stay healthy (e.g., poverty, unstable housing, drug use, lack of medical insurance or medical home, high burden of STIs in some communities).

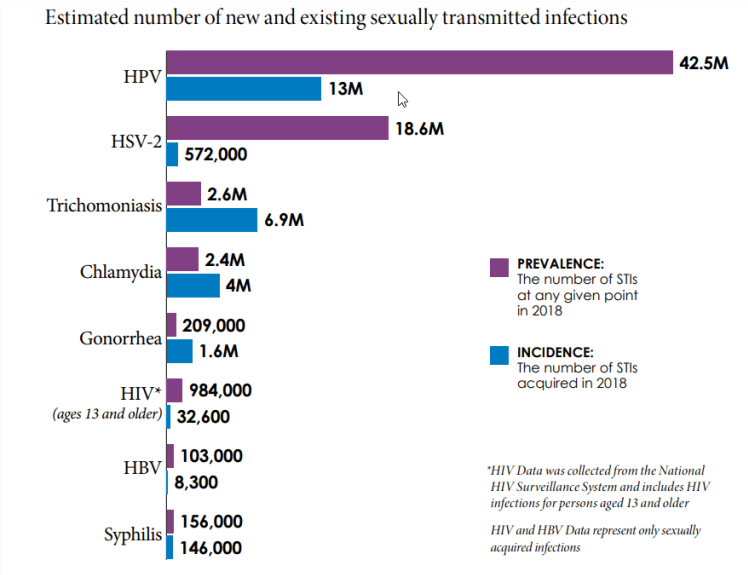


Figure 2: Estimated number of new and existing sexually transmitted infections. (Public Domain; CDC)

More information on STD prevention is available here.

For all individuals who are sexually active – particularly young people and women – STI screening and prompt treatment (if infected) are critical to protect a person's health and prevent transmission to others. If you are sexually active, be sure to talk to your healthcare provider about STI testing and which tests may be right for you.

While medical costs alone are significant, the overall cost of STIs is higher when factoring in costs associated with lost productivity, other non-medical costs and STI prevention.

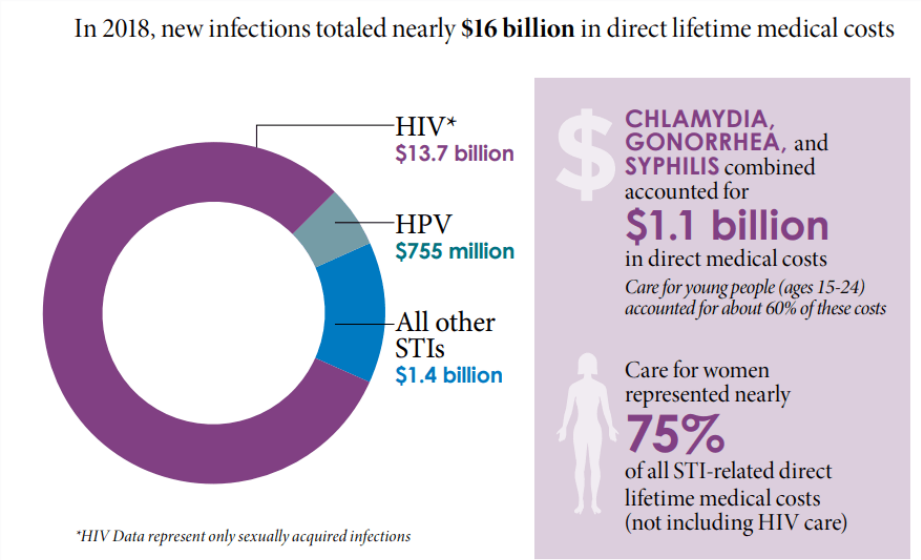


Figure 3: STIs cost the U.S. Healthcare system Billions each year. (Public Domain; CDC)

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Contributors

- Center for Disease Control

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2.4.13.5: STI Treatment Options-

The following information about the most common STIs is published by the US Department of Health and Human Services and found on the NIH's website on the page "What are the treatments for sexually transmitted diseases and sexually transmitted infections (STDs/STIs)?":

STDs/STIs caused by bacteria, yeast, or parasites can be treated with antibiotics. These antibiotics are most often given by mouth (orally). However, sometimes they are injected or applied directly to the affected area. Whatever the infection, and regardless of how quickly the symptoms resolve after beginning treatment, the infected person must take all of the medicine prescribed by the health care provider to ensure that the STD/STI is completely treated.

Although treatments, complications, and outcomes vary among viral STDs/STIs depending on the particular virus (HIV, genital herpes, human papillomavirus, hepatitis, or cytomegalovirus), health care providers can provide treatments to reduce the symptoms and the progression of most of these illnesses. For example, medications are available to limit the frequency and severity of genital herpes outbreaks while reducing the risk that the virus will be passed on to other people.

Individuals with HIV need to take special antiretroviral drugs that control the amount of virus they carry. These drugs, called*h*ighly *a*ctive *a*nti*r*etroviral *t*herapy, or HAART,1 can help people live longer, healthier lives. If a woman with HIV becomes pregnant, these medicines also can reduce the chance that her fetus or infant will get the infection.

Being tested and treated for STDs/STIs is especially important for pregnant women because some STDs/STIs may be passed on to their infants during pregnancy or delivery. Testing women for these STDs/STIs early in their pregnancy is important, so that steps can be taken to help ensure delivery of a healthy infant. The necessary treatment will depend on the type of STD/STI involved.

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2.4.13.6: Developing a Personal Plan for STI Prevention

Complete the following lab to develop a personal plan for STI prevention. Submit the Lab per your Instructor's directions.

Plan for Change: Preventing STIs

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2.4.13.7: Helpful Resources

If you are a student contact the Student Support Services at your institution, for example, the author's of this book at Georgia Highlands College suggest that their students contact GHC's Student Support Services

How to Get Tested

Departments of Public Health in your state or city offer important help for example the Georgia Department of Public Health

Lesbian and Bisexual Health

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Sexually Transmitted Diseases

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This course focuses on the exploration of major health issues and behaviors in the various dimensions of health. Emphasis is placed on individual responsibility for personal health and the promotion of informed, positive health behaviors. Topics include nutrition, exercise, weight control, mental health, stress management, violence, substance abuse, reproductive health, disease prevention, aging, health care, and environmental hazards and safety.



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2.5.1: SUBSTANCE ABUSE AND ADDICTIONS

Learning Objectives

- understand a set of fundamentals about neurobiology and how drugs of abuse change the brain
- recognize that drug addiction is a treatable, chronic brain disease
- experience the process of scientific inquiry and develop an enhanced understanding of the nature and methods of science
- appreciate the role of science in society and the relationship between basic science and human health. understand that drug abuse initially is a voluntary behavior
- to define drug addiction as the continued compulsive drug abuse despite known adverse health or social consequences
- understand that drug abuse and addiction are associated with long-term physical and functional changes in the brain
- recognize that addiction is influenced by biological factors (for example, genetics and age) and by the social and behavioral context of drug use.

2.5.1.1: Drugs

2.5.1.2: Alcohol

2.5.1.3: Tobacco

2.5.1.4: Misuse of Prescription Drugs

2.5.1.5: Drugs, Abuse, and Addiction

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2.5.1.1: Drugs

Drug abuse is a serious public health problem that affects almost every community and family in some way. Each year drug abuse results in around 40 million serious illnesses or injuries among people in the United States. Abused drugs include:

- Club drugs
- Amphetamines
- Anabolic steroids
- Cocaine
- Heroin
- Inhalants
- Marijuana
- Prescription drugs

Drug abuse also plays a role in many major social problems, such as drugged driving, violence, stress and child abuse. Drug abuse can lead to homelessness, crime, and missed work or problems with keeping a job. There are different types of treatment for drug abuse. But the best is to prevent drug abuse in the first place.

Learning Activity

Watch this video about the Long Term Effects of Drugs on the Brain.

- Explain how drug addiction is a brain disease.
- What are three reasons that make finding answers to the health impact of drug addiction difficult to do?

Club Drugs

The term club drug refers to a wide variety of dangerous drugs. These drugs are often used by young adults at all-night dance parties, dance clubs and bars. They include

- Methylenedioxymethamphetamine (MDMA), also known as Ecstasy, XTC, X, Adam, Clarity and Lover's Speed
- Gamma-hydroxybutyrate (GHB), also known as Grievous Bodily Harm, G, Liquid Ecstasy and Georgia Home Boy
- Ketamine, also known as Special K, K, Vitamin K, Cat Valium
- Rohypnol, also known as Roofies, Rophies, Roche, Forget-me Pill
- Methamphetamine, also known as Speed, Ice, Chalk, Meth, Crystal, Crank, Fire, Glass
- Lysergic Acid Diethylamide (LSD), also known as or Acid, Boomers, Yellow Sunshines

Club drugs have become more common in recent years. Sometimes people use them to commit sexual assaults. Club drugs can cause serious health problems and sometimes death. They are even more dangerous if you use them with alcohol.

What Type of Drugs are Club Drugs?

Club drugs are a pharmacologically heterogeneous group of psychoactive drugs that tend to be abused by teens and young adults at bars, nightclubs, concerts, and parties. Gamma hydroxybutyrate (GHB), Rohypnol, ketamine, as well as MDMA (ecstasy) and methamphetamine are some of the drugs included in this group.

- GHB (Xyrem) is a central nervous system (CNS) depressant that was approved by the Food and Drug Administration (FDA) in 2002 for use in the treatment of narcolepsy (a sleep disorder). This approval came with severe restrictions, including its use only for the treatment of narcolepsy, and the requirement for a patient registry monitored by the FDA. GHB is also a metabolite of the inhibitory neurotransmitter gamma-aminobutyric acid (GABA). It exists naturally in the brain, but at much lower concentrations than those found when GHB is abused.
- Rohypnol (flunitrazepam) use began gaining popularity in the United States in the early 1990s. It is a benzodiazepine (chemically similar to sedative-hypnotic drugs such as Valium or Xanax), but it is not approved for medical use in this country,

and its importation is banned.
- Ketamine is a dissociative anesthetic, mostly used in veterinary practice.

How Are Club Drugs Abused?

- GHB and Rohypnol are available in odorless, colorless, and tasteless forms that are frequently combined with alcohol and other beverages. Both drugs have been used to commit sexual assaults (also known as “date rape,” “drug rape,” “acquaintance rape,” or “drug-assisted” assault) due to their ability to sedate and incapacitate unsuspecting victims, preventing them from resisting sexual assault.
- GHB is usually ingested orally, either in liquid or powder form, while Rohypnol is typically taken orally in pill form. Recent reports, however, have shown that Rohypnol is being ground up and snorted.
- Both GHB and Rohypnol are also abused for their intoxicating effects, similar to other CNS depressants.
- GHB also has anabolic effects (it stimulates protein synthesis) and has been used by bodybuilders to aid in fat reduction and muscle building.
- Ketamine is usually snorted or injected intramuscularly.

How Do Club Drugs Affect the Brain?

- At high doses, GHB’s sedative effects may result in sleep, coma, or death.
- Rohypnol can produce anterograde amnesia, in which individuals may not remember events they experienced while under the influence of the drug.
- Ketamine is a dissociative anesthetic, so called because it distorts perceptions of sight and sound and produces feelings of detachment from the environment and self. Low-dose intoxication results in impaired attention, learning ability, and memory. At higher doses, ketamine can cause dreamlike states and hallucinations; and at higher doses still, ketamine can cause delirium and amnesia.

Addictive Potential

- Repeated use of GHB may lead to withdrawal effects, including insomnia, anxiety, tremors, and sweating. Severe withdrawal reactions have been reported among patients presenting from an overdose of GHB or related compounds, especially if other drugs or alcohol are involved.
- Like other benzodiazepines, chronic use of Rohypnol can produce tolerance, physical dependence, and addiction.
- There have been reports of people binging on ketamine, a behavior that is similar to that seen in some cocaine- or amphetamine-dependent individuals. Ketamine users can develop signs of tolerance and cravings for the drug.

What Other Adverse Effects Do Club Drugs Have on Health?

Uncertainties about the sources, chemicals, and possible contaminants used to manufacture many club drugs make it extremely difficult to determine toxicity and associated medical consequences. Nonetheless, we do know that:

- Coma and seizures can occur following use of GHB. Combined use with other drugs such as alcohol can result in nausea and breathing difficulties. GHB has been involved in poisonings, overdoses, date rapes, and deaths.
- Rohypnol may be lethal when mixed with alcohol and/or other CNS depressants.
- Ketamine, in high doses, can cause impaired motor function, high blood pressure, and potentially fatal respiratory problems.

Methamphetamine

Methamphetamine is a very addictive stimulant drug. It can be smoked, injected, inhaled or taken by mouth. It has many street names, such as speed, meth, and chalk. Methamphetamine hydrochloride, the crystal form inhaled by smoking, is referred to as ice, crystal, glass and tina.

Methamphetamine affects the brain and can create feelings of pleasure, increase energy and elevate mood. Abusers may become addicted quickly, needing higher doses more often. Adverse health effects include irregular heartbeat, increased blood pressure and a variety of psychological problems. Long-term effects may include severe mental disorders, memory loss and severe dental problems.

What Type of Drug is Methamphetamine?

Methamphetamine is a central nervous system stimulant drug that is similar in structure to amphetamine. Due to its high potential for abuse, methamphetamine is classified as a Schedule II drug and is available only through a prescription that cannot be refilled. Although methamphetamine can be prescribed by a doctor, its medical uses are limited, and the doses that are prescribed are much lower than those typically abused. Most of the methamphetamine abused in this country comes from foreign or domestic superlabs, although it can also be made in small, illegal laboratories, where its production endangers the people in the labs, neighbors, and the environment.

How Is Methamphetamine Abused?

Methamphetamine is a white, odorless, bitter-tasting crystalline powder that easily dissolves in water or alcohol and is taken orally, intranasally (snorting the powder), by needle injection, or by smoking.

How Does Methamphetamine Affect the Brain?

Methamphetamine increases the release and blocks the reuptake of the brain chemical (or neurotransmitter) dopamine, leading to high levels of the chemical in the brain—a common mechanism of action for most drugs of abuse. Dopamine is involved in reward, motivation, the experience of pleasure, and motor function. Methamphetamine's ability to release dopamine rapidly in reward regions of the brain produces the intense euphoria, or "rush," that many users feel after snorting, smoking, or injecting the drug.

Chronic methamphetamine abuse significantly changes how the brain functions. Noninvasive human brain imaging studies have shown alterations in the activity of the dopamine system that are associated with reduced motor skills and impaired verbal learning. Recent studies in chronic methamphetamine abusers have also revealed severe structural and functional changes in areas of the brain associated with emotion and memory, which may account for many of the emotional and cognitive problems observed in chronic methamphetamine abusers.

Repeated methamphetamine abuse can also lead to addiction—a chronic, relapsing disease characterized by compulsive drug seeking and use, which is accompanied by chemical and molecular changes in the brain. Some of these changes persist long after methamphetamine abuse is stopped. Reversal of some of the changes, however, may be observed after sustained periods of abstinence (e.g., more than 1 year).

What Other Adverse Effects Does Methamphetamine Have on Health?

Taking even small amounts of methamphetamine can result in many of the same physical effects as those of other stimulants, such as cocaine or amphetamines, including increased wakefulness, increased physical activity, decreased appetite, increased respiration, rapid heart rate, irregular heartbeat, increased blood pressure, and hyperthermia.

Long-term methamphetamine abuse has many negative health consequences, including extreme weight loss, severe dental problems ("meth mouth"), anxiety, confusion, insomnia, mood disturbances, and violent behavior. Chronic methamphetamine abusers can also display a number of psychotic features, including paranoia, visual and auditory hallucinations, and delusions (for example, the sensation of insects crawling under the skin).

Transmission of HIV and hepatitis B and C can be consequences of methamphetamine abuse. The intoxicating effects of methamphetamine, regardless of how it is taken, can also alter judgment and inhibition and can lead people to engage in unsafe behaviors, including risky sexual behavior. Among abusers who inject the drug, HIV/AIDS and other infectious diseases can be spread through contaminated needles, syringes, and other injection equipment that is used by more than one person. Methamphetamine abuse may also worsen the progression of HIV/AIDS and its consequences. Studies of methamphetamine abusers who are HIV-positive indicate that HIV causes greater neuronal injury and cognitive impairment for individuals in this group compared with HIV-positive people who do not use the drug.

Anabolic Steroids

Anabolic-androgenic steroids (AAS) are synthetically produced variants of the naturally occurring male sex hormone testosterone. "Anabolic" refers to muscle-building, and "androgenic" refers to increased male sexual characteristics. "Steroids" refers to the

class of drugs. These drugs can be legally prescribed to treat conditions resulting from steroid hormone deficiency, such as delayed puberty, as well as diseases that result in loss of lean muscle mass, such as cancer and AIDS.

How Are AAS Abused?

Some people, both athletes and non-athletes, abuse AAS in an attempt to enhance performance and/or improve physical appearance. AAS are taken orally or injected, typically in cycles rather than continuously. “Cycling” refers to a pattern of use in which steroids are taken for periods of weeks or months, after which use is stopped for a period of time and then restarted. In addition, users often combine several different types of steroids in an attempt to maximize their effectiveness, a practice referred to as “stacking.”

How Do AAS Affect the Brain?

The acute effects of AAS in the brain are substantially different from those of other drugs of abuse. The most important difference is that AAS are not euphorigenic, meaning they do not trigger rapid increases in the neurotransmitter dopamine, which is responsible for the “high” that often drives substance abuse behaviors. However, long-term use of AAS can eventually have an impact on some of the same brain pathways and chemicals—such as dopamine, serotonin, and opioid systems—that are affected by other drugs of abuse. Considering the combined effect of their complex direct and indirect actions, it is not surprising that AAS can affect mood and behavior in significant ways.

AAS and Mental Health

Preclinical, clinical, and anecdotal reports suggest that steroids may contribute to psychiatric dysfunction. Research shows that abuse of anabolic steroids may lead to aggression and other adverse effects. For example, although many users report feeling good about themselves while on anabolic steroids, extreme mood swings can also occur, including manic-like symptoms that could lead to violence. Researchers have also observed that users may suffer from paranoid jealousy, extreme irritability, delusions, and impaired judgment stemming from feelings of invincibility.

Addictive Potential

Animal studies have shown that AAS are reinforcing—that is, animals will self-administer AAS when given the opportunity, just as they do with other addictive drugs. This property is more difficult to demonstrate in humans, but the potential for AAS abusers to become addicted is consistent with their continued abuse despite physical problems and negative effects on social relations. Also, steroid abusers typically spend large amounts of time and money obtaining the drug: this is another indication of addiction. Individuals who abuse steroids can experience withdrawal symptoms when they stop taking AAS—these include mood swings, fatigue, restlessness, loss of appetite, insomnia, reduced sex drive, and steroid cravings, all of which may contribute to continued abuse. One of the most dangerous withdrawal symptoms is depression—when persistent, it can sometimes lead to suicide attempts.

Research also indicates that some users might turn to other drugs to alleviate some of the negative effects of AAS. For example, a study of 227 men admitted in 1999 to a private treatment center for dependence on heroin or other opioids found that 9.3 percent had abused AAS before trying any other illicit drug. Of these, 86 percent first used opioids to counteract insomnia and irritability resulting from the steroids.

What Other Adverse Effects Do AAS Have on Health?

Steroid abuse can lead to serious, even irreversible health problems. Some of the most dangerous among these include liver damage; jaundice (yellowish pigmentation of skin, tissues, and body fluids); fluid retention; high blood pressure; increases in LDL (“bad” cholesterol); and decreases in HDL (“good” cholesterol). Other reported effects include renal failure, severe acne, and trembling. In addition, there are some gender- and age-specific adverse effects:

- For *men*—shrinking of the testicles, reduced sperm count, infertility, baldness, development of breasts, increased risk for prostate cancer
- For *women*—growth of facial hair, male-pattern baldness, changes in or cessation of the menstrual cycle, enlargement of the clitoris, deepened voice
- For *adolescents*—stunted growth due to premature skeletal maturation and accelerated puberty changes; risk of not reaching

expected height if AAS is taken before the typical adolescent growth spurt

In addition, people who inject AAS run the added risk of contracting or transmitting HIV/AIDS or hepatitis, which causes serious damage to the liver.

Learning Activity

Watch this video titled: Psychoactive Drugs and take the ungraded quiz.

- What factors impact the influence of a drug?
- What can tolerance of a drug cause?

Cocaine

Cocaine is a powerful drug that stimulates the brain. People who use it can form a strong addiction. They may have to use more and more of the drug to get high. It's sold on the street as a fine, white powder. There are two forms of cocaine: hydrochloride salt and freebase. The salt dissolves in water. People can take it in a vein or in the nose. The freebase form can be smoked. Crack is the street name of a smokable form of cocaine.

No matter how cocaine is taken, it is dangerous. Some of the most common serious problems include

- Heart problems, including heart attacks
- Respiratory effects, including respiratory failure
- Nervous system problems, including strokes
- Digestive problems

Any of these can be fatal. Using cocaine with alcohol is a common cause of drug-related death.

What Type of Drug is Cocaine?

Cocaine is a powerfully addictive stimulant drug. The powdered hydrochloride salt form of cocaine can be snorted or dissolved in water and then injected. Crack is the street name given to the form of cocaine that has been processed to make a rock crystal, which, when heated, produces vapors that are smoked. The term "crack" refers to the crackling sound produced by the rock as it is heated.

How Is Cocaine Abused?

Three routes of administration are commonly used for cocaine: snorting, injecting, and smoking. Snorting is the process of inhaling cocaine powder through the nose, where it is absorbed into the bloodstream through the nasal tissues. Injecting is the use of a needle to insert the drug directly into the bloodstream. Smoking involves inhaling cocaine vapor or smoke into the lungs, where absorption into the bloodstream is as rapid as it is by injection. All three methods of cocaine abuse can lead to addiction and other severe health problems, including increasing the risk of contracting HIV/AIDS and other infectious diseases.

The intensity and duration of cocaine's effects—which include increased energy, reduced fatigue, and mental alertness—depend on the route of drug administration. The faster cocaine is absorbed into the bloodstream and delivered to the brain, the more intense the high. Injecting or smoking cocaine produces a quicker, stronger high than snorting. On the other hand, faster absorption usually means shorter duration of action: the high from snorting cocaine may last 15 to 30 minutes, but the high from smoking may last only 5 to 10 minutes. In order to sustain the high, a cocaine abuser has to administer the drug again. For this reason, cocaine is sometimes abused in binges—taken repeatedly within a relatively short period of time, at increasingly higher doses.

How Does Cocaine Affect the Brain?

Cocaine is a strong central nervous system stimulant that increases levels of dopamine, a brain chemical (or neurotransmitter) associated with pleasure and movement, in the brain's reward circuit. Certain brain cells, or neurons, use dopamine to

communicate. Normally, dopamine is released by a neuron in response to a pleasurable signal (e.g., the smell of good food), and then recycled back into the cell that released it, thus shutting off the signal between neurons.

Cocaine acts by preventing the dopamine from being recycled, causing excessive amounts of the neurotransmitter to build up, amplifying the message to and response of the receiving neuron, and ultimately disrupting normal communication. It is this excess of dopamine that is responsible for cocaine's euphoric effects. With repeated use, cocaine can cause long-term changes in the brain's reward system and in other brain systems as well, which may eventually lead to addiction. With repeated use, tolerance to the cocaine high also often develops. Many cocaine abusers report that they seek but fail to achieve as much pleasure as they did from their first exposure. Some users will increase their dose in an attempt to intensify and prolong the euphoria, but this can also increase the risk of adverse psychological or physiological effects.

What Adverse Effects Does Cocaine Have on Health?

Abusing cocaine has a variety of adverse effects on the body. For example, cocaine constricts blood vessels, dilates pupils, and increases body temperature, heart rate, and blood pressure. It can also cause headaches and gastrointestinal complications such as abdominal pain and nausea. Because cocaine tends to decrease appetite, chronic users can become malnourished as well.

Different methods of taking cocaine can produce different adverse effects. Regular intranasal use (snorting) of cocaine, for example, can lead to loss of the sense of smell; nosebleeds; problems with swallowing; hoarseness; and a chronically runny nose. Ingesting cocaine can cause severe bowel gangrene as a result of reduced blood flow. Injecting cocaine can bring about severe allergic reactions and increased risk for contracting HIV/AIDS and other blood-borne diseases. Binge-patterned cocaine use may lead to irritability, restlessness, and anxiety. Cocaine abusers can also experience severe paranoia—a temporary state of full-blown paranoid psychosis—in which they lose touch with reality and experience auditory hallucinations.

Regardless of the route or frequency of use, cocaine abusers can experience acute cardiovascular or cerebrovascular emergencies, such as a heart attack or stroke, which may cause sudden death. Cocaine-related deaths are often a result of cardiac arrest or seizure followed by respiratory arrest.

Learning Activity

Watch these videos to find out about the effect of drugs on the brain:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

- What is one thing you learned from these videos that you didn't know before?

Heroin

Heroin is a drug made from morphine, a natural substance in the seedpod of the Asian poppy plant. Heroin usually appears as a white or brown powder. Heroin can be injected, smoked or snorted. Heroin abuse is a serious problem in the United States. Major health problems from heroin include miscarriages, heart infections and death from overdose. People who inject the drug also risk infectious diseases, including HIV/AIDS and hepatitis.

Regular use of heroin can lead to tolerance. This means users need more and more drug to have the same effect. At higher doses over time, the body becomes dependent on heroin. If dependent users stop heroin, they have withdrawal symptoms. These symptoms include restlessness, muscle and bone pain, diarrhea, vomiting and cold flashes.

Heroin is an opiate drug that is synthesized from morphine, a naturally occurring substance extracted from the seed pod of the Asian opium poppy plant. Heroin usually appears as a white or brown powder or as a black sticky substance, known as "black tar

heroin."

How Is Heroin Abused?

Heroin can be injected, snorted/sniffed, or smoked—routes of administration that rapidly deliver the drug to the brain. Injecting is the use of a needle to administer the drug directly into the bloodstream. Snorting is the process of inhaling heroin powder through the nose, where it is absorbed into the bloodstream through the nasal tissues. Smoking involves inhaling heroin smoke into the lungs. All three methods of administering heroin can lead to addiction and other severe health problems.

How Does Heroin Affect the Brain?

Heroin enters the brain, where it is converted to morphine and binds to receptors known as opioid receptors. These receptors are located in many areas of the brain (and in the body), especially those involved in the perception of pain and in reward. Opioid receptors are also located in the brain stem—important for automatic processes critical for life, such as breathing (respiration), blood pressure, and arousal. Heroin overdoses frequently involve a suppression of respiration.

After an intravenous injection of heroin, users report feeling a surge of euphoria ("rush") accompanied by dry mouth, a warm flushing of the skin, heaviness of the extremities, and clouded mental functioning. Following this initial euphoria, the user goes "on the nod," an alternately wakeful and drowsy state. Users who do not inject the drug may not experience the initial rush, but other effects are the same.

With regular heroin use, tolerance develops, in which the user's physiological (and psychological) response to the drug decreases, and more heroin is needed to achieve the same intensity of effect. Heroin users are at high risk for addiction—it is estimated that about 23 percent of individuals who use heroin become dependent on it.

What Other Adverse Effects Does Heroin Have on Health?

Heroin abuse is associated with serious health conditions, including fatal overdose, spontaneous abortion, and—particularly in users who inject the drug—infectious diseases, including HIV/AIDS and hepatitis. Chronic users may develop collapsed veins, infection of the heart lining and valves, abscesses, and liver or kidney disease. Pulmonary complications, including various types of pneumonia, may result from the poor health of the abuser as well as from heroin's depressing effects on respiration. In addition to the effects of the drug itself, street heroin often contains toxic contaminants or additives that can clog blood vessels leading to the lungs, liver, kidneys, or brain, causing permanent damage to vital organs.

Chronic use of heroin leads to physical dependence, a state in which the body has adapted to the presence of the drug. If a dependent user reduces or stops use of the drug abruptly, he or she may experience severe symptoms of withdrawal. These symptoms—which can begin as early as a few hours after the last drug administration—can include restlessness, muscle and bone pain, insomnia, diarrhea and vomiting, cold flashes with goose bumps ("cold turkey"), and kicking movements ("kicking the habit"). Users also experience severe craving for the drug during withdrawal, which can precipitate continued abuse and/or relapse.

Major withdrawal symptoms peak between 48 and 72 hours after the last dose of the drug and typically subside after about 1 week. Some individuals, however, may show persistent withdrawal symptoms for months. Although heroin withdrawal is considered less dangerous than alcohol or barbiturate withdrawal, sudden withdrawal by heavily dependent users who are in poor health is occasionally fatal. In addition, heroin craving can persist years after drug cessation, particularly upon exposure to triggers such as stress or people, places, and things associated with drug use.

Heroin abuse during pregnancy, together with related factors like poor nutrition and inadequate prenatal care, has been associated with adverse consequences including low birthweight, an important risk factor for later developmental delay. If the mother is regularly abusing the drug, the infant may be born physically dependent on heroin and could suffer from serious medical complications requiring hospitalization.

Marijuana

Marijuana is the most commonly abused illicit drug in the United States. It is a dry, shredded green and brown mix of flowers, stems, seeds, and leaves derived from the hemp plant *Cannabis sativa*. The main active chemical in marijuana is delta-9-tetrahydrocannabinol, or THC for short.

How is Marijuana Abused?

Marijuana is usually smoked as a cigarette (joint) or in a pipe. It is also smoked in blunts, which are cigars that have been emptied of tobacco and refilled with a mixture of marijuana and tobacco. This mode of delivery combines marijuana's active ingredients with nicotine and other harmful chemicals. Marijuana can also be mixed in food or brewed as a tea. As a more concentrated, resinous form, it is called hashish; and as a sticky black liquid, hash oil. Marijuana smoke has a pungent and distinctive, usually sweet-and-sour odor.

How Does Marijuana Affect the Brain?

Scientists have learned a great deal about how THC acts in the brain to produce its many effects. When someone smokes marijuana, THC rapidly passes from the lungs into the bloodstream, which carries the chemical to the brain and other organs throughout the body.

THC acts upon specific sites in the brain, called cannabinoid receptors, kicking off a series of cellular reactions that ultimately lead to the "high" that users experience when they smoke marijuana. Some brain areas have many cannabinoid receptors; others have few or none. The highest density of cannabinoid receptors are found in parts of the brain that influence pleasure, memory, thinking, concentrating, sensory and time perception, and coordinated movement.

Not surprisingly, marijuana intoxication can cause distorted perceptions, impaired coordination, difficulty with thinking and problem solving, and problems with learning and memory. Research has shown that, in chronic users, marijuana's adverse impact on learning and memory can last for days or weeks after the acute effects of the drug wear off. As a result, someone who smokes marijuana every day may be functioning at a suboptimal intellectual level all of the time.

Research into the effects of long-term cannabis use on the structure of the brain has yielded inconsistent results. It may be that the effects are too subtle for reliable detection by current techniques. A similar challenge arises in studies of the effects of chronic marijuana use on brain function. Brain imaging studies in chronic users tend to show some consistent alterations, but their connection to impaired cognitive functioning is far from clear. This uncertainty may stem from confounding factors such as other drug use, residual drug effects, or withdrawal symptoms in long-term chronic users.

What Other Adverse Effect Does Marijuana Have on Health?

Effects on the Heart

Marijuana increases heart rate by 20-100 percent shortly after smoking; this effect can last up to 3 hours. In one study, it was estimated that marijuana users have a 4.8-fold increase in the risk of heart attack in the first hour after smoking the drug. This may be due to increased heart rate as well as the effects of marijuana on heart rhythms, causing palpitations and arrhythmias. This risk may be greater in aging populations or in those with cardiac vulnerabilities.

Effects on the Lungs

Numerous studies have shown marijuana smoke to contain carcinogens and to be an irritant to the lungs. In fact, marijuana smoke contains 50–70 percent more carcinogenic hydrocarbons than tobacco smoke. Marijuana users usually inhale more deeply and hold their breath longer than tobacco smokers do, which further increase the lungs' exposure to carcinogenic smoke. Marijuana smokers show dysregulated growth of epithelial cells in their lung tissue, which could lead to cancer; however, a recent case-controlled study found no positive associations between marijuana use and lung, upper respiratory, or upper digestive tract cancers. Thus, the link between marijuana smoking and these cancers remains unsubstantiated at this time.

Nonetheless, marijuana smokers can have many of the same respiratory problems as tobacco smokers, such as daily cough and phlegm production, more frequent acute chest illness, and a heightened risk of lung infections. A study of 450 individuals found that people who smoke marijuana frequently but do not smoke tobacco have more health problems and miss more days of work than nonsmokers. Many of the extra sick days among the marijuana smokers in the study were for respiratory illnesses.

How Widespread is Marijuana Abuse?

According to the National Survey on Drug Use and Health, in 2009, 16.7 million Americans aged 12 or older used marijuana at least once in the month prior to being surveyed, an increase over the rates reported in all years between 2002 and 2008. There was also a significant increase among youth aged 12–17, with current use up from 6.7 percent in 2008 to 7.3 percent in 2009, although this rate is lower than what was reported in 2002 (8.2 percent). Past-month use also increased among those 18–25, from 16.5 percent in 2008 to 18.1 percent in 2009.

Is Marijuana Medicine?

The potential medicinal properties of marijuana have been the subject of substantive research and heated debate. Scientists have confirmed that the cannabis plant contains active ingredients with therapeutic potential for relieving pain, controlling nausea, stimulating appetite, and decreasing ocular pressure. Cannabinoid-based medications include synthetic compounds, such as dronabinol (Marinol®) and nabilone (Cesamet®), which are FDA approved, and a new, chemically pure mixture of plant-derived THC and cannabidiol called Sativex®, formulated as a mouth spray and approved in Canada and parts of Europe for the relief of cancer-associated pain and spasticity and neuropathic pain in multiple sclerosis.

Scientists continue to investigate the medicinal properties of THC and other cannabinoids to better evaluate and harness their ability to help patients suffering from a broad range of conditions, while avoiding the adverse effects of smoked marijuana.

Sources

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How Widespread is Marijuana Abuse?: National Survey on Drug Use and Health (NSDUH)

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2.5.1.2: Alcohol

Alcohol Abuse

If you are like many Americans, you drink alcohol at least occasionally. For many people, moderate drinking is probably safe. It may even have health benefits, including reducing your risk of certain heart problems. Moderate drinking is one drink a day for women or anyone over 65, and two drinks a day for men under 65.

Some people should not drink at all, including alcoholics, children, pregnant women, people on certain medicines and people with some medical conditions.

Anything more than moderate drinking can be risky. Binge drinking—drinking five or more drinks at one time—can damage your health and increase your risk for accidents, injuries and assault. Years of heavy drinking can lead to liver disease, heart disease, cancer and pancreatitis. It can also cause problems at home, at work and with friends.

Exercise 2.5.1.2.1

1. How many drinks for males within a short period of time is considered binge drinking? How many drinks for females within a short period of time is considered binge drinking?
2. True or false: Binge drinking is a risk factor for sexual assault, especially among young women in college settings. Each year, about 1 in 20 college women are sexually assaulted. Binge drinking also increases the chances of car crashes, violence against others, unintended pregnancies, and the spread of HIV and sexually transmitted diseases.
3. What is the most commonly used and abused substance among youth in the United States, more than tobacco and illicit drugs?
4. True or false: Teens and young adults who do not get enough sleep are at risk for automobile crashes, poor grades and performance in school, depressed moods, and problems with peer and adult relationships.

Answer available at the end of this section.

Beyond Hangovers

A brightly colored cosmopolitan is the drink of choice for the glamorous characters in Sex and the City. James Bond depends on his famous martini—shaken, not stirred—to unwind with after confounding a villain. And what wedding concludes without a champagne toast?

Alcohol is part of our culture—it helps us celebrate and socialize, and it enhances our religious ceremonies. But drinking too much—on a single occasion or over time—can have serious consequences for our health. Most Americans recognize that drinking too much can lead to accidents and dependence. But that's only part of the story. In addition to these serious problems, alcohol abuse can damage organs, weaken the immune system, and contribute to cancers. Plus, much like smoking, alcohol affects different people differently. Genes, environment, and even diet can play a role in whether you develop an alcohol-related disease.

On the flip side, some people actually may benefit from drinking alcohol in small quantities. Sound complicated? It sure can be. To stay healthy, and to decide what role alcohol should play in your life, you need accurate, up-to-date information. This brochure is designed to offer you guidance based on the latest research on alcohol's effect on your health.

Moderate and Binge Drinking

Moderate or "low-risk" drinking

Research shows that people who drink moderately may be less likely to experience an alcohol use disorder (AUD). These drinking levels, which differ for men and women, are:

For men:

- No more than 4 drinks on any single day AND no more than 14 drinks per week

For women:

- No more than 3 drinks on any single day AND no more than 7 drinks per week

To stay low risk for AUDs, you must keep within both the single-day and weekly limits.

Even within these limits, you can have problems if you drink too quickly or have other health issues. To keep your risk for problems low, make sure you:

- Drink slowly
- Eat enough while drinking

Certain people should avoid alcohol completely, including those who:

- Plan to drive a vehicle or operate machinery
- Take medications that interact with alcohol
- Have a medical condition that alcohol can aggravate
- Are pregnant or trying to become pregnant

Heavy or “at-risk” drinking

For healthy adults in general, heavy drinking means consuming more than the single-day or the weekly amounts listed above. About 1 in 4 people who drink above these levels already has alcohol dependence or alcohol abuse problems.

Binge drinking

Binge drinking means drinking so much within about 2 hours that blood alcohol concentration (BAC) levels reach 0.08g/dL. For women, this usually occurs after about 4 drinks, and for men, after about 5.

Drinking this way can pose health and safety risks, including car crashes and injuries. Over the long term, binge drinking can damage the liver and other organs.

Learning Activity

Find out about alcohol content in drinks, calories in alcoholic drinks, and the cost of drinking. Use the Cocktail Content Calculator to find out how strong your mixed drink or cocktail is.

1. Do you know how many “standard drinks” are in an alcoholic beverage? Use the Drink Size Calculator to find out.
2. Find out how many calories are in your alcoholic beverage of choice using the Alcohol Calorie Calculator.
3. How much do you spend on alcohol. Use the Alcohol Spending Calculator to find out.

A Little Goes a Long Way: Know the Amounts

Knowing how much alcohol constitutes a “standard” drink can help you determine how much you are drinking and understand the risks. One standard drink contains about 0.6 fluid ounces or 14 grams of pure alcohol. In more familiar terms, the following amounts constitute one standard drink:

- 12 fluid ounces of beer (about 5% alcohol)
- 8 to 9 fluid ounces of malt liquor (about 7% alcohol)
- 5 fluid ounces of table wine (about 12% alcohol)
- 1.5 fluid ounces of hard liquor (about 40% alcohol)

You're chatting with friends at a party and a waitress comes around with glasses of champagne. You drink one, then another, maybe even a few more. Before you realize it, you are laughing more loudly than usual and swaying as you walk. By the end of the evening, you are too slow to move out of the way of a waiter with a dessert tray and have trouble speaking clearly. The next morning, you wake up feeling dizzy and your head hurts. You may have a hard time remembering everything you did the night before.

These reactions illustrate how quickly and dramatically alcohol affects the brain. The brain is an intricate maze of connections that keeps our physical and psychological processes running smoothly. Disruption of any of these connections can affect how the brain works. Alcohol also can have longer-lasting consequences for the brain—changing the way it looks and works and resulting in a range of problems.

Most people do not realize how extensively alcohol can affect the brain. But recognizing these potential consequences will help you make better decisions about what amount of alcohol is appropriate for you.

What happens inside the brain?

The brain's structure is complex. It includes multiple systems that interact to support all of your body's functions—from thinking to breathing to moving.

These multiple brain systems communicate with each other through about a trillion tiny nerve cells called neurons. Neurons in the brain translate information into electrical and chemical signals the brain can understand. They also send messages from the brain to the rest of the body.

Chemicals called *neurotransmitters* carry messages between the neurons. Neurotransmitters can be very powerful. Depending on the type and the amount of neurotransmitter, these chemicals can either intensify or minimize your body's responses, your feelings, and your mood. The brain works to balance the neurotransmitters that speed things up with the ones that slow things down to keep your body operating at the right pace.

Alcohol can slow the pace of communication between neurotransmitters in the brain.

Fetal Alcohol Syndrome

Alcohol can affect the brain at any stage of development—even before birth. Fetal alcohol spectrum disorders are the full range of physical, learning, and behavioral problems, and other birth defects that result from prenatal alcohol exposure. The most serious of these disorders, *fetal alcohol syndrome* (FAS), is characterized by abnormal facial features and is usually associated with severe reductions in brain function and overall growth. FAS is the leading preventable birth defect associated with mental and behavioral impairment in the United States today.

The brains of children with FAS are smaller than normal and contain fewer cells, including neurons. These deficiencies result in life-long learning and behavioral problems. Current research is investigating whether the brain function of children and adults with FAS can be improved with complex rehabilitative training, dietary supplements, or medications.

Alcohol and Heart Disease

Americans know how prevalent heart disease is—about 1 in 12 of us suffer from it. What we don't always recognize are the connections heart disease shares with alcohol. On the one hand, researchers have known for centuries that excessive alcohol consumption can damage the heart. Drinking a lot over a long period of time or drinking too much on a single occasion can put your heart—and your life—at risk. On the other hand, researchers now understand that drinking moderate amounts of alcohol can protect the hearts of some people from the risks of coronary artery disease.

Deciding how much, if any, alcohol is right for you can be complicated. To make the best decision for yourself, you need to know the facts and then consult your physician.

Cancer Risk

Genetics, environment, and lifestyle habits can all heighten your risk of getting cancer. We can't do anything to change our genes, and we often can't do much to change our environment. But lifestyle habits are a different story.

Drinking too much alcohol is one lifestyle habit that can increase your risk of developing certain cancers. This does not mean that anyone who drinks too much will develop cancer. But numerous studies do show the more you drink, the more you increase your chances of developing certain types of cancer.

For example, a group of Italy-based scientists reviewed more than 200 studies examining alcohol's impact on cancer risk. The collective results of these studies clearly demonstrate that the more you drink, the higher your risk for developing a variety of cancers. The National Cancer Institute identifies alcohol as a risk factor for the following types of cancer:

- Mouth
- Esophagus
- Pharynx
- Larynx
- Liver
- Breast

At least 7 out of 10 people with mouth cancer drink heavily. Drinking five or more drinks per day can also increase your risk of developing other types of cancers, including colon or rectal cancer. In fact, summary estimates from the recent World Cancer Research Fund report indicate that women who drink five standard alcohol drinks each day have about 1.2 times the risk of developing colon or rectal cancer than women who do not drink at all.

People who drink are also more likely to smoke, and the combination increases the risk significantly. Smoking alone is a known risk factor for some cancers. But smoking and drinking together intensifies the cancer-causing properties of each substance. The overall effect poses an even greater risk.

The risk of throat and mouth cancers is especially high because alcohol and tobacco both come in direct contact with those areas. Overall, people who drink and smoke are 15 times more likely to develop cancers of the mouth and throat than nondrinkers and nonsmokers. In addition, recent studies estimate that alcohol and tobacco together are responsible for:

- 80 percent of *throat and mouth cancer* in men
- 65 percent of throat and mouth cancer in women
- 80 percent of *esophageal squamous cell carcinoma*, a type of esophagus cancer
- 25 to 30 percent of all liver cancers

Know the Benefits

Research shows that healthy people who drink moderate amounts of alcohol may have a lower risk of developing coronary heart disease than nondrinkers. Moderate drinking is usually defined as no more than two drinks in a given day for men and one drink per day for women who are not pregnant or trying to conceive.

A variety of factors, including diet, genetics, high blood pressure, and age, can cause fat to build up in your arteries, resulting in coronary heart disease. An excess of fat narrows the coronary arteries, which are the blood vessels that supply blood directly to the heart. Clogged arteries reduce blood supply to the heart muscle, and make it easier for blood clots to form. Blood clots can lead to both heart attacks and strokes.

According to recent studies, drinking moderately can protect your heart from these conditions. Moderate drinking helps inhibit and reduce the build-up of fat in the arteries. It can raise the levels of HDL—or "good" cholesterol—in the blood, which wards off heart disease. It can help guard against heart attack and stroke by preventing blood clots from forming and by dissolving blood clots that do develop. Drinking moderately also may help keep blood pressure levels in check.

These benefits may not apply to people with existing medical conditions, or who regularly take certain medications. In addition, researchers discourage people from beginning to drink just for the health benefits. Rather, you can use this research to help you spark a conversation with your medical professional about the best path for you.

Learning Activity

Find out what it takes to cut down or quit drinking alcohol at Rethinking Drinking, Alcohol and Your Health.

- What are your reasons for and against making a change?
- What are small changes that can make a big difference?

See where you stand:

- Check your drinking pattern.
- See if you have signs of a problem.
- Track what you drink with drinking tracker cards.

Decide whether & how to change:

- Weigh your reasons for and against making a change
- Plan a change.
- Choose tips for cutting back or quitting.

Stay in control:

- Handle urges to drink.
- Build skills in refusing drinks.

Sources

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Beyond Hangovers: Beyond Hangovers, NIAAA, NIH, pubs.niaaa.nih.gov/publications/Hangovers/beyondHangovers.htm

Moderate and Binge Drinking: Moderate & Binge Drinking, National Institute on Alcohol Abuse and Alcoholism, NIAAA, NIH

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Answers

Exercise 2.5.1.2.1

1. males—5 or more within a short period of time, females—4 or more within a short period of time;
2. true
3. Alcohol
4. true

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2.5.1.3: Tobacco

The 30th tobacco-related Surgeon General's report issued since 1964 describes in detail the specific pathways by which tobacco smoke damages the human body. The scientific evidence supports the following conclusions:

There is no safe level of exposure to tobacco smoke.

- Any exposure to tobacco smoke—even an occasional cigarette or exposure to secondhand smoke—is harmful.
- You don't have to be a heavy smoker or a long-time smoker to get a smoking-related disease or have a heart attack or asthma attack that is triggered by tobacco smoke.
- Low levels of smoke exposure, including exposures to secondhand tobacco smoke, lead to a rapid and sharp increase in dysfunction and inflammation of the lining of the blood vessels, which are implicated in heart attacks and stroke.
- Cigarette smoke contains more than 7,000 chemicals and compounds. Hundreds are toxic and at least 69 cause cancer. Tobacco smoke itself is a known human carcinogen.
- Chemicals in tobacco smoke interfere with the functioning of fallopian tubes, increasing risk for adverse pregnancy outcomes such as ectopic pregnancy, miscarriage, and low birth weight. They also damage the DNA in sperm which might reduce fertility and harm fetal development.

Damage from tobacco smoke is immediate.

- The chemicals in tobacco smoke reach your lungs quickly every time you inhale. Your blood then carries the toxicants to every organ in your body.
- The chemicals and toxicants in tobacco smoke damage DNA, which can lead to cancer. Nearly one-third of all cancer deaths every year are directly linked to smoking. Smoking causes about 85% of lung cancers in the U.S.
- Exposure to tobacco smoke quickly damages blood vessels throughout the body and makes blood more likely to clot. This damage can cause heart attacks, strokes, and even sudden death.
- The chemicals in tobacco smoke inflame the delicate lining of the lungs and can cause permanent damage that reduces the ability of the lungs to exchange air efficiently and leads to chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis.

Smoking longer means more damage.

- Both the risk and the severity of many diseases caused by smoking are directly related to how long the smoker has smoked and the number of cigarettes smoked per day.
- Chemicals in tobacco smoke cause inflammation and cell damage, and can weaken the immune system. The body makes white blood cells to respond to injuries, infections, and cancers. White blood cell counts stay high while smoking continues, meaning the body is constantly fighting against the damage caused by smoking which can lead to disease in almost any part of the body.
- Smoking can cause cancer and weaken your body's ability to fight cancer. With any cancer—even those not related to tobacco use—smoking can decrease the benefits of chemotherapy and other cancer treatments. Exposure to tobacco smoke can help tumors grow.
- The chemicals in tobacco smoke complicate the regulation of blood sugar levels, exacerbating the health issues resulting from diabetes. Smokers with diabetes have a higher risk of heart and kidney disease, amputation, eye disease causing blindness, nerve damage and poor circulation.

Cigarettes are designed for addiction.

- The design and contents of tobacco products make them more attractive and addictive than ever before. Cigarettes today deliver nicotine more quickly from the lungs to the heart and brain.
- The powerful addicting elements of tobacco products affect multiple types of nicotine receptors in the brain.
- Evidence suggests that psychosocial, biologic, and genetic factors may also play a role in nicotine addiction.

There is no safe cigarette.

- The evidence indicates that changing cigarette designs over the last five decades, including filtered, low-tar, and "light" variations, have NOT reduced overall disease risk among smokers and may have hindered prevention and cessation efforts.

- The overall health of the public could be harmed if the introduction of novel tobacco products encourages tobacco use among people who would otherwise be unlikely to use a tobacco product or delays cessation among persons who would otherwise quit using tobacco altogether.

The only proven strategy for reducing the risk of tobacco-related disease and death is to never smoke, and if you do smoke to quit.

- Quitting at any age and at any time is beneficial. It's never too late to quit, but the sooner the better.
- Quitting gives your body a chance to heal the damage caused by smoking.
- When smokers quit, the risk for a heart attack drops sharply after just 1 year; stroke risk can fall to about the same as a nonsmoker's after 2–5 years; risks for cancer of the mouth, throat, esophagus, and bladder are cut in half after 5 years; and the risk for dying of lung cancer drops by half after 10 years.
- Smokers often make several attempts before they are able to quit, but new strategies for cessation, including nicotine replacement and non-nicotine medications, can make it easier.

The evidence indicates that changing cigarette designs over the last five decades, including filtered, low-tar, and "light" variations, have NOT reduced overall disease risk among smokers and may have hindered prevention and cessation efforts.

The overall health of the public could be harmed if the introduction of novel tobacco products encourages tobacco use among people who would otherwise be unlikely to use a tobacco product or delays cessation among persons who would otherwise quit using tobacco altogether.

Learning Activity

Follow two people as they attempt to lead healthier lives, and learn how the choices you make depend on what choices are available.

- If you were told you had to quit smoking and lose 20 pounds, how easy would it be for you?

Quitting

The only proven strategy for reducing the risk of tobacco-related disease and death is to never smoke, and if you do smoke to quit.

Quitting at any age and at any time is beneficial. It's never too late to quit, but the sooner the better. Quitting gives your body a chance to heal the damage caused by smoking. When smokers quit, the risk for a heart attack drops sharply after just 1 year; stroke risk can fall to about the same as a nonsmoker's after 2-5 years; risks for cancer of the mouth, throat, esophagus, and bladder are cut in half after 5 years; and the risk for dying of lung cancer drops by half after 10 years. Smokers often make several attempts before they are able to quit, but new strategies for cessation, including nicotine replacement and non-nicotine medications, can make it easier.

Tobacco smoke is a toxic mix of more than 7,000 chemicals. Many are poisons. When these chemicals get deep into your body's tissues, they cause damage. Your body must fight to heal the damage each time you smoke. Over time, the damage can lead to disease.

The chemicals in tobacco smoke reach your lungs quickly when you inhale. What this new report shows is that *these same poisonous chemicals reach every organ in your body*. They go quickly from your lungs into your blood. Then the blood flows through your arteries. It carries the chemicals to tissues in all parts of your body. Your lungs, blood vessels, and other delicate tissues become inflamed and damaged when you smoke.

Smoking Keeps Your Body under Attack

If you spilled drain cleaner on your skin, it would hurt and become inflamed. If you did this many times a day, your skin would not have a chance to heal. It would stay red, irritated, and inflamed. The organs in your body also have a lining of cells similar to skin. Chemicals in tobacco smoke cause inflammation and damage to these cells. When you keep smoking, the damage cannot heal.

Smoking makes your immune system work overtime. Your body makes white blood cells to respond to injuries, infections, and even cancers. Blood tests show that your white blood cell numbers stay high when you smoke. High numbers mean that your body is constantly fighting against the damage caused by tobacco smoke. This constant stress disrupts how your body works. New research shows that stress can lead to disease in almost any part of your body.

Damage is Immediate

The poisons in smoke pose a danger right away. Sudden blood clots, heart attacks, and strokes can be triggered by tobacco smoke. Poisons in tobacco smoke disrupt the way your body heals itself. Even smoking a cigarette now and then is enough to hurt you. Sitting in a smoky bar raises your odds of a heart attack.

The more years you smoke, the more you hurt your body. Scientists now know that your disease risk surges even higher after you have smoked for about 20 years. But research shows that if you quit by age 30, your health could become almost as good as a nonsmoker's. At any age, the sooner you quit, the sooner your body can begin to heal.

Nicotine is Powerfully Addictive

Addiction to nicotine changes the chemical balance in your brain. Addiction keeps people smoking even when they want to quit. Breaking addiction is harder for some people than others. Many people need more than one try in order to quit.

Scientists now know more about why the brain craves nicotine. Like heroin or cocaine, nicotine changes the way your brain works and causes you to crave more and more nicotine. These powerful cravings make it hard for you to think about anything else. Smoking can cause both physical and mental addiction.

Cigarettes are Designed for Addiction

Cigarette makers have long known that nicotine addiction helps sell their products. Cigarettes today deliver more nicotine and deliver it quicker than ever before. The additives and chemicals that tobacco companies put in cigarettes may have helped make them.

You might have thought that "filtered," "low-tar," or "light" cigarettes were less dangerous than others. But research shows that these cigarettes are every bit as addictive and are no safer than other cigarettes. Misleading labels are no longer allowed.

Many teens who try cigarettes don't know how easy it is to become addicted. Nicotine addiction is so powerful that every day about 1,000 teens become daily smokers. Why is this important? Because most current smokers became addicted as teenagers.

You Can Beat Addiction to Tobacco

Smokers who quit go through withdrawal. The first days are the most uncomfortable. The physical symptoms of nicotine addiction end about 3 weeks after you quit smoking. But you may still have an urge to smoke when you wake up, drink coffee, or are out with friends. It takes longer to break these patterns. But you can beat it.

Learning Activity

Youth are being targeted by the big tobacco industry through Hollywood movies. This video was created by the Sudbury & District Health Unit's Youth Program Advisors to raise public awareness of this issue.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

- What movies and TV shows do you think glorify smoking?

Myths about Smoking and Cigarettes

Smoking is just a choice.

The first time? Yes. After just a few cigarettes? No. Addiction to nicotine can happen quickly. It changes the chemical balance in your brain. Smoking may seem like it's just a choice or a habit. In fact, most people who use tobacco are addicted. Breaking nicotine addiction is harder for some people than others. Quitting can take several tries. But don't give up. If you need help to quit, ask your doctor about nicotine replacement, medicines, or coaching.

Filters make cigarettes safer.

Filters do not protect you. They are designed to make smoke particles smaller. That makes nicotine easier to absorb. This increases addiction. Cigarettes have been engineered to speed up nicotine's path to your brain. Their design feeds addiction. Light or low-tar cigarettes may sound less dangerous. They aren't. These misleading labels are no longer allowed. No cigarette is safe. Tobacco smoke contains more than 7,000 chemicals. At least 250 are toxic.

An occasional cigarette is no big deal.

Smoking doesn't just cause diseases for heavy smokers or longtime smokers. The 2010 Surgeon General's Report shows how breathing tobacco smoke can cause immediate harm. Tobacco smoke can trigger sudden heart attacks and death, even in nonsmokers. Each cigarette you smoke hurts your lungs, your blood vessels, and cells throughout your body. Smoking a few cigarettes a week can cause a heart attack. Cutting back is not enough to protect you. You have to quit entirely.

It's too late to quit—the damage is already done.

It's true that the longer you use tobacco, the more you hurt your body. But at any age, the sooner you quit, the sooner your health can improve. The 2010 Surgeon General's Report shows how using tobacco causes disease almost everywhere in your body. Within 20 minutes after quitting, your body starts to heal. After 2 to 5 years, your risk for stroke is similar to that of a nonsmoker. In 10 years, your lung cancer risk is cut in half.

Secondhand smoke may bother people, but it isn't dangerous.

Tens of thousands of nonsmokers die every year from breathing others' secondhand smoke. Breathing the chemicals in tobacco smoke changes your blood's chemistry almost immediately. Deadly clots can form and block arteries to your heart or brain. When you smoke at work, home, or at a restaurant, everyone there breathes poisons. If you smoke in your car, rolling down a window does not protect your passengers. It is not healthy to breathe any amount of tobacco smoke.

The little bit of smoke that my kids get doesn't hurt them.

Don't smoke or let others smoke around your children. They can get bronchitis, pneumonia, and ear infections from smoke. Even if you only smoke by an open window, some of the smoke stays in your house and poisons the air your children breathe. Children with asthma can have a serious, even deadly, asthma attack from breathing secondhand smoke. The best way to protect children is to quit smoking. If you or someone else in your household are not ready to quit, be sure to make your home and car 100% smoke-free.

Sources

Source: A Report of the Surgeon General: How Tobacco Smoke Causes Disease, The Biology and Behavioral Basis for Smoking-Attributable Disease Fact Sheet 2010, http://www.surgeongeneral.gov/library/tobaccosmoke/factsheet.htmlMore Information

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2.5.1.4: Misuse of Prescription Drugs

Prescription Drugs

Most people take medicines only for the reasons their doctors prescribe them. But an estimated 20 percent of people in the United States have used prescription drugs for nonmedical reasons. This is prescription drug abuse. It is a serious and growing problem.

Abusing some prescription drugs can lead to addiction. You can develop an addiction to:

- Narcotic painkillers
- Sedatives and tranquilizers
- Stimulants

Experts don't know exactly why this type of drug abuse is increasing. The availability of drugs is probably one reason. Doctors are prescribing more drugs for more health problems than ever before. Online pharmacies make it easy to get prescription drugs without a prescription, even for youngsters.

Learning Activity

Pillbox was developed to aid in the identification of unknown solid dosage pharmaceuticals. The system combines high-resolution images of tablets and capsules with appearance information (imprint, shape, color, etc.) to enable users to visually search for and identify an unknown solid dosage pharmaceutical.

This system is designed for use by emergency physicians, first responders, other health care providers, Poison Control Center staff, and concerned citizens.

The system enables users to identify solid dosage forms based on physical criteria: imprint (characters or number printed on a medication), shape, color, size, and scoring. Users are shown thumbnail images of possible matches. These images are continually updated as the user enters additional information.

- Visit the Pillbox to check the pills in your family medicine cabinet.
- Find any surprises?

Learning Activity 4.2: Clean out your medicine cabinet.

You may want to consider getting rid of expired medications. For tips, read Spring Cleaning: A Dose of Your Own Medicine

Commonly Abused Prescription Drugs

Medications can be effective when they are used properly, but some can be addictive and dangerous when abused. Some prescribed medications that—when used in ways or by people other than prescribed—have the potential for adverse medical consequences, including addiction.

In 2010, approximately 16 million Americans reported using a prescription drug for nonmedical reasons in the past year; 7 million in the past month.

After marijuana, prescription and over-the-counter medications account for most of the commonly abused drugs.

What types of prescription drugs are abused?

Three types of drugs are abused most often:

- Opioids—prescribed for pain relief
- CNS depressants—barbiturates and benzodiazepines prescribed for anxiety or sleep problems (often referred to as sedatives or tranquilizers)
- Stimulants—prescribed for attention-deficit hyperactivity disorder (ADHD), the sleep disorder narcolepsy, or obesity.

How can you help prevent prescription drug abuse?

- Ask your doctor or pharmacist about your medication, especially if you are unsure about its effects.
- Keep your doctor informed about all medications you are taking, including over-the-counter medications.
- Read the information your pharmacist provides before starting to take medications.
- Take your medication(s) as prescribed.
- Keep all prescription medications secured at all times and properly dispose of any unused medications.

Prescription Drug Advertising

Your healthcare provider is the best source of information about the right medicines for you.

The Food and Drug Administration (FDA) protects public health by assuring the safety, effectiveness, and security of a wide range of products, including human prescription drugs. We also advance public health by helping people get the accurate, science-based information they need to use medicines appropriately and improve their health. Prescription drug advertisements can provide useful information for consumers to work with their health care providers to make wise decisions about treatment.

FDA Authority Over Advertising

The FDA serves the public health and welfare in many ways. One way is overseeing the approval and marketing of prescription drugs. It's authority is based on a number of federal laws, including the Federal Food, Drug, and Cosmetic Act. Among other areas, this law specifically addresses prescription drug advertising. This law requires that advertisements for prescription drugs be accurate and not misleading.

Direct-to-consumer (DTC) advertising is a relatively new area of prescription drug promotion. No federal law has ever banned DTC advertising. Until the mid-1980s, drug companies gave information about prescription drugs only to doctors and pharmacists. When these professionals thought it appropriate, they gave that information to their patients. However, during the 1980s, some drug companies started to give the general public more direct access to this information through DTC ads.

The law requires that product claim ads give a "fair balance" of information about drug risks as compared with information about drug benefits. This means that the content and presentation of a drug's most important risks must be reasonably similar to the content and presentation of its benefits.

This does not mean that equal space must be given to risks and benefits in print ads, or equal time to risks and benefits in broadcast ads. The amount of time or space needed to present risk information will depend on the drug's risks and the way that both the benefits and risks are presented.

Think about the following questions when you see an ad for a prescription drug. Also, think about asking these questions when you talk to your doctor or pharmacist about a drug.

- What condition does this drug treat?
- Why do I think that I might have this condition?
- If I have the condition, am I part of the population the drug is approved to treat?
- Should I take this drug if I have a certain condition?
- Should I take this drug if I am taking certain other drugs?
- Which of the drug's possible side effects am I concerned about?
- How will this drug affect other drugs I am taking?
- Will foods, beverages (alcoholic or non-alcoholic), vitamins, or other supplements affect how this drug works?

- Are there other drugs that treat my condition?
- Is there a less costly drug I could use to treat my condition?
- What else can I do to help deal with my condition? For example, should I exercise or change my diet?
- Do other drugs for my condition have different side effects?
- How can I learn more about this condition and this drug?

Harmful Interactions: Mixing Alcohol with Medicines

You've probably seen this warning on medicines you've taken. The danger is real. Mixing alcohol with certain medications can cause nausea and vomiting, headaches, drowsiness, fainting, or loss of coordination.

It also can put you at risk for internal bleeding, heart problems, and difficulties in breathing. In addition to these dangers, alcohol can make a medication less effective or even useless, or it may make the medication harmful or toxic to your body.

Some medicines that you might never have suspected can react with alcohol, including many medications which can be purchased "over-the-counter"—that is, without a prescription. Even some herbal remedies can have harmful effects when combined with alcohol.

See the NIH publication Harmful Interactions: Mixing Alcohol with Medicines for a list of medications that can cause harm when taken with alcohol and description of the effects that can result. The list gives the brand name by which each medicine is commonly known (for example, Benadryl®) and its generic name or active ingredient (in Benadryl®, this is diphenhydramine). **The list presented here does not include all the medicines that may interact harmfully with alcohol. Most important, the list does not include all the ingredients in every medication.**

Medications are safe and effective when used appropriately. Your pharmacist or other health care provider can help you determine which medications interact harmfully with alcohol.

Did You Know . . .

Mixing alcohol and medicines can be harmful. Alcohol, like some medicines, can make you sleepy, drowsy, or lightheaded. Drinking alcohol while taking medicines can intensify these effects. You may have trouble concentrating or performing mechanical skills. Small amounts of alcohol can make it dangerous to drive, and when you mix alcohol with certain medicines you put yourself at even greater risk. Combining alcohol with some medicines can lead to falls and serious injuries, especially among older people.

Medicines may have many ingredients

Some medications—including many popular painkillers and cough, cold, and allergy remedies—contain more than one ingredient that can react with alcohol. Read the label on the medication bottle to find out exactly what ingredients a medicine contains. Ask your pharmacist if you have any questions about how alcohol might interact with a drug you are taking.

Some medicines contain alcohol

Certain medicines contain up to 10 percent alcohol. Cough syrup and laxatives may have some of the highest alcohol concentrations.

Alcohol affects women differently

Women, in general, have a higher risk for problems than men. When a woman drinks, the alcohol in her bloodstream typically reaches a higher level than a man's even if both are drinking the same amount. This is because women's bodies generally have less water than men's bodies. Because alcohol mixes with body water, a given amount of alcohol is more concentrated in a woman's body than in a man's. As a result, women are more susceptible to alcohol-related damage to organs such as the liver.

Older people face greater risk

Older people are at particularly high risk for harmful alcohol– medication interactions. Aging slows the body's ability to break

down alcohol, so alcohol remains in a person's system longer. Older people also are more likely to take a medication that interacts with alcohol—in fact, they often need to take more than one of these medications.

Timing is important

Alcohol and medicines can interact harmfully even if they are not taken at the same time.

Remember

Mixing alcohol and medicines puts you at risk for dangerous reactions. Protect yourself by avoiding alcohol if you are taking a medication and don't know its effect. To learn more about a medicine and whether it will interact with alcohol, talk to your pharmacist or other health care provider.

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2.5.1.5: Drugs, Abuse, and Addiction

Many people do not understand why or how other people become addicted to drugs. It can be wrongfully assumed that drug abusers lack moral principles or willpower and that they could stop using drugs simply by choosing to change their behavior. In reality, drug addiction is a complex disease, and quitting takes more than good intentions. In fact, because drugs change the brain in ways that foster compulsive drug abuse, quitting is difficult, even for those who are ready to do so. Through scientific advances, we know more about how drugs work in the brain than ever, and we also know that drug addiction can be successfully treated to help people stop abusing drugs and lead productive lives.

Drug abuse and addiction have negative consequences for individuals and for society. Estimates of the total overall costs of substance abuse in the United States, including productivity and health- and crime-related costs, exceed $600 billion annually. This includes approximately $181 billion for illicit drugs, $193 billion for tobacco, and $235 billion for alcohol. As staggering as these numbers are, they do not fully describe the breadth of destructive public health and safety implications of drug abuse and addiction, such as family disintegration, loss of employment, failure in school, domestic violence, and child abuse.

Optional Learning Activity

Read this short article titled: Breaking Bad Habits, Why It's So Hard to Change from *NIH News in Health.*

Wise Choices

- **Avoid tempting situations.** If you always stop for a donut on your way to work, try a different route. Keep fatty foods, cigarettes, alcohol and other tempting items out of your home.
- **Replace unhealthy behaviors with healthy ones.** Try exercise, a favorite hobby or spending time with family.
- **Prepare mentally.** If you can't avoid a tempting situation, prepare yourself in advance. Think about how you want to handle it and mentally practice what you plan.
- **Enlist support.** Ask friends, family and co-workers to support your efforts to change.
- **Reward yourself for small steps.** Give yourself a healthy treat when you've achieved a small goal or milestone.

Have you ever tried any of these strategies to break a bad habit?

What Is Drug Addiction?

Addiction is a chronic, often relapsing brain disease that causes compulsive drug seeking and use, despite harmful consequences to the addicted individual and to those around him or her. Although the initial decision to take drugs is voluntary for most people, the brain changes that occur over time challenge a person's self control and ability to resist intense impulses urging them to take drugs.

Fortunately, treatments are available to help people counter addiction's powerful disruptive effects. Research shows that combining addiction treatment medications with behavioral therapy is the best way to ensure success for most patients. Treatment approaches that are tailored to each patient's drug abuse patterns and any co-occurring medical, psychiatric, and social problems can lead to sustained recovery and a life without drug abuse.

Similar to other chronic, relapsing diseases, such as diabetes, asthma, or heart disease, drug addiction can be managed successfully. And as with other chronic diseases, it is not uncommon for a person to relapse and begin abusing drugs again. Relapse, however, does not signal treatment failure—rather, it indicates that treatment should be reinstated, adjusted, or that an alternative treatment is needed to help the individual regain control and recover.

What Happens to Your Brain When You Take Drugs?

Drugs contain chemicals that tap into the brain's communication system and disrupt the way nerve cells normally send, receive, and process information. There are two primary ways that drugs cause this disruption:

1. by imitating the brain's natural chemical messengers
2. by overstimulating the "reward circuit" of the brain

Some drugs (e.g., marijuana and heroin) have a similar structure to chemical messengers called neurotransmitters, which are naturally produced by the brain. This similarity allows the drugs to "fool" the brain's receptors and activate nerve cells to send abnormal messages.

Other drugs, such as cocaine or methamphetamine, can cause the nerve cells to release abnormally large amounts of natural neurotransmitters (mainly dopamine) or to prevent the normal recycling of these brain chemicals, which is needed to shut off the signaling between neurons. The result is a brain awash in dopamine, a neurotransmitter present in brain regions that control movement, emotion, motivation, and feelings of pleasure. The overstimulation of this reward system, which normally responds to natural behaviors linked to survival (eating, spending time with loved ones, etc.), produces euphoric effects in response to psychoactive drugs. This reaction sets in motion a reinforcing pattern that "teaches" people to repeat the rewarding behavior of abusing drugs.

As a person continues to abuse drugs, the brain adapts to the overwhelming surges in dopamine by producing less dopamine or by reducing the number of dopamine receptors in the reward circuit. The result is a lessening of dopamine's impact on the reward circuit, which reduces the abuser's ability to enjoy the drugs, as well as the events in life that previously brought pleasure. This decrease compels the addicted person to keep abusing drugs in an attempt to bring the dopamine function back to normal, except now larger amounts of the drug are required to achieve the same dopamine high—an effect known as tolerance.

Long-term abuse causes changes in other brain chemical systems and circuits as well. Glutamate is a neurotransmitter that influences the reward circuit and the ability to learn. When the optimal concentration of glutamate is altered by drug abuse, the brain attempts to compensate, which can impair cognitive function. Brain imaging studies of drug-addicted individuals show changes in areas of the brain that are critical to judgment, decision-making, learning and memory, and behavior control. Together, these changes can drive an abuser to seek out and take drugs compulsively despite adverse, even devastating consequences—that is the nature of addiction.

Why Do Some People Become Addicted While Others Do Not?

No single factor can predict whether a person will become addicted to drugs. Risk for addiction is influenced by a combination of factors that include individual biology, social environment, and age or stage of development. The more risk factors an individual has, the greater the chance that taking drugs can lead to addiction. Consider the following risk factors:

- **Biology.** The genes that people are born with––in combination with environmental influences––account for about half of their addiction vulnerability. Additionally, gender, ethnicity, and the presence of other mental disorders may influence risk for drug abuse and addiction.
- **Environment.** A person's environment includes many different influences, from family and friends to socioeconomic status and quality of life in general. Factors such as peer pressure, physical and sexual abuse, stress, and quality of parenting can greatly influence the occurrence of drug abuse and the escalation to addiction in a person's life.
- **Development.** Genetic and environmental factors interact with critical developmental stages in a person's life to affect addiction vulnerability. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it will progress to more serious abuse, which poses a special challenge to adolescents. Because their brains are still developing in the areas that govern decision-making, judgment, and self-control, adolescents may be especially prone to risk-taking behaviors, including trying drugs of abuse.

Prevention Is the Key

Drug addiction is a preventable disease. Results from NIDA-funded research have shown that prevention programs involving families, schools, communities, and the media are effective in reducing drug abuse. Although many events and cultural factors affect drug abuse trends, when youths perceive drug abuse as harmful, they reduce their drug taking. Thus, education and outreach are key in helping youth and the general public understand the risks of drug abuse. Teachers, parents, and medical and public health professionals must keep sending the message that drug addiction can be prevented if one never abuses drugs.

Learning Activity

Watch this video titled Anyone Can Become Addicted to Drugs:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

What Is Addiction?

More than three decades of research supported by the National Institute on Drug Abuse (NIDA) has proven that addiction is a complex brain disease characterized by compulsive, at times uncontrollable, drug craving, seeking, and use that persist despite potentially devastating consequences. Addiction is also a developmental disease; that is, it usually starts in adolescence or even childhood and can last a lifetime if untreated.

Disagreements about the nature of addiction remain: namely, whether it reflects voluntary or involuntary behavior and whether it should be punished or treated as a health issue. Even though the first time a person takes a drug, it is often by choice—to achieve a pleasurable sensation or desired emotional state—we now know from a large body of research that this ability to choose can be affected by drugs. And when addiction takes hold in the brain, it disrupts a person's ability to exert control over behavior—reflecting the compulsive nature of this disease.

The human brain is an extraordinarily complex and fine-tuned communications network made up of billions of cells that govern our thoughts, emotions, perceptions, and drives. Our brains reward certain behaviors such as eating or procreating—registering these as pleasurable activities that we want to repeat. Drug addiction taps into these vital mechanisms geared for our survival. And although not a life necessity, to an addicted person, drugs become life itself, driving the compulsive use of drugs—even in the face of dire life consequences—*that is the essence of addiction*.

How Does Addiction Take Hold in the Brain?

The rewarding effects of drugs of abuse come from large and rapid upsurges in dopamine, a neurochemical critical to stimulating feelings of pleasure and to motivating behavior. The rapid dopamine "rush" from drugs of abuse mimics but greatly exceeds in intensity and duration the feelings that occur in response to such pleasurable stimuli as the sight or smell of food, for example. Repeated exposure to large, drug-induced dopamine surges has the insidious consequence of ultimately blunting the response of the dopamine system to everyday stimuli. Thus the drug disturbs a person's normal hierarchy of needs and desires and substitutes new priorities concerned with procuring and using the drug.

Drug abuse also disrupts the brain circuits involved in memory and control over behavior. Memories of the drug experience can trigger craving as can exposure to people, places, or things associated with former drug use. Stress is also a powerful trigger for craving. Control over behavior is compromised because the affected frontal brain regions are what a person needs to exert inhibitory control over desires and emotions.

That is why addiction is a brain disease. As a person's reward circuitry becomes increasingly dulled and desensitized by drugs, nothing else can compete with them—food, family, and friends lose their relative value, while the ability to curb the need to seek and use drugs evaporates. Ironically and cruelly, eventually even the drug loses its ability to reward, but the compromised brain leads addicted people to pursue it, anyway; the memory of the drug has become more powerful than the drug itself.

When does drug abuse become drug addiction? It rarely happens with the first use of a drug. Drug abuse and drug addiction can be thought of as points along a continuum. Any use of a mind-altering drug or the inappropriate use of medication (either prescription or over-the-counter drugs) is **drug abuse**, but the point when drug abuse becomes drug addiction is less clear. Different people may reach the point of addiction at different stages. Scientists continue to investigate the factors that contribute to the transition to drug addiction.

Drug addiction is defined as the continued compulsive use of drugs despite adverse health or social consequences. Drug-addicted people have lost control of their drug use. Individuals who are addicted to drugs often become isolated from family or friends, have difficulty at work or school, may commit crimes, and become involved with the criminal justice system. For a person addicted to drugs, continuing to take them becomes the primary focus in life.

Certain drugs, including opioids and alcohol, cause strong physical reactions in the body when drug use stops. When a person addicted to heroin stops taking heroin, he or she can experience a variety of symptoms ranging from watery eyes and a runny nose to irritability and loss of appetite and then diarrhea, shivering, sweating, abdominal cramps, increased sensitivity to pain, and sleep problems. In general, withdrawal from heroin makes people feel miserable. Withdrawal from alcohol can cause serious effects such as seizures and even death. Withdrawal from other drugs, such as cocaine and amphetamines, does not lead to strong physical reactions, but it may make the person feel depressed or lethargic. For most drugs, physical withdrawal symptoms can usually be controlled effectively with medications. Even though withdrawal from some drugs does not cause the person abusing them to have physical reactions, stopping drug use is difficult because of the changes the drugs have caused in the brain. Once the drugs stop, the person will have **cravings**, or intense desire for the drugs. Craving arises from the brain's need to maintain a state of homeostasis that now relies on the presence of the drug. A person may experience cravings at any stage of drug abuse or addiction, even early in the experimentation phase of drug abuse. Cravings have a physical basis in the brain. Using PET imaging, scientists have shown that just seeing images of drug paraphernalia can stimulate the amygdala (part of the brain involved in emotional memory) in an addicted person.

Drugs of addiction do not merely cause short-term changes in an individual's cognitive skill and behavior. A drug "high" lasts a short time, ranging from less than an hour to 12 hours, depending on the drug, dose, and route of administration. The changes in the brain that result from continued drug use, however, can last a long time. Scientists believe that some of these changes disappear when drug use stops; some disappear within a short time after drug use stops, and other changes are potentially permanent.

One of the first changes in the brain that may occur in response to repeated drug abuse is tolerance. **Tolerance** develops when a person needs increasing doses of a drug to achieve the same high or "rush" that previously resulted from a lower dose of the drug. Two primary mechanisms underlie the development of tolerance. First, the body may become more efficient at metabolizing the drug, thereby reducing the amount that enters the brain. Second, the cells of the body and brain may become more resistant to the effect of the drug. For example, after continued cocaine use, neurons decrease the number of dopamine receptors, which results in decreasing cocaine's stimulatory effect. Opioids, on the other hand, do not cause a change in the number of receptors. Instead the opioid receptors become less efficient in activating associated cellular processes, thus reducing the effects of the opioids.

In addition to the functional and anatomical changes in the brain, drug abuse puts people at higher risk for other health problems. For example, inhalant abuse can lead to disruption of heart rhythms, and snorting cocaine can lead to ulcerations in the mucous membranes of the nose. In addition, injection drug users (IDUs) are at higher risk of contracting HIV through the sharing of potentially contaminated needles. Similarly, hepatitis B and hepatitis C are much more common among drug addicts than the general population. Tuberculosis is another concern. Drug abuse and addiction also are contributing factors in motor vehicle accidents.

Sources

Source: Understanding Drug Abuse and Addition, www.drugabuse.gov/publications/infofacts/understanding-drug-abuse-addiction

What Is Addiction?: The Essence of Drug Addiction by Nora Volkow, M.D., Director, National Institute on Drug Abuse,science.education.nih.gov/supplements/nih2/Addiction/guide/essence.htm

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2.5.2: AGING, DYING, AND DEATH

2.5.2.1: Profile of Older Americans

2.5.2.2: Diseases Common in Elderly Population

2.5.2.3: Aging and Mental Health

2.5.2.4: Healthy Aging

2.5.2.5: Safety

2.5.2.6: Ageism

2.5.2.7: End-of-Life Issues

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2.5.2.1: Profile of Older Americans

Population Growth

Older adults are among the fastest growing age groups, and the first “baby boomers” (adults born between 1946 and 1964) turned 65 in 2011.*A Profile of Older Americans: 2010*, www.aoa.gov/aoaroot/aging_statistics/Profile/2010/3.aspx[/footnote]

The older population (65+) numbered 40.4 million in 2010, an increase of 5.4 million or 15.3% since 2000. The number of Americans aged 45–64—who will reach 65 over the next two decades—increased by 31% during this decade.

- Over one in every eight, or 13.1%, of the population is an older American.
- Persons reaching age 65 have an average life expectancy of an additional 18.8 years (20.0 years for females and 17.3 years for males).
- Older women outnumber older men at 23.0 million older women to 17.5 million older men.

The population 65 and over has increased from 35 million in 2000 to 40 million in 2010 (a 15% increase) and is projected to increase to 55 million in 2020 (a 36% increase for that decade). The 85+ population is projected to increase from 5.5 million in 2010 and then to 6.6 million in 2020 (19%) for that decade.

Think for Yourself

How will the upcoming increases in the percentage of older adults impact health and health services? Why does it matter?

Income

The median income of older persons in 2010 was $25,704 for males and $15,072 for females. Median money income (after adjusting for inflation) of all households headed by older people fell 1.5% (not statistically significant) from 2009 to 2010. Households containing families headed by persons 65+ reported a median income in 2010 of $45,763. The major sources of income as reported by older persons in 2009 were Social Security (reported by 87% of older persons), income from assets (reported by 53%), private pensions (reported by 28%), government employee pensions (reported by 14%), and earnings (reported by 26%). Social Security constituted 90% or more of the income received by 35% of beneficiaries in 2009 (22% of married couples and 43% of non-married beneficiaries).

Poverty

Almost 3.5 million elderly persons (9.0%) were below the poverty level in 2010. This poverty rate is not statistically different from the poverty rate in 2009 (8.9%). During 2011, the U.S. Census Bureau also released a new Supplemental Poverty Measure (SPM) which takes into account regional variations in the livings costs, non-cash benefits received, and non-discretionary expenditures but does not replace the official poverty measure. The SPM shows a poverty level for older persons of 15.9%, an increase of over 75% over the official rate of 9.0% mainly due to medical out-of-pocket expenses. About 11% (3.7 million) of older Medicare enrollees received personal care from a paid or unpaid source in 1999.

Minority Groups Over Age 65

In 2010, 20.0% of persons 65+ were minorities—8.4% were African-Americans. Persons of Hispanic origin (who may be of any race) represented 6.9% of the older population. About 3.5% were Asian or Pacific Islander, and less than 1% were American Indian or Native Alaskan. In addition, 0.8% of persons 65+ identified themselves as being of two or more races. Minority populations have increased from 5.7 million in 2000 (16.3% of the elderly population) to 8.1 million in 2010 (20% of the elderly) and are projected to increase to 13.1 million in 2020 (24% of the elderly).

- Older men were much more likely to be married than older women: 72% of men vs. 42% of women (Figure 2). 40% older

women in 2010 were widows.
- About 29% (11.3 million) of non-institutionalized older persons live alone (8.1 million women, 3.2 million men).
- Almost half of older women (47%) age 75+ live alone.
- About 485,000 grandparents aged 65 or more had the primary responsibility for their grandchildren who lived with them.

Learning Activity

Use the BenefitsCheckUp tool to determine what benefit programs you might be eligible for if you were over age 65 right now.

- Complete the form as though you were born before 1945. Make estimates to answer the questions.
- Ask someone you know who is over the age of 65 to complete the form.
- Which of these benefits do you think will still be available for older adults in 2020 or 2030?

BenefitsCheckUp quickly finds federal, state, and private benefit programs available to help you save money on health care, food assistance, prescriptions, utilities, and more.

Population Growth

Source: Healthy People, healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=31

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2.5.2.2: Diseases Common in Elderly Population

More than 37 million “baby boomer” adults born between 1946 and 1964 (60 percent) will manage more than 1 chronic condition by 2030.

Older adults are at high risk for developing chronic illnesses and related disabilities. These chronic conditions include:

- Diabetes mellitus
- Arthritis
- Congestive heart failure
- Dementia

Many experience hospitalizations, nursing home admissions, and low-quality care. They also may lose the ability to live independently at home. Chronic conditions are the leading cause of death among older adults.

Learning Activity

Interview an older adult who has a chronic illness and related disability.

Ask about:

- what it is like to deal with the health care system in order to manage the illness
- quality of life and the impact the illness has on daily activities
- caregivers

Why Is the Health of Older Adults Important?

Health Services

- Preventive health services are valuable for maintaining the quality of life and wellness of older adults. In fact, the Patient Protection and Affordable Care Act of 2010 includes provisions related to relevant Medicare services. However, preventive services are underused, especially among certain racial and ethnic groups.
- Ensuring quality health care for older adults is difficult, but the Centers for Medicare & Medicaid Services (CMS) has programs designed to improve physician, hospital, and nursing home care, among others.
- Older adults use many health care services, have complex conditions, and require professional expertise that meets their needs. Most providers receive some type of training on aging, but the percentage of those who actually specialize in this area is small. More certified specialists are needed to meet the needs of this group.

Quality of Life

- Through programs that address chronic illnesses, Federal Government agencies are improving the quality of life for older adults. To combat existing health disparities, many of these programs target minorities and underserved populations.
- The ability to complete basic daily activities may decrease if illness, chronic disease, or injury limit physical or mental abilities of older adults. These limitations make it hard for older adults to remain at home. Early prevention and physical activity can help prevent such declines. Unfortunately, less than 20 percent of older adults engage in enough physical activity, and fewer do strength training. Minority populations often have lower rates of physical activity.
- Most older adults want to remain in their communities as long as possible. Unfortunately, when they acquire disabilities, there is often not enough support available to help them. States that invest in such services show lower rates of growth in long-term care expenditures.

Injury Prevention

- Each year, 1 out of 3 older adults falls. Falls often cause severe disability among survivors. Injuries from falls lead to:
  - Fear of falling
  - Sedentary behavior
  - Impaired function
  - Lower quality of life

Falls are the leading cause of death due to unintentional injury among older adults; deaths and injuries can be prevented by addressing risk factors.

Caregivers

- Caregivers for older adults living at home are typically unpaid family members. Caregiver stress often results in unnecessary nursing home placement.
- One to 2 million older adults in the United States are injured or mistreated by a loved one or a caregiver. A measure of elder abuse has been added to encourage data collection on this issue.

Understanding the Health of Older Adults

The Healthy People 2020 objectives on older adults are designed to promote healthy outcomes for this population. Many factors affect the health, function, and quality of life of older adults.

Individual Behavioral Determinants of Health in Older Adults

Behaviors such as participation in physical activity, self-management of chronic diseases, or use of preventive health services can improve health outcomes.

Social Environment Determinants of Health in Older Adults

Housing and transportation services affect the ability of older adults to access care. People from minority populations tend to be in poorer health and use health care less often than people from nonminority populations.

Health Services-Related Determinants of Health in Older Adults

The quality of the health and social services available to older adults and their caregivers affects their ability to manage chronic conditions and long-term care needs effectively.

Emerging Issues in the Health of Older Adults

Emerging issues for improving the health of older adults include efforts to:

- Coordinate care.
- Help older adults manage their own care.
- Establish quality measures.
- Identify minimum levels of training for people who care for older adults.
- Research and analyze appropriate training to equip providers with the tools they need to meet the needs of older adults.

There is growing recognition that data sources are limited for certain subpopulations of older adults, including the aging lesbian, gay, bisexual, and transgender populations. Research for these groups will inform future health and policy initiatives.

Chronic Diseases among Older Adults

Chronic diseases are long-term illnesses that are rarely cured. Chronic diseases such as heart disease, stroke, cancer, and diabetes are among the most common and costly health conditions. Chronic health conditions negatively affect quality of life,

contributing to declines in functioning and the inability to remain in the community. Many chronic conditions can be prevented or modified with behavioral interventions. Six of the seven leading causes of death among older Americans are chronic diseases.

As shown in the bar chart above, the prevalence of certain chronic conditions differs by sex. Women report higher levels of arthritis and hypertension than men. Men report higher levels of heart disease and cancer.

There are differences by race and ethnicity in the prevalence of certain chronic conditions. In 2007–2008, among people age 65 and over, non-Hispanic blacks report higher levels of hypertension and diabetes than non-Hispanic whites (71 percent compared with 54 percent for hypertension and 30 percent compared with 16 percent for diabetes). Hispanics also report higher levels of diabetes than non-Hispanic whites (27 percent compared with 16 percent), but lower levels of arthritis (42 percent compared with 51 percent).

Arthritis, Osteoporosis, and Chronic Back Conditions

Arthritis, osteoporosis, and chronic back conditions all have major effects on quality of life, the ability to work, and basic activities of daily living.

There are more than 100 types of arthritis. Arthritis commonly occurs with other chronic conditions, such as diabetes, heart disease, and obesity. Interventions to treat the pain and reduce the functional limitations from arthritis are important, and may also enable people with these other chronic conditions to be more physically active.

Osteoporosis is a disease marked by reduced bone strength leading to an increased risk of fractures (broken bones). Chronic back pain (CBP) is common, costly, and potentially disabling.

Arthritis

Arthritis affects 1 in 5 adults and continues to be the most common cause of disability. It costs more than $128 billion per year. All of the human and economic costs are projected to increase over time as the population ages.

There are interventions that can reduce arthritis pain and functional limitations, but they remain underused. These include:

- Increased physical activity
- Self-management education
- Weight loss among overweight/obese adults

Osteoporosis

In the United States, an estimated 5.3 million people aged 50 years and older have osteoporosis. Most of these people are women, but about 0.8 million are men. Just over 34 million more people, including 12 million men, have low bone mass, which puts them at increased risk for developing osteoporosis. Half of all women and as many as 1 in 4 men aged 50 years and older will have an osteoporosis-related fracture in their lifetime.

Chronic Back Conditions

About 80 percent of Americans experience low back pain (LBP) in their lifetime. It is estimated that each year:

- 15-20 percent of the population develop protracted back pain.
- 2-8 percent have chronic back pain (pain that lasts more than 3 months).
- 3-4 percent of the population is temporarily disabled due to back pain.
- 1 percent of the working-age population is disabled completely and permanently as a result of LBP.

Americans spend at least $50 billion each year on LBP. LBP is the:

- Second leading cause of lost work time (after the common cold)
- Third most common reason to undergo a surgical procedure
- Fifth most frequent cause of hospitalization

Understanding Arthritis, Osteoporosis, and Chronic Back Conditions

Arthritis

Many factors determine the pain, function, and quality of life of those with arthritis. Greater physical activity can reduce pain and improve function. However, physical activity remains an underused intervention, even though there are a variety of programs to help people with arthritis increase physical activity safely and with little pain. Self-management education can achieve similar positive outcomes by teaching people skills and techniques to deal with the day-to-day issues that result from arthritis. Weight loss among those who are overweight or obese also helps reduce symptoms of arthritis.

Osteoporosis

There are many factors that contribute to osteoporosis and fractures. Nutrition and physical activity are important modifiable (controllable) risk factors. Family history and personal history of fractures are also risk factors for osteoporosis.

Chronic Back Conditions

CBP is often progressive and its cause(s) can be difficult to determine. Most important, previous studies have shown that patients with CBP make up at least 90 percent of total spending on the treatment of lower back pain.

Emerging Issues in Arthritis, Osteoporosis, and Chronic Back Conditions

Several emerging issues may warrant future Healthy People objectives for arthritis, osteoporosis, and chronic back conditions.

- Fatigue is a clinically important symptom of many types of arthritis and other rheumatic conditions. It is often just as problematic as pain.
- Early diagnosis of inflammatory types of arthritis is of growing importance, because the early use of disease-modifying anti-rheumatic drugs has resulted in much more successful treatment of these conditions. There is a continuing effort to develop early biomarkers (both biochemical and imaging markers) of arthritis, osteoporosis, and chronic back conditions to allow adequate and early assessment and treatment of these conditions.
- Worksite accommodation will become a greater issue as the number of working-age people with arthritis and chronic back conditions increases.
- Social participation, an important part of the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF), should be measured for people with arthritis and other chronic conditions.
- Anxiety and depression re frequently observed outcomes associated with chronic conditions such as arthritis, osteoporosis, and chronic back conditions.
- Better measures of arthritis and chronic back pain self-management education will help focus intervention efforts.
- A greater availability of health-related quality-of-life measures will be important in order to monitor nonfatal, but chronic, disabling conditions such as arthritis, osteoporosis, and chronic back conditions.

Dementias, Including Alzheimer's Disease

Dementia is the loss of cognitive functioning—thinking, remembering, and reasoning—to such an extent that it interferes with a person's daily life. Dementia is not a disease itself, but rather a set of symptoms. Memory loss is a common symptom of dementia, although memory loss by itself does not mean a person has dementia. Alzheimer's disease is the most common cause of dementia, accounting for the majority of all diagnosed cases.
Diagnosis of dementia is key to effective treatment and care. It is important to distinguish dementia from temporary, reversible conditions that may cause loss of cognitive functioning. Temporary, reversible conditions include:

- Series of strokes
- Side effects from medication
- Chronic alcoholism
- Some tumors and infections in the brain
- Vitamin B12 deficiency
- Dehydration

These conditions are not dementia, but they can be serious and should be treated by a doctor as soon as possible.

Why Are Dementias, Including Alzheimer's Disease, Important?

Alzheimer's disease is the 6th leading cause of death among adults aged 18 years and older. Estimates vary, but experts suggest that up to 5.1 million Americans aged 65 years and older have Alzheimer's disease. These numbers are predicted to more than double by 2050 unless more effective ways to treat and prevent Alzheimer's disease are found.

Dementia affects an individual's health, quality of life, and ability to live independently. It can diminish a person's ability to effectively:

- Manage medications and medical conditions.
- Maintain a bank account.
- Drive a car or use appliances safely.
- Avoid physical injury.
- Maintain social relationships.
- Carry out activities of daily living, such as bathing or dressing.

People living with dementia are at greater risk for general disability and experience frequent injury from falls. Older adults with dementia are 3 times more likely to have preventable hospitalizations. As their dementia worsens, people need more health services and, oftentimes, long-term care. Many individuals requiring long-term care experience major personal and financial challenges that affect their families, their caregivers, and society.

There are important steps to take to improve the identification of and care for people with dementia. These include:

- Increasing the availability of existing effective diagnostic tools.
- Decreasing the number of people with undiagnosed dementia.
- Reducing the severity of symptoms through better medical management.
- Supporting family caregivers with social, behavioral, and legal resources.
- Encouraging healthy behaviors to reduce the risk of co-occurring conditions.

Understanding Dementias, Including Alzheimer's Disease

Several factors determine the risk of developing dementia, including age and family history. Other factors affect the management of dementia by families, communities, and the health care system.

Age

Aging is a well-known risk factor for Alzheimer's disease and other types of dementias. Among adults aged 65 years and older, the prevalence of Alzheimer's disease doubles every 5 years.

Family History

People with a family history of Alzheimer's disease are generally considered to be at greater risk of developing the disease. Researchers have identified 3 genes that are linked to early-onset Alzheimer's disease. Until recently, only 1 gene had been identified that increases the risk of late-onset Alzheimer's disease. However, during 2009 and 2010, international teams studying the genetics of Alzheimer's disease have identified and confirmed 3 new genes that are associated with increased risk of late-onset Alzheimer's disease.

Health Services

Many individuals with Alzheimer's disease or other dementias are undiagnosed. Primary care providers do not routinely test for Alzheimer's disease. Alzheimer's disease and other dementias are more often undiagnosed in rural and minority populations than in urban or white populations.

Some chronic conditions are common in people with Alzheimer's disease and other dementias. Dementias can greatly complicate

the medical management of these conditions; this increases the need for coordination of care among different specialists.

Lack of diagnosis seriously reduces a person's access to available treatments and valuable information. Active medical management, information and support, and coordination of medical and community services have been shown to improve quality and outcomes of care for people with dementia.

Emerging Issues in Dementias, Including Alzheimer's Disease

Over the past decade, there has been significant scientific progress in understanding and managing dementia, with most of the research focused on Alzheimer's disease. During the next decade, it will be important that progress be made in:

- Improving the early diagnosis of Alzheimer's disease and other dementias.
- Developing interventions to delay or prevent Alzheimer's disease and other dementias.
- Finding better ways to manage dementia when other chronic conditions are present.
- Understanding the influence of lifestyle factors on a person's risk of cognitive decline and dementia.

Think for Yourself

If you had the opportunity to decide how to spend some limited funding to improve the health of older adults, how would spend it? Why?

- Spend it all on a specific condition?
- Which condition?
- Spend it on prevention, treatment, or cure?
- Spend it on national, state, or local efforts?

Sources

Source: Healthy People, healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=31

Chronic Diseases among Older Adults: www.agingstats.gov/agingstatsdotnet/Main_Site/Data/2010_Documents/Docs/OA_2010.pdf

Arthritis, Osteoporosis, and Chronic Back Conditions: healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=3

Dementias, Including Alzheimer's Disease: Healthy People, healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=7

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2.5.2.3: Aging and Mental Health

It is estimated that 20% of people age 55 years or older experience some type of mental health concern. The most common conditions include anxiety, severe cognitive impairment, and mood disorders (such as depression or bipolar disorder). Mental health issues are often implicated as a factor in cases of suicide. **Older men have the highest suicide rate of any age group.** Men aged 85 years or older have a suicide rate of 45.23 per 100,000, compared to an overall rate of 11.01 per 100,000 for all ages.

Social Support

Social support serves major support functions, including emotional support (e.g., sharing problems or venting emotions), informational support (e.g., advice and guidance), and instrumental support (e.g., providing rides or assisting with housekeeping).

- Adequate social and emotional support is associated with reduced risk of mental illness, physical illness, and mortality
- The majority (nearly 90%) of adults age 50 or older indicated that they are receiving adequate amounts of support.
- Adults age 65 or older were more likely than adults age 50–64 to report that they "rarely" or "never" received the social and emotional support they needed (12.2% compared to 8.1%, respectively).
- Approximately one-fifth of Hispanic and other, non-Hispanic adults age 65 years or older reported that they were not receiving the support they need, compared to about one-tenth of older white adults.
- Among adults age 50 or older, men were more likely than women to report they "rarely" or "never" received the support they needed (11.39% compared to 8.49%).

Depression is Not a Normal Part of Growing Older

Depression is a true and treatable medical condition, not a normal part of aging. However older adults are at an increased risk for experiencing depression. If you are concerned about a loved one, offer to go with him or her to see a health care provider to be diagnosed and treated.

Depression is not just having "the blues" or the emotions we feel when grieving the loss of a loved one. It is a true medical condition that is treatable, like diabetes or hypertension.

How Do I Know If It's Depression?

Someone who is depressed has feelings of sadness or anxiety that last for weeks at a time. He or she may also experience

- Feelings of hopelessness and/or pessimism
- Feelings of guilt, worthlessness and/or helplessness
- Irritability, restlessness
- Loss of interest in activities or hobbies once pleasurable
- Fatigue and decreased energy
- Difficulty concentrating, remembering details and making decisions
- Insomnia, early-morning wakefulness, or excessive sleeping
- Overeating or appetite loss
- Thoughts of suicide, suicide attempts
- Persistent aches or pains, headaches, cramps, or digestive problems that do not get better, even with treatment

How is Depression Different for Older Adults?

- **Older adults are at increased risk.** We know that about 80% of older adults have at least one chronic health condition, and 50% have two or more. Depression is more common in people who also have other illnesses (such as heart disease or cancer) or whose function becomes limited.
- **Older adults are often misdiagnosed and undertreated.** Healthcare providers may mistake an older adult's symptoms of depression as just a natural reaction to illness or the life changes that may occur as we age, and therefore not see the

depression as something to be treated. Older adults themselves often share this belief and do not seek help because they don't understand that they could feel better with appropriate treatment.

How Many Older Adults Are Depressed?

The good news is that the majority of older adults are *not* depressed. Some estimates of major depression in older people living in the community range from less than 1% to about 5% but rise to 13.5% in those who require home healthcare and to 11.5% in older hospital patients.

Optional Learning Activity

Use the interactive maps at this website to determine The State of Mental Health and Aging in America. You can explore different aspects of health by adjusting the Location and Category filters. You can also read this a summary of the information.

Sources

Mental Health Problems in Older Adults: CDC, http://www.cdc.gov/aging/pdf/mental_health.pdf

Depression is Not a Normal Part of Growing Older: http://www.cdc.gov/aging/mentalhealth/depression.htm

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2.5.2.4: Healthy Aging

Implications of an Aging Society

By 2030, the number of U.S. adults aged 65 or older will more than double to about 71 million. The rapidly increasing number of older Americans has far-reaching implications for our nation's public health system and will place unprecedented demands on the provision of health care and aging-related services. Public health efforts to promote health and functional independence are critical strategies in helping older adults stay healthy. Research has shown that poor health does not have to be an inevitable consequence of aging. Older adults who practice healthy behaviors, take advantage of clinical preventive services, and continue to engage with family and friends are more likely to remain healthy, live independently, and incur fewer health-related costs.

An essential component to keeping older adults healthy is preventing chronic diseases and reducing associated complications. About 80% of older adults have one chronic condition, and 50% have at least two. Infectious diseases (such as influenza and pneumococcal disease) and injuries also take a disproportionate toll on older adults. Efforts to identify strategies to prevent or reduce the risk of disease and injury and to widely apply effective interventions must be pursued.

Tips on how to stay healthy, get good health care, and manage lifestyle changes as you age are available at Healthy Aging at NIH Senior Health.

Sources

Source: *Helping People To Live Long and Productive Lives and Enjoy a Good Quality Of Life: At a Glance* 2011, www.cdc.gov/chronicdisease/resources/publications/AAG/aging.htm

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2.5.2.5: Safety

Falls Among Older Adults: An Overview

Each year, one in every three adults age 65 and older falls. Falls can cause moderate to severe injuries, such as hip fractures and head traumas, and can increase the risk of early death. Fortunately, falls are a public health problem that is largely preventable.

How big is the problem?

- One out of three adults age 65 and older falls each year, but less than half talk to their healthcare providers about it.
- Among older adults (those 65 or older), falls are the leading cause of injury death. They are also the most common cause of nonfatal injuries and hospital admissions for trauma.
- In 2008, over 19,700 older adults died from unintentional fall injuries.
- In 2009, 2.2 million nonfatal fall injuries among older adults were treated in emergency departments and more than 581,000 of these patients were hospitalized.
- In 2000, direct medical costs of falls totaled a little over $19 billion—$179 million for fatal falls and $19 billion for nonfatal fall injuries. This equals $28.2 billion in 2010 dollars.

What outcomes are linked to falls?

- Twenty to thirty percent of people who fall suffer moderate to severe injuries such as lacerations, hip fractures, or head traumas. These injuries can make it hard to get around or live independently, and increase the risk of early death.
- Falls are the most common cause of traumatic brain injuries (TBI). In 2000, TBI accounted for 46% of fatal falls among older adults.
- Most fractures among older adults are caused by falls. The most common are fractures of the spine, hip, forearm, leg, ankle, pelvis, upper arm, and hand.
- Many people who fall, even if they are not injured, develop a fear of falling. This fear may cause them to limit their activities leading to reduced mobility and loss of physical fitness, which in turn increases their actual risk of falling.

Who is at risk?

Fall-related Deaths

- In 2008, 82% of fall deaths were among people 65 and older.
- Men are more likely to die from a fall. After taking age into account, the fall death rate in 2007 was 46% higher for men than for women.
- Older whites are 2.5 times more likely to die from falls as their black counterparts.
- Rates also differ by ethnicity. Older non-Hispanics have higher fatal fall rates than Hispanics.

Fall Injuries

- The chances of falling and of being seriously injured in a fall increase with age. In 2009, the rate of fall injuries for adults 85 and older was almost four times that for adults 65 to 74.
- People age 75 and older who fall are four to five times more likely than those age 65 to 74 to be admitted to a long-term care facility for a year or longer.
- Women are more likely than men to be injured in a fall. In 2009, women were 58% more likely than men to suffer a nonfatal fall injury.
- Rates of fall-related fractures among older women are more than twice those for men.
- Over 90% of hip fractures are caused by falls. In 2007, there were 264,000 hip fractures and the rate for women was almost three times the rate for men.
- White women have significantly higher hip fracture rates than black women.

How can older adults reduce risk?

To lower their hip fracture risk, older adults can:

- Get adequate calcium and vitamin D—from food and/or from supplements.
- Do weight bearing exercise.
- Get screened and treated for osteoporosis.

Falls in the Bathroom

Activities that take place in the bathroom, such as showering and bathing, are a simple part of most peoples' daily routine. Yet, slips in the tub and falls in the shower or from the toilet may cause serious injuries.

According to a CDC study published in the *Morbidity and Mortality Weekly Report*, an estimated 234,000 people ages 15 and older were treated in U.S. emergency departments (ED) in 2008 for injuries that occurred in bathrooms. Four out of 5 of these injuries were caused by falls—which can have especially serious consequences for older adults.

Almost one-third (30 percent) of adults aged 65 and above who were injured in bathrooms were diagnosed with fractures. Among adults aged 85 and older, 38 percent were hospitalized as a result of their injuries.
Read the new CDC study on bathroom injuries and the related press release.

Steps for Safety in the Bathroom

Certain home safety measures may reduce the risk for all household members of being injured in the bathroom. Some prevention strategies include:

- Adding non-slip surfaces and grab bars inside and outside the tub or shower to reduce slips and falls.
- Installing grab bars next to the toilet for added support, if needed.

Preventing Falls among Older Adults

Four out of five injuries that took place in bathrooms in 2008 were the result of falls. Falls can be especially dangerous for adults ages 65 and older.

Older adults can take steps to make falls less likely. If you are 65 or older, take the following steps to reduce your risk of falling:

- **Get some exercise**: Lack of exercise can lead to weak legs, which increases the chance of falling. Exercise programs like Tai Chi can increase strength as well as improve balance, making falls less likely for aging adults.
- **Be mindful of medications:** Some medicines—or combinations of medicines—can have side effects like dizziness or drowsiness. This can make falls more likely. Having a doctor or pharmacist review all your medications can help reduce the chance of risky side effects and drug interactions.
- **Keep your vision sharp:** Poor vision can make it harder to get around safely. To help make sure you're seeing clearly, have your eyes checked every year and wear glasses or contact lenses with the right prescription strength.
- **Eliminate hazards at home.** About half of all falls happen at home. A home safety check can help identify fall hazards, like clutter and poor lighting that should be removed or changed.

Learning Activity

Make your own home safe for older adults.

- What would you need to do to make your home safer for older adults?
- How much would it cost and how much time would it take for you to make these changes?

Violence Elder Abuse

Elder maltreatment includes several types of violence that occur among those ages 60 and older. The violence usually occurs at the hands of a caregiver or a person the elder trusts. There are six types of elder maltreatment:

- Physical—This occurs when an elder is injured as a result of hitting, kicking, pushing, slapping, burning, or other show of force.
- Sexual—This involves forcing an elder to take part in a sexual act when the elder does not or cannot consent.
- Emotional—This refers to behaviors that harm an elder's self-worth or emotional well being. Examples include name calling, scaring, embarrassing, destroying property, or not letting the elder see friends and family.
- This is the failure to meet an elder's basic needs. These needs include food, housing, clothing, and medical care.
- This happens when a caregiver leaves an elder alone and no longer provides care for him or her.
- Financial—This is illegally misusing an elder's money, property, or assets.

Elder maltreatment can have several physical and emotional effects on an elder.

Many victims suffer physical injuries. Some are minor like cuts, scratches, bruises, and welts. Others are more serious and can cause lasting disabilities. These include head injuries, broken bones, constant physical pain, and soreness. Physical injuries can also lead to premature death and make existing health problems worse.

Elder maltreatment can have emotional effects as well. Victims are often fearful and anxious. They may have problems with trust and be wary around others.

Many cases are not reported because elders are afraid to tell police, friends, or family about the violence. Victims have to decide: tell someone they are being hurt or continue being abused by someone they depend upon or care for deeply.

Risk Factors

A combination of individual, relational, community, and societal factors contribute to the risk of becoming a perpetrator of elder maltreatment. They are contributing factors and may or may not be direct causes.

Understanding these factors can help identify various opportunities for prevention.

Risk Factors for Perpetration

- Individual Level
  - Current diagnosis of mental illness
  - Current abuse of alcohol
  - High levels of hostility
  - Poor or inadequate preparation or training for care giving responsibilities
  - Assumption of caregiving responsibilities at an early age
  - Inadequate coping skills
  - Exposure to maltreatment as a child
- Relationship Level
  - High financial and emotional dependence upon a vulnerable elder
  - Past experience of disruptive behavior
  - Lack of social support
- Community Level
  - Formal services, such as respite care for those providing care to elders, are limited, inaccessible, or unavailable
- Societal Level
  - A culture where there is high tolerance and acceptance of aggressive behavior.
  - A culture where health care personnel, guardians, and other agents are given greater freedom in routine care provision and decision making.
  - A culture where family members are expected to care for elders without seeking help from others.
  - A culture where persons are encouraged to endure suffering or remain silent regarding their pains.
  - A culture where there are negative beliefs about aging and elders.

In addition to the above factors, there are also specific characteristics of institutional settings that may increase the risk for perpetration of vulnerable elders in these settings, including: unsympathetic or negative attitudes toward residents, chronic staffing problems, lack of administrative oversight, staff burnout, and stressful working conditions.

Protective Factors for Elder Maltreatment

Protective factors reduce risk for perpetrating abuse and neglect. Protective factors have not been studied as extensively or rigorously as risk factors. However, identifying and understanding protective factors are equally as important as researching risk factors.

Several potential protective factors are identified below. Research is needed to determine whether these factors do indeed buffer elders from maltreatment.

The goal is to stop elder maltreatment before it starts. While not much research has been done, there are several things we can do to prevent it:

- Listen to elders and their caregivers
- Report abuse or suspected abuse to Adult Protective Services
- Educate oneself and others about how to recognize and report elder abuse
- Learn how the signs of elder abuse differ from the normal aging process
- If you take care of an elder here are some things you can do to prevent violence:
- Get help from friends, family, or local relief care groups
- Take a break—if only for a couple of hours
- Involve more people than just family in financial matters
- Find an adult day care program
- Seek counseling or other support if you are feeling depressed
- If you are having problems with drug or alcohol abuse, get help

Sources

Falls Among Older Adults: An Overview: www.cdc.gov/HomeandRecreationalSafety/Falls/adultfalls.html

Falls in the Bathroom: http://www.cdc.gov/features/fallrisks/

Violence Elder Abuse: Centers for Disease Control, http://www.cdc.gov/violenceprevention/pdf/EM-FactSheet-a.pdf

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2.5.2.6: Ageism

In the 1960s, Robert Butler coined the phrase ageism, which he defined as:

> A process of systematic stereotyping of and discrimination against people because they are old, just as racism and sexism accomplish this with skin color and gender. Old people are categorized as senile, rigid in thought and manner, old-fashioned in morality and skills. . . . Ageism allows the younger generations to see older people as different from themselves; thus they subtly cease to identify with their elders as human beings.
>
> —R. Butler, *Why Survive? Being Old in America*, 1975

While some advocates for elders suggest that ageism is a cause of elder abuse, neglect, and exploitation, we do not have enough valid research into the attitudes of known perpetrators of elder mistreatment to be able to definitively make that statement. However, as the following references indicate, ageism contributes to conditions that disadvantage and marginalize older individuals in society.

Inequitable treatment occurring in the workplace, in the health care sector, and in the legal arena appears to be based, at least in part, on age discrimination. Even efforts to offer protection may be based upon compassionate ageism that may lead to disempowerment. Ageist beliefs and policies categorize seniors as a homogenous group, ignoring diversity issues and individual needs. Furthermore, it appears that aging individuals are not only subjected to ageist beliefs by others; they internalize these beliefs as well. Age discrimination can impact elders in tangible ways by contributing to reduced financial security and poorer health outcomes, but also appears to a have subtler, though perhaps more pervasive impact, by contributing to social isolation (a risk factor for mistreatment), lower self-esteem and poorer quality of life. When combined with other prejudices, such as sexism, racism and biases against the disabled (known as “ableism”), the health and well-being of elders is further jeopardized.

Learning Activity

Take the Implicit Association Test (IAT) on aging and reflect on your results then ask someone else to take the IAT and interview that person about the results.

- How might the results may impact your attitudes?

Consequences of Attributing Illness to Old Age

Stereotypic beliefs about older adults and the aging process have led to endorsement of the myth that “to be old is to be ill.” A study on older adults’ beliefs about the causes of their chronic illness (i.e., heart disease, cancer, diabetes, etc.), found that attributing an illness to “old age” is associated with negative health outcomes. ‘Old age’ attributions were associated with more frequent perceived health symptoms, poorer health maintenance behaviors and a greater likelihood of mortality. The probability of death was more than double among those who strongly attributed illness symptoms to “old age” as compared to those who did not.[1]

Sources

Source: Ageism, NCEA, AOA, www.ncea.aoa.gov/main_site/library/cane/CANE_Series/CANE_ageism.aspx

1. Stewart TL, Chipperfield JG, Perry RP, Weiner B. (2011). *Attributing illness to 'old age:' Consequences of a self-directed stereotype for health and mortality*. Psychol Health. http://www.ncbi.nlm.nih.gov/pubmed/22149693↵

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2.5.2.7: End-of-Life Issues

Life Expectancy

Life expectancy is a summary measure of the overall health of a population. It represents the average number of years of life remaining to a person at a given age if death rates were to remain constant. In the United States, improvements in health have resulted in increased life expectancy and contributed to the growth of the older population over the past century.

Americans are living longer than ever before. Life expectancies at both age 65 and age 85 have increased. Under current mortality conditions, people who survive to age 65 can expect to live an average of 18.5 more years, about 4 years longer than people age 65 in 1960. The life expectancy of people who survive to age 85 today is 6.8 years for women and 5.7 years for men.

Life expectancy varies by race, but the difference decreases with age. In 2006, life expectancy at birth was 5 years higher for white people than for black people. At age 65, white people can expect to live an average of 1.5 years longer than black people. Among those who survive to age 85, however, the life expectancy among black people is slightly higher (6.7 years) than white people (6.3 years).

Life expectancy at age 65 in the United States is lower than that of many other industrialized nations. In 2005, women age 65 in Japan could expect to live on average 3.7 years longer than women in the United States. Among men, the difference was 1.3 years.

Heart disease and cancer are the top two leading causes of death among all people age 65 and over, irrespective of sex, race, or Hispanic origin. Other causes of death vary among older people by sex and race and Hispanic origin. For example, men have higher suicide rates than do women at all ages, with the largest difference occurring at age 85 and over (43 deaths per 100,000 population for men compared with 3 per 100,000 for women). Non-Hispanic white men age 85 and over have the highest rate of suicide overall at 48 deaths per 100,000.

End-of-Life Issues

Sometimes, in spite of treatment, a condition or illness will cause death. In those cases, patients can decide what they do and do not want done. They can decide whether they want aggressive treatment that might prolong life or whether they prefer to stop treatment, which could mean dying sooner but more comfortably. They may want to plan their own funeral. Advance directives can help make the patient's wishes clear to families and health care providers.

Care at the end of life focuses on making patients comfortable. They still receive medicines and treatments to control pain and other symptoms. Some patients choose to die at home. Others enter a hospital or a hospice. Either way, services are available to help patients and their families deal with issues surrounding death.

> For more about dying and death, read End of Life: Helping With Comfort and Care, a 68-page guide that discusses finding hospice care, what happens at the time of death, managing grief, and preparing advance directives along with resources for more information.

Costs of End-of-Life Care

End-of-life care is often a controversial subject, and when policymakers are looking for ways to control Medicare costs, such care typically comes up in the discussion. That's not surprising, because end-of-life care accounted for more than one-quarter of Medicare spending last year, according to background information in the study. One concern is that this spending may be largely earmarked for aggressive care that's not necessarily what the patient might have wanted.

And, that's where advance directives can be useful. They allow patients to document their wishes, whether they want all life-sustaining measures to be taken or if they'd prefer to avoid such procedures.

Advance Directives

What kind of medical care would you want if you were too ill or hurt to express your wishes? Advance directives are legal documents that allow you to convey your decisions about end-of-life care ahead of time. They provide a way for you to communicate your wishes to family, friends and health care professionals, and to avoid confusion later on.

A living will tells how you feel about care intended to sustain life. You can accept or refuse medical care. There are many issues to address, including

- The use of dialysis and breathing machines
- If you want to be resuscitated if breathing or heartbeat stops
- Tube feeding
- Organ or tissue donation

A durable power of attorney for health care is a document that names your health care proxy. Your proxy is someone you trust to make health decisions if you are unable to do so.

Optional Learning Activity

Watch this video about advance care planning:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online



- Have YOU made your health care wishes known to someone?

Hospice Care

Hospice care is end-of-life care provided by health professionals and volunteers. They give medical, psychological and spiritual support. The goal of the care is to help people who are dying have peace, comfort and dignity. The caregivers try to control pain and other symptoms so a person can remain as alert and comfortable as possible. Hospice programs also provide services to support a patient's family.
Usually, a hospice patient is expected to live 6 months or less. Hospice care can take place

- At home
- At a hospice center
- In a hospital
- In a skilled nursing facility

Sources

Life Expectancy: www.agingstats.gov/agingstatsdotnet/Main_Site/Data/2010_Documents/Docs/OA_2010.pdf

End-of-Life Issues: NLM, NIH, http://www.nlm.nih.gov/medlineplus/endoflifeissues.html

Costs of End-of-Life Care: Advance Directives Might Curb Cost of End-of-Life Care by Serena Gordon, *Health News*, www.healthfinder.gov/news/newsstory.aspx?Docid=657551

Advance Directives: NIH, *Medline,*http://www.nlm.nih.gov/medlineplus/advancedirectives.html

Hospice Care: NIH, *Medline*,http://www.nlm.nih.gov/medlineplus/hospicecare.html

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2.5.3: DISEASES AND DISORDERS

Learning Objectives

- examine and discuss the role of epidemiology in public health
- recognize, examine and formulate the importance of immunization
- identify the major means of transmission for communicable diseases
- identify and examine immunizations in relationship to immunity
- differentiate the major classifications of communicable and non-communicable diseases

2.5.3.1: Introduction to Epidemiology

2.5.3.2: Noncommunicable Diseases and Disorders

2.5.3.3: Cardiovascular Diseases and Disorders

2.5.3.4: Cancer

2.5.3.5: Communicable (Infectious) Diseases

2.5.3.6: Immunity and Immunizations

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2.5.3.1: Introduction to Epidemiology

This background lesson provides several working definitions of epidemiology—the basic science of public health; an introduction to the different categories of epidemiology and types of epidemiological studies; and an overview of the disease transmission cycle. First, to set the stage, consider the three incidents that follow, stepping into the shoes of the public health officer who received the initial report and asking yourself the question, "What do I do now?" Some of these examples made national news and may be familiar to you.

First Incident

In March 1985, a nurse epidemiologist in a county health department noted, while reviewing surveillance data, three cases in a single month of hepatitis B of unusual origin. Hepatitis B, or serum hepatitis, is transmitted through sexual contact and by exposure to infected bodily fluids, but these three patients did not seem to have the usual risk factors. All three people did, however, indicate having received injections at the same health care facility.

The nurse's immediate questions were: *"Is this a coincidence? Did these three cases occur by chance or is there a link?"* In this instance, the nurse decided to pursue an investigation.

Second Incident

At 8:30 in the morning on August 2, 1976, Dr. Robert B. Craven of Centers for Disease Control's (CDC) Viral Diseases Division received a call from a nurse at a Veterans' Hospital in Philadelphia, Pennsylvania. The nurse reported two cases of severe respiratory illness, one of which had been fatal. Both people had attended the annual American Legion Convention held July 21-24. By the evening of August 2, 71 more of the people attending the convention had the same illness, with symptoms of acute onset of fever, chills, headache, malaise, dry cough, and myalgia. Further conversations with local and state public health officials revealed that between July 26 and August 2, 18 conventioneers had died. Deaths were due primarily to pneumonia.

An intense investigation began immediately. The incident became known as the first outbreak of Legionnaires' disease and led to the discovery of the gram-negative pathogen, *Legionnella pneumophila*.

Third Incident

On October 30, 1989, a New Mexico physician notified the state's health department of three patients with marked peripheral eosinophilia and severe myalgia. All three patients had been taking oral preparations of L-tryptophan, a nonprescription drug sold as a dietary supplement in health food stores. Despite extensive clinical evaluation and testing, the illness could not be identified.

An investigation followed and resulted in the characterization of eosinophilia-myalgia syndrome, EMS. The investigation implicated a vehicle for exposure—L-tryptophan dietary supplements—before a suspected agent was identified, and the product was taken off the market. Eventually, the problem was traced to a contaminant that had been introduced by changes in the production process at a single manufacturing facility.

These three examples illustrate some of the key reasons for needing applied, or field, epidemiology:

- They were unexpected.
- They demanded a response.
- The investigators had to go out into the field to solve the problem.

Epidemiology Defined

A definition of epidemiology is "the study of the distribution and determinants of health-related states in specified populations, and the application of this study to control health problems." A look at the key words will help illuminate the meaning:

- Epidemiology is the basic science of public health. It's a highly quantitative discipline based on principles of statistics and

research methodologies.
- Distribution Epidemiologists study the distribution of frequencies and patterns of health events within groups in a population. To do this, they use descriptive epidemiology, which characterizes health events in terms of time, place, and person
- Determinant Epidemiologists also attempt to search for causes or factors that are associated with increased risk or probability of disease. This type of epidemiology, where we move from questions of "who," "what," "where," and "when" and start trying to answer "how" and "why," is referred to as analytical epidemiology

A comparison between the practice of public health and the more familiar practice of health care helps in describing epidemiology. First, where health care practitioners collect data on an individual patient by taking a medical history and conducting a physical exam, epidemiologists collect data about an entire population through surveillance systems or descriptive epidemiological studies. The health care practitioner uses his or her data to make a differential diagnosis. The epidemiologist's data is used to generate hypotheses about the relationships between exposure and disease. Both disciplines then test the hypotheses, the health care practitioner by conducting additional diagnostic studies or tests, the epidemiologist by conducting analytical studies such as cohort or case-control studies. The final step is to take action. The health care practitioner prescribes medical treatment, and the epidemiologist, some form of community intervention to end the health problem and prevent its recurrence.

Health Care Professional	Epidemiologist
Collects data on an individual patient by taking a medical history and conducting a physical exam	Collects data about an entire population through surveillance systems or descriptive epidemiological studies
Uses his or her data to make a differential diagnosis	Data is used to generate hypotheses about the relationships between exposure and disease
Tests the hypothesis by conducting additional diagnostic studies or tests	Tests the hypothesis by conducting analytical studies such as cohort or case-control studies
Prescribes medical treatment	Develops community intervention to end the health problem and prevent its recurrence

One way to sum up the task of epidemiologists is to say that they "count things." Basically, epidemiologists count cases of disease or injury, define the affected population, and then compute rates of disease or injury in that population. Then they compare these rates with those found in other populations and make inferences regarding the patterns of disease to determine whether a problem exists.

For example, in the hepatitis B example earlier, you might ask: Is the rate of disease among people with no know risk factors greater than we would expect? Is the pattern or distribution of the cases suspicious? Once a problem has been identified, the data are used to determine the cause of the health problem; the modes of transmission; any factors that are related to susceptibility, exposure, or risk; and any potential environmental determinants.

Epidemiological Studies

As mentioned earlier, epidemiologists used several different types of studies. Simply speaking, these can be classified as either **experimental**, where the epidemiologists have control over the circumstances from the start, or **observational**, where they do not. Vaccine efficacy trials are a good example of experimental studies because investigators control who gets the vaccine and who doesn't. Observational studies can be further subdivided into **descriptive** and **analytical** studies. In a descriptive study, the epidemiologist collects information to characterize and summarize the health event or problem. In an analytical study, the epidemiologist relies on comparisons between groups to determine the role of various risk factors in causing the problem. Descriptive epidemiology is the most basic of these categories and is fundamental to the work of an epidemiologists.

Another way of comparing descriptive and analytical epidemiology is to say that in the descriptive process, we are concerned with "person" (Who was affected?), "place" (Where were they affected?), and time (When were they affected?). Once we know the answers to these questions, we can enter the realm of analytical epidemiology and ask how and why these people were affected.

Disease Transmission

In talking about epidemiology, it is important to review how outbreaks occur. First, we'll look at three commonly used, and often

misunderstood, terms: “epidemic,” “outbreak,” and “cluster.” An **epidemic** is the occurrence of more cases of disease than would normally be expected in a specific place or group of people over a given period of time. To an epidemiologist, “**outbreak**” means basically the same thing. In the public’s mind, however, “epidemic” has a far more serious connotation than “outbreak.” For this reason, “outbreak” is often used to avoid sensationalism. The third term, “**cluster**,” is occasionally used, incorrectly, in place of “epidemic” or “outbreak.” A cluster is a group of cases in a specific time and place that may or may not be greater than the expected rate. Often the aim of investigating clusters is to determine the baseline rate of disease for that time and place. Two other terms you will come across are “**endemic**,” meaning a high background rate of disease, and “**pandemic**,” meaning very widespread, often global, disease.

Learning Activity

Watch this TED-Ed video: How Pandemics Spread and take the Quick Quiz.

- Why are epidemics and pandemics a relatively recent phenomenon in human history?

For an outbreak, or epidemic, to occur, the basic elements of disease causation and an adequate chain of transmission must be present. Disease occurs when an outside **agent** capable of causing the disease meets a **host** that is vulnerable to the agent in an **environment** that allows the agent and host to interact. Then, given a chain of transmission from one host to another and a suitable mode of spread, an outbreak can develop. These basic concepts help guide the selection of public health strategies to prevent health problems. Depending on which approach might be most effective, we might direct efforts at the specific agent (e.g., guinea worm), host (e.g., immunization to prevent measles), or environment (e.g., sanitation improvements to prevent salmonella). We can also target a specific point in the chain of transmission. This was the response in the E.coli outbreak in Washington State in the early 1990s, when health officials called for the thorough cooking of hamburgers to interrupt transmission of the bacterium.

The **host** is the person, or in a more generic definition, the organism, that is susceptible to the effect of the agent. The status of the host is quite important and is generally classifiable as susceptible, immune, or infected. Finally, and also quite important, is that the host’s response to exposure can vary widely, from showing no effect to manifesting illness.

The **environment** is the conditions or influences that are not part of either the agent or the host, but that influence their interaction. A wide variety of factors, including physical, climatologic, biologic, social, and economic conditions, can come into play. For instance, in a study of motor vehicle injuries, the agent (mechanical energy) and the host (driver) could be affected by the topography, the weather, and the actions of other drivers. In many infectious disease outbreaks, social and economic conditions cause overcrowding and lead to high levels of exposure.

Agent, host, and environment alone are not sufficient to cause an epidemic; an adequate chain of transmission must be present. This process requires a source for the agent, a portal of exit, a mode of transmission, and a portal of entry. The first element, the **source for the agent**, is often the place where the agent originates, where it lives, grows, and multiplies, but this is not always the case. The agent that causes botulism (*Clostridium botulinum*), for example, originates in soil, but the source of most botulism infections is improperly canned food containing *C. botulinum* spores.

The second element, a **portal of exit**, is a pathway by which the agent can leave the source. This pathway is usually related to the place where the agent is localized. For instance, the agents causing tuberculosis and the flu are released through the respiratory tract, whereas agents for many stomach ailments are released through the digestive tract. Agents found in the blood, such as hepatitis B and HIV, can be released through cuts or needles.

Once the agent leaves the source, a **mode of transmission**, or means of carrying it to the host, is needed. This can happen in a number of ways, some of which are direct and some indirect. **Direct transmission** includes contact with soil or plants as well as contact between people. In **indirect transmission**, the agent can be **airborne**, **vector borne**, or **vehicle borne**. In airborne transmission, the agent is carried from the source to the host suspended in air particles. Vector-borne diseases are transmitted indirectly by a live carrier, usually an arthropod, such as mosquitos, fleas, or ticks. Vehicle-borne diseases are carried by inanimate objects, such as food or water, blood, or items like handkerchiefs, bedding, and surgical instruments.

Finally, there must be a pathway into the host, a **portal of entry**, that gives the agent access to tissue where it can multiply or act. Often the agent enters the host in the same way that it left the source. This is the case with the flu virus, which leaves the source through the respiratory tract and enters a new host through the respiratory tract.

Learning Activity

Your Disease Risk: Here, you can find out your risk of developing five of the most important diseases in the United States and get personalized tips for preventing them.

The Chain of Infection Model

This model explains the spread of a communicable disease from one host (or person) to another. The basic idea represented in the chain of infection is that individuals can break the chain (reduce the risk) at any point, thus the spread of the disease can be stopped.

Table 1. Chain of infection.

Component of the model	Definition	Preventive measures
Communicable disease	Disease caused by an infectious agent	Pasteurization, chlorination, antibiotics, disinfectants, hand washing, etc.
Human reservoir	The human being who is harboring the infectious agent	Isolation, surveillance, treatment with medications, etc.
Portal of exit	The body part through which the infectious agent is exiting from the reservoir, for example the mouth or the anus	Utilization of handkerchiefs, condoms, hair nets, insect repellents, hand washing, etc.
Transmission	The spread of the infectious agent from the reservoir to the host	Isolation, hand washing, mosquito control, sexual abstinence, condom users, etc.
Portal of entry	The body part through which the infectious agent will enter the new host, for example the skin after a mosquito bite, the mouth	Condoms, hair nets, insect repellents, hand washing, etc.
Establishment of disease in new host (susceptible person)	The host develops signs and symptoms of the new disease	Immunizations, health education, nutrition promotion; sexual abstinence, condom use, etc.

Now look at Table 1 carefully again. There are two sets of components that have some similar preventive measures. As a way of helping yourself become familiar with this chart see if you can spot which these are.

The portal of entry and exit both involve preventive measures such as hand washing, condoms, hair nets and insect repellents, while the human reservoir and transmission measures both involve isolation. Be sure you have a clear picture of the definition and prevention of each element before you continue.

With the application of such information, health education can help to create programs that are aimed at breaking the chain and reducing the risks of infection in other people.

The communicable disease model

- The **communicable diseasemodel** presents three elements; infectious agent, host and environment, as the minimal requirements for the presence and spread of a communicable disease in a population.
- The **infectious agent** is the element that must be present for the disease to occur and spread. Bacteria, viruses and parasites are examples of infectious agents.
- The **host** is any susceptible organism. Plants, animals or humans can be invaded by the infectious agent and become the host.
- The **environment** includes all other factors that either promote or prohibit disease transmission.

Communicable disease transmission occurs when a susceptible host and an infectious agent exist in an environment that allows

disease transmission.

According to the communicable disease model, the role of health education and health promotion in reducing the occurrence and transmission of diseases can be brought about by specific actions.

Think of tuberculosis (TB), malaria and intestinal infections as examples, and then answer the following questions:

1. Note one way to reduce the susceptibility of hosts.
2. Note one way to destroy infectious agents.
3. Note one way to reduce the contact between the host and the agent.
4. Note one way to modify the environment so that it is not conducive for disease transmission.

You may have answered with the following examples:

1. Good nutrition will build a person's defenses against infection and reduce their risk of developing TB.
2. Cooking food properly destroys infectious agents that could cause intestinal infections.
3. Wearing a mask or holding your hand in front of your mouth while coughing will reduce the contact between the agent that causes TB, and other human beings.
4. Drying swampy and marshy areas will make the environment less easy for mosquitoes to breed in and therefore reduce the incidence of malaria.

Health risk reduction for non-communicable diseases

Both the chain of infection and communicable disease models are helpful in trying to prevent disease caused by an infectious agent. However, these models are *not* applicable to non-communicable diseases, which include many of the chronic diseases such as heart disease and cancers. Most of these diseases become apparent in people over a period of time and are not caused by a single factor, but by a combination of factors. The concept of 'caused by many factors' is often called the **multi causation disease model**. For example, it is known that heart disease is most likely to be a problem for individuals who are older, who smoke, who do not exercise, who are overweight, who have high blood pressure, who have high blood cholesterol and who have a family history of heart disease.

Note that within the list of factors you have just read there are both modifiable and non-modifiable risk factors.

Learning Activity

Look at the list again and put an "M" against the modifiable factors and an "NM" against the non-modifiable factors.

- Are older:
- Smoke:
- Do not exercise:
- Are overweight:
- Have high blood pressure:
- Have high cholesterol:
- Have a family history of heart disease:

According to this model, health education will be useful in risk reduction and disease prevention if you can create programs that help people control as many of the multi causative risk factors as possible.

[reveal-answer q="126259"]Show Answer[/reveal-answer]
[hidden-answer a="126259"]

- Are older: NM
- Smoke: M
- Do not exercise: M
- Are overweight: M
- Have high blood pressure: M
- Have high cholesterol: M

- Have a family history of heart disease: NM

Learning Activity

Go to the Cost of Getting Sick webpage then click on the different color pies in the circle to find out the healthcare costs associated with various chronic health conditions.

Learning Activity: Leading Causes of Death

Go to 10 Leading Causes of Death, United States

- **Choose your Report Options, then click the Submit Request button.**
  - For more information about an option or a category of options, click on the underlined name or phrase.

Go to 10 Leading Causes of Injury

Sources

Source: Centers for Disease Control, EXCITE, www.cdc.gov/excite/classroom/intro_epi.htm

The Chain of Infection Model: Health Education, Advocacy and Community Mobilization Chapter, CC-BY-NC-SA, http://labspace.open.ac.uk/mod/oucontent/view.php?id=452835&printable=1

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2.5.3.2: Noncommunicable Diseases and Disorders

Diseases are classified as either communicable or noncommunicable. Communicable diseases are spread to other people and they are caused by viral, bacterial, parasitic, or fungal infection. Noncommunicable diseases, also known as non-infectious diseases, are not transferred and are typically caused by heredity, deficiencies in nutrition or factors involving the environment. Some noncommunicable diseases include

- Respiratory disorders
- Diabetes
- Headaches
- Arthritis
- Skin disorders
- Neurological disorders
- Cancer
- Cardiovascular Diseases and Disorders

Respiratory Disorders

Chronic Obstructive Pulmonary Disease

- COPD, or chronic obstructive pulmonary (PULL-mun-ary) disease, is a progressive disease that makes it hard to breathe. “Progressive” means the disease gets worse over time.
- COPD can cause coughing that produces large amounts of mucus (a slimy substance), wheezing, shortness of breath, chest tightness, and other symptoms.
- Cigarette smoking is the leading cause of COPD. Most people who have COPD smoke or used to smoke. Long-term exposure to other lung irritants, such as air pollution, chemical fumes, or dust, also may contribute to COPD.
- COPD, or chronic obstructive pulmonary disease, is a major cause of disability and the third leading cause of death in the United States. More than 12 million people are currently diagnosed with COPD. An additional 12 million likely have the disease and don’t even know it.

Learning Activity

Download this video titled *COPD Learn More Breathe Better by clicking on Windows media or Quicktime below.*

- Windows media or Quicktime
- Transcript

Profiling the personal experiences of three people diagnosed with COPD, this video answers basic questions about the disease and its risk factors, and demonstrates how real people took steps to manage the disease and breathe easier.

- Could you identify with any of the people in this video?
- What seems to be most helpful to these folks when it comes to managing their COPD?
- What did you learn that you didn’t already know before watching this video?

Overview

To understand COPD, it helps to understand how the lungs work. The air that you breathe goes down your windpipe into tubes in your lungs called bronchial tubes or airways.

The airways and air sacs are elastic (stretchy). When you breathe in, each air sac fills up with air like a small balloon. When you breathe out, the air sacs deflate and the air goes out.

In COPD, less air flows in and out of the airways because of one or more of the following:

- The airways and air sacs lose their elastic quality.
- The walls between many of the air sacs are destroyed.
- The walls of the airways become thick and inflamed.
- The airways make more mucus than usual, which tends to clog them.

In the United States, the term “COPD” includes two main conditions—emphysema and chronic bronchitis.

In emphysema, the walls between many of the air sacs are damaged, causing them to lose their shape and become floppy. This damage also can destroy the walls of the air sacs, leading to fewer and larger air sacs instead of many tiny ones. If this happens, the amount of gas exchange in the lungs is reduced.

In chronic bronchitis, the lining of the airways is constantly irritated and inflamed. This causes the lining to thicken. Lots of thick mucus forms in the airways, making it hard to breathe. Most people who have COPD have both emphysema and chronic obstructive bronchitis. Thus, the general term “COPD” is more accurate.

Outlook

- COPD is a major cause of disability, and it’s the third leading cause of death in the United States. More than 12 million people are currently diagnosed with COPD. Many more people may have the disease and not even know it.
- COPD develops slowly. Symptoms often worsen over time and can limit your ability to do routine activities. Severe COPD may prevent you from doing even basic activities like walking, cooking, or taking care of yourself.
- Most of the time, COPD is diagnosed in middle-aged or older people. The disease isn’t passed from person to person—you can’t catch it from someone else.
- COPD has no cure yet, and doctors don’t know how to reverse the damage to the airways and lungs. However, treatments and lifestyle changes can help you feel better, stay more active, and slow the progress of the disease.

How Can COPD Be Prevented?

You can take steps to prevent COPD before it starts. If you already have COPD, you can take steps to prevent complications and slow the progress of the disease.

Prevent COPD Before It Starts

The best way to prevent COPD is to not start smoking or to quit smoking. Smoking is the leading cause of COPD.

Learning Activity

Take an ungraded quiz about COPD.

Test your knowledge about the causes and symptoms of COPD. Learn how the disease affects the lungs and how you can prevent its complications.

Chronic Bronchitis

Bronchitis is an inflammation of the bronchial tubes, the airways that carry air to your lungs. It causes a cough that often brings up mucus, as well as shortness of breath, wheezing, and chest tightness. There are two main types of bronchitis: acute and chronic.

Chronic bronchitis is one type of COPD (chronic obstructive pulmonary disease). The inflamed bronchi produce a lot of mucus. This leads to cough and difficulty getting air in and out of the lungs. Cigarette smoking is the most common cause. Breathing in other fumes and dusts over a long period of time may also cause chronic bronchitis. Treatment will help your symptoms, but chronic bronchitis is a long-term condition that keeps coming back or never goes away completely.

Emphysema

Emphysema is a type of chronic obstructive pulmonary disease (COPD) involving damage to the air sacs (alveoli) in the lungs. As a result, your body does not get the oxygen it needs. Emphysema makes it hard to catch your breath. You may also have a chronic cough and have trouble breathing during exercise.

The most common cause is cigarette smoking. If you smoke, quitting can help prevent you from getting the disease. If you already have emphysema, not smoking might keep it from getting worse. Treatment is based on whether your symptoms are mild, moderate or severe. Treatments include inhalers, oxygen, medications and sometimes surgery to relieve symptoms and prevent complications.

Asthma

Asthma is a chronic lung disease that inflames and narrows the airways, making it hard to breathe. The disease affects people of all ages, but it most often starts in childhood. People who have asthma may wheeze, cough, feel short of breath, or have chest tightness.

Asthma can't be cured, but it can be controlled. People who have asthma, or those who have children with asthma, can take an active role in their treatment. For example, they can work with their health care providers to create an asthma action plan. This plan gives guidance on taking medicines properly, avoiding asthma triggers, tracking levels of asthma control, responding to worsening symptoms, and seeking emergency care when needed. When asthma is well controlled, most people who have the disease are able to live normal, active lives.

> For more information about living with and managing asthma, go to the Health Topics Asthma article.

Diabetes

Diabetes is a disease in which your blood glucose, or sugar, levels are too high. Glucose comes from the foods you eat. Insulin is a hormone that helps the glucose get into your cells to give them energy. With Type 1 diabetes, your body does not make insulin. With Type 2 diabetes, the more common type, your body does not make or use insulin well. Without enough insulin, the glucose stays in your blood.

Over time, having too much glucose in your blood can cause serious problems. It can damage your eyes, kidneys, and nerves. Diabetes can also cause heart disease, stroke and even the need to remove a limb. Pregnant women can also get diabetes, called gestational diabetes.

A blood test can show if you have diabetes. Exercise, weight control and sticking to your meal plan can help control your diabetes. You should also monitor your glucose level and take medicine if prescribed.

Diabetes means your blood glucose, or blood sugar, is too high. With Type 1 diabetes, your pancreas does not make insulin. Insulin is a hormone that helps glucose get into your cells to give them energy. Without insulin, too much glucose stays in your blood. Over time, high blood glucose can lead to serious problems with your heart, eyes, kidneys, nerves, and gums and teeth.

Type 1 diabetes happens most often in children and young adults but can appear at any age. Symptoms may include

- Being very thirsty
- Urinating often
- Feeling very hungry or tired
- Losing weight without trying
- Having sores that heal slowly
- Having dry, itchy skin
- Losing the feeling in your feet or having tingling in your feet
- Having blurry eyesight

What are the most important things to do to prevent diabetes?

The Diabetes Prevention Program (DPP), a major federally funded study of 3,234 people at high risk for diabetes, showed that people can delay and possibly prevent the disease by losing a small amount of weight (5 to 7 percent of total body weight) through 30 minutes of physical activity 5 days a week and healthier eating.

What are the risk factors which increase the likelihood of developing diabetes?

- Being overweight or obese.
- Having a parent, brother, or sister with diabetes.
- Being African American, American Indian, Asian American, Pacific Islander, or Hispanic American/Latino heritage.
- Having a prior history of gestational diabetes or birth of at least one baby weighing more than 9 pounds.
- Having high blood pressure measuring 140/90 or higher.
- Having abnormal cholesterol with HDL ("good") cholesterol is 35 or lower, or triglyceride level is 250 or higher.
- Being physically inactive—exercising fewer than three times a week.

How does body weight affect the likelihood of developing diabetes?

Being overweight or obese is a leading risk factor for type 2 diabetes. Being overweight can keep your body from making and using insulin properly, and can also cause high blood pressure. The Diabetes Prevention Program (DPP), a major federally funded study of 3,234 people at high risk for diabetes, showed that moderate diet and exercise of about 30 minutes or more, 5 or more days per week, or of 150 or more minutes per week, resulting in a 5% to 7% weight loss can delay and possibly prevent type 2 diabetes.

Headache

Oh my aching head! Nearly everyone has had a headache. The most common type of headache is a tension headache. Tension headaches are due to tight muscles in your shoulders, neck, scalp and jaw. They are often related to stress, depression or anxiety. You are more likely to get tension headaches if you work too much, don't get enough sleep, miss meals or use alcohol.

Other common types of headaches include migraines, cluster headaches and sinus headaches. Most people can feel much better by making lifestyle changes, learning ways to relax and taking pain relievers.

Headaches can have many causes, but serious causes of headaches are rare. Sometimes headaches warn of a more serious disorder. Let your health care provider know if you have sudden, severe headaches. Get medical help right away if you have a headache after a blow to your head, or if you have a headache along with a stiff neck, fever, confusion, loss of consciousness or pain in the eye or ear.

A migraine is a very painful type of headache. People who get migraines often describe the pain as pulsing or throbbing in one area of the head. During migraines, people are very sensitive to light and sound. They may also become nauseated and vomit.

Migraine is three times more common in women than in men. Some people can tell when they are about to have a migraine because they see flashing lights or zigzag lines or they temporarily lose their vision.

Many things can trigger a migraine. These include

- Stress
- Lack of food or sleep
- Exposure to light
- Hormonal changes (in women)

Doctors used to believe migraines were linked to the opening and narrowing of blood vessels in the head. Now they believe the cause is related to genes that control the activity of some brain cells. Medicines can help prevent migraine attacks or help relieve symptoms of attacks when they happen. For many people, treatments to relieve stress can also help.

Arthritis

If you feel pain and stiffness in your body or have trouble moving around, you might have arthritis. Most kinds of arthritis cause pain and swelling in your joints. Joints are places where two bones meet, such as your elbow or knee. Over time, a swollen joint can become severely damaged. Some kinds of arthritis can also cause problems in your organs, such as your eyes or skin.

One type of arthritis, osteoarthritis, is often related to aging or to an injury. Other types occur when your immune system, which normally protects your body from infection, attacks your body's own tissues. Rheumatoid arthritis is the most common form of this kind of arthritis. Juvenile rheumatoid arthritis is a form of the disease that happens in children. Infectious arthritis is an infection that has spread from another part of the body to the joint.

Osteoarthritis is the most common form of arthritis. It causes pain, swelling and reduced motion in your joints. It can occur in any joint, but usually it affects your hands, knees, hips or spine.

Osteoarthritis breaks down the cartilage in your joints. Cartilage is the slippery tissue that covers the ends of bones in a joint. Healthy cartilage absorbs the shock of movement. When you lose cartilage, your bones rub together. Over time, this rubbing can permanently damage the joint. Factors that may cause osteoarthritis include

- Being overweight
- Getting older
- Injuring a joint

Therapies that manage osteoarthritis pain and improve function include exercise, weight control, rest, pain relief, alternative therapies, and surgery.

Skin Disorders

Did you know that your skin is the largest organ of your body? It is, in terms of both weight, between 6 and 9 pounds, and surface area, about 2 square yards. Your skin separates the inside of your body from the outside world. Skin:

- Protects you from bacteria and viruses that can cause infections
- Helps you sense the outside world, such as whether it is hot or cold, wet or dry
- Regulates your body temperature

Conditions that irritate, clog or inflame your skin can cause symptoms such as redness, swelling, burning and itching. Allergies, irritants, your genetic makeup and certain diseases and immune system problems can cause dermatitis, hives and other skin conditions. Many skin problems, such as acne, also affect your appearance.

Dermatitis

A rash is an area of irritated or swollen skin. It might be red and itchy, bumpy, scaly, crusty or blistered. Rashes are a symptom of many different medical conditions. Things that can cause a rash include other diseases, irritating substances, allergies, and your genetic makeup.

Contact dermatitis is a common cause of rashes. It causes redness, itching and burning where you have touched an irritant, such as a chemical, or something you are allergic to, like poison ivy.

Some rashes develop immediately. Others form over several days. If you scratch your rash, it might take longer to heal. The treatment for a rash usually depends on its cause. Options include moisturizers, lotions, baths, cortisone creams that relieve swelling, and antihistamines, which relieve itching.

Hives

Hives are red and sometimes itchy bumps on your skin. An allergic reaction to a drug or food usually causes them. Allergic reactions cause your body to release chemicals that can make your skin swell up in hives. People who have other allergies are more likely to get hives than other people. Other causes include infections and stress.

Hives are very common. They usually go away on their own, but if you have a serious case, you might need medicine or a shot. In rare cases, allergic reactions can cause a dangerous swelling in your airways, making it hard to breathe – which is a medical emergency.

Acne

Acne is a common skin disease that causes pimples. Pimples form when hair follicles under your skin clog up. Most pimples form on the face, neck, back, chest and shoulders. Anyone can get acne, but it is common in teenagers and young adults. It is not serious, but it can cause scars.

No one knows exactly what causes acne. Hormone changes, such as those during the teenage years and pregnancy, probably play a role. There are many myths about what causes acne. Chocolate and greasy foods are often blamed, but there is little evidence that foods have much effect on acne in most people. Another common myth is that dirty skin causes acne; however, blackheads and pimples are not caused by dirt. Stress doesn't cause acne, but stress can make it worse.

If you have acne

- Clean your skin gently
- Try not to touch your skin
- Avoid the sun

Treatments for acne include medicines and creams.

Scabies

Scabies is an itchy skin condition caused by the microscopic mite *Sarcoptes scabei*. It is common all over the world, and it affects people of all races and social classes. Scabies spreads quickly in crowded conditions where there is frequent skin-to-skin contact between people. Hospitals, child-care centers and nursing homes are examples. Scabies can easily infect sex partners and other household members. Sharing clothes, towels, and bedding can also spread scabies. You cannot get scabies from a pet. Pets get a different mite infection called mange.

Symptoms are

- Pimple-like irritations or a rash
- Intense itching, especially at night
- Sores caused by scratching

Several lotions are available to treat scabies. The infected person's clothes, bedding and towels should be washed in hot water and dried in a hot dryer.

Psoriasis

Psoriasis is a skin disease that causes itchy or sore patches of thick, red skin with silvery scales. You usually get them on your elbows, knees, scalp, back, face, palms and feet, but they can show up on other parts of your body. A problem with your immune system causes psoriasis. In a process called cell turnover, skin cells that grow deep in your skin rise to the surface. Normally, this takes a month. In psoriasis, it happens in just days because your cells rise too fast.

Psoriasis can last a long time, even a lifetime. Symptoms come and go. Things that make them worse include

- Infections
- Stress
- Dry skin
- Certain medicines

Psoriasis usually occurs in adults. It sometimes runs in families. Treatments include creams, medications and light therapy.

Neurological Disorders

Neurological disorders include:

- Diseases caused by faulty genes, such as Huntington's disease and muscular dystrophy
- Problems with the way the nervous system develops, such as spina bifida
- Degenerative diseases, where nerve cells are damaged or die, such as Parkinson's disease and Alzheimer's disease
- Injuries to the spinal cord and brain
- Seizure disorders, such as epilepsy
- Cancer, such as brain tumors
- Meningitis

Huntington's Disease

Huntington's disease (HD) is an inherited disease that causes certain nerve cells in the brain to waste away. People are born with the defective gene, but symptoms usually don't appear until middle age. Early symptoms of HD may include uncontrolled movements, clumsiness or balance problems. Later, HD can take away the ability to walk, talk or swallow. Some people stop recognizing family members. Others are aware of their environment and are able to express emotions. If one of your parents has Huntington's disease, you have a 50-50 chance of getting it. A blood test can tell if you have the HD gene and will develop the disease. Genetic counseling can help you weigh the risks and benefits of taking the test. There is no cure. Medicines can help manage some of the symptoms, but cannot slow down or stop the disease.

Muscular Dystrophy

Muscular dystrophy (MD) refers to a group of more than 30 inherited diseases that cause muscle weakness and muscle loss. Some forms of MD appear in infancy or childhood, while others may not appear until middle age or later. The different muscular dystrophies vary in who they affect and the symptoms. All forms of MD grow worse as the person's muscles get weaker. Most people with MD eventually lose the ability to walk.
There is no cure for muscular dystrophy. Treatments include physical and speech therapy, orthopedic devices, surgery and medications. Some people with muscular dystrophy have mild cases that worsen slowly. Other cases are disabling and severe.

Spina Bifida

Spina bifida is the most common disabling birth defect in the United States. It is a type of neural tube defect, which is a problem with the spinal cord or its coverings. It happens if the fetal spinal column doesn't close completely during the first month of pregnancy. There is usually nerve damage that causes at least some paralysis of the legs. Many people with spina bifida will need assistive devices such as braces, crutches or wheelchairs. They may have learning difficulties, urinary and bowel problems or hydrocephalus, a buildup of fluid in the brain.

There is no cure. Treatments focus on the complications, and can include surgery, medicine and physiotherapy. Taking folic acid can reduce the risk of having a baby with spina bifida. It's in most multivitamins. Women who could become pregnant should take it daily.

Parkinson's Disease

Parkinson's disease is a disorder that affects nerve cells, or neurons, in a part of the brain that controls muscle movement. In Parkinson's, neurons that make a chemical called dopamine die or do not work properly. Dopamine normally sends signals that help coordinate your movements. No one knows what damages these cells. Symptoms of Parkinson's disease may include

- Trembling of hands, arms, legs, jaw and face
- Stiffness of the arms, legs and trunk
- Slowness of movement
- Poor balance and coordination

As symptoms get worse, people with the disease may have trouble walking, talking or doing simple tasks. They may also have problems such as depression, sleep problems or trouble chewing, swallowing or speaking.

Parkinson's usually begins around age 60, but it can start earlier. It is more common in men than in women. There is no cure for Parkinson's disease. A variety of medicines sometimes help symptoms dramatically.

Alzheimer's Disease

Alzheimer's disease (AD) is the most common form of dementia among older people. Dementia is a brain disorder that seriously affects a person's ability to carry out daily activities.

AD begins slowly. It first involves the parts of the brain that control thought, memory and language. People with AD may have trouble remembering things that happened recently or names of people they know. A related problem, mild cognitive impairment(MCI), causes more memory problems than normal for people of the same age. Many, but not all, people with MCI will develop AD.

In AD, over time, symptoms get worse. People may not recognize family members or have trouble speaking, reading or writing. They may forget how to brush their teeth or comb their hair. Later on, they may become anxious or aggressive, or wander away from home. Eventually, they need total care. This can cause great stress for family members who must care for them.

AD usually begins after age 60. The risk goes up as you get older. Your risk is also higher if a family member has had the disease.

No treatment can stop the disease. However, some drugs may help keep symptoms from getting worse for a limited time.

Spinal Cord Injury

Your spinal cord is the part of your nervous system that relays messages to and from your brain. It is housed inside your vertebrae, which are the bone disks that make up your spine. Normally, your vertebrae protect your spinal cord. If they don't, you can sustain a spinal cord injury. Besides injuries, the spinal cord can develop

- Tumors
- Infections such as meningitis and poliomyelitis
- Inflammatory diseases
- Autoimmune diseases
- Degenerative diseases such as amyotrophic lateral sclerosis and spinal muscular atrophy

Symptoms vary but might include pain, numbness, loss of sensation and muscle weakness. These symptoms can occur around the spinal cord, and also in other areas such as your arms and legs. Treatments vary but often include medicines and surgery.

Epilepsy

Epilepsy is a brain disorder that causes people to have recurring seizures. The seizures happen when clusters of nerve cells, or neurons, in the brain send out the wrong signals. People may have strange sensations and emotions or behave strangely. They may have violent muscle spasms or lose consciousness.

Epilepsy has many possible causes, including illness, brain injury and abnormal brain development. In many cases, the cause is unknown.

Doctors use brain scans and other tests to diagnose epilepsy. It is important to start treatment right away. There is no cure for epilepsy, but medicines can control seizures for most people. When medicines are not working well, surgery or implanted devices such as vagus nerve stimulators may help. Special diets can help some children with epilepsy.

Meningitis

Meningitis is inflammation of the thin tissue that surrounds the brain and spinal cord, called the meninges. There are several types of meningitis. The most common is viral meningitis, which you get when a virus enters the body through the nose or mouth and travels to the brain. Bacterial meningitis is rare, but can be deadly. It usually starts with bacteria that cause a cold-like infection. It can block blood vessels in the brain and lead to stroke and brain damage. It can also harm other organs. Pneumococcal infections and meningococcal infections can cause bacterial meningitis.

Anyone can get meningitis, but it is more common in people whose bodies have trouble fighting infections. Meningitis can progress rapidly. You should seek medical care quickly if you have

- A sudden fever
- A severe headache
- A stiff neck

Early treatment can help prevent serious problems, including death. Vaccines can prevent some of the bacterial infections that cause meningitis. Parents of adolescents and students living in college dorms should talk to a doctor about the vaccination.

Learning Activity: What disease are you most afraid to get?

Click on Most Feared Diseases to compare your answer with others.

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Parkinson's Disease: MedlinePlus.gov

Spinal Cord Injury: MedlinePlus.gov

Epilepsy: NIH: National Institute of Neurological Disorders and Stroke via MedlinePlus.gov

Meningitis: NIH: National Institute of Neurological Disorders and Stroke via MedlinePlus.gov

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2.5.3.3: Cardiovascular Diseases and Disorders

If you're like most people, you think that heart disease is a problem for other folks. But heart disease is the number one killer in the U.S. It is also a major cause of disability. There are many different forms of heart disease. The most common cause of heart disease is narrowing or blockage of the coronary arteries, the blood vessels that supply blood to the heart itself. This is called coronary artery disease and happens slowly over time. It's the major reason people have heart attacks.

Other kinds of heart problems may happen to the valves in the heart, or the heart may not pump well and cause heart failure. Some people are born with heart disease.

Heart disease is the leading cause of the death in the U.S. Over one quarter of all deaths are from heart disease. It is also a major cause of disability. The risk of heart disease increases as you age. You have a greater risk of heart disease if you are a man over age 45 or a woman over age 55. You also are at greater risk if you have a close family member who had heart disease at an early age.

Fortunately, there are many things you can do reduce your chances of getting heart disease. You should

- Know your blood pressure and keep it under control
- Exercise regularly
- Don't smoke
- Get tested for diabetes and if you have it, keep it under control
- Know your cholesterol and triglyceride levels and keep them under control
- Eat a lot of fruits and vegetables
- Maintain a healthy weight

The vascular system is the body's network of blood vessels. It includes the arteries, veins and capillaries that carry blood to and from the heart. Problems of the vascular system are common and can be serious. Arteries can become thick and stiff, a problem called arteriosclerosis. Blood clots can clog vessels and block blood flow to the heart or brain. Weakened blood vessels can burst, causing bleeding inside the body.

You are more likely to have vascular disease as you get older. Other factors that make vascular disease more likely include

- Family history of vascular or heart diseases
- Pregnancy
- Illness or injury
- Long periods of sitting or standing still
- Any condition that affects the heart and blood vessels, such as diabetes or high cholesterol
- Smoking
- Obesity

Losing weight, eating healthy foods, being active and not smoking can help vascular disease. Other treatments include medicines and surgery.

Learning Activity

Complete the Risk Assessment Tool for Estimating Your 10-year Risk of Having a Heart Attack.

- Were there any surprises for you in the results?
- If so, what are you going to do about it?

Heart Disease Risk Factors

This video—presented by the National Heart, Lung, and Blood Institute, part of the National Institutes of Health—discusses the risk factors for heart disease. You can control many heart disease risk factors, but some you cannot. Taking steps to prevent heart

disease is key. For example, don't smoke or quit smoking; aim for a healthy weight; be physically active; eat for heart health; know your cholesterol, blood pressure, and blood glucose numbers; and know your family's medical history.

For more information, visit the Health Topics Coronary Heart Disease Risk Factors and Heart Disease in Women articles.

Learning Activity

Watch this video about Managing High Blood Pressure With Lifestyle Changes:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

This video—presented by the National Heart, Lung, and Blood Institute, part of the National Institutes of Health—shows how Kendra, the mother of a teenaged daughter, has learned to manage her high blood pressure. Before being diagnosed with high blood pressure, Kendra suffered from chronic headaches and tiredness. At a health fair sponsored by her company, Kendra learned that her blood pressure was high, which prompted her to see her doctor.

After being diagnosed with high blood pressure, Kendra made a commitment to living a healthier lifestyle. By following a healthy diet and being physically active, she lost almost 60 pounds. With the support of her girlfriend and daughter, Kendra has maintained her weight loss and continues to make lifestyle changes that allow her to live an active, happy life.

What Is Coronary Heart Disease?

Coronary heart disease (CHD), also called coronary artery disease, is a condition in which plaque (pronounced: plak) builds up inside the coronary arteries. These arteries supply oxygen-rich blood to your heart muscle.

Plaque is made up of fat, cholesterol, calcium, and other substances found in the blood. When plaque builds up in the arteries, the condition is called atherosclerosis. The buildup of plaque occurs over many years.

Atherosclerosis

Over time, plaque hardens and narrows your coronary arteries. This limits the flow of oxygen-rich blood to your heart muscle.mEventually, an area of plaque can rupture (break open). This causes a blood clot to form on the surface of the plaque. If the clot becomes large enough, it can mostly or completely block blood flow through a coronary artery.

Overview

If the flow of oxygen-rich blood to your heart muscle is reduced or blocked, angina or a heart attack may occur.

Angina is chest pain or discomfort. It may feel like pressure or squeezing in your chest. The pain also may occur in your shoulders, arms, neck, jaw, or back. Angina pain may even feel like indigestion.

A heart attack occurs if the flow of oxygen-rich blood to a section of heart muscle suddenly becomes blocked. If blood flow isn't restored quickly, the section of heart muscle begins to die. Without quick treatment, a heart attack can lead to serious problems and even death.

Over time, CHD can weaken the heart muscle and lead to heart failure and arrhythmias. Heart failure is a condition in which your heart can't pump enough blood to meet your body's needs. Arrhythmias are problems with the rate or rhythm of the heartbeat.

Outlook

CHD is the most common type of heart disease. In the United States, CHD is the #1 cause of death for both men and women. Lifestyle changes, medicines, and medical procedures can help prevent or treat CHD and may reduce the risk of related health problems.

Learning Activity

Watch Living With and Managing Coronary Artery Disease:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

This video—presented by the National Heart, Lung, and Blood Institute, part of the National Institutes of Health—describes coronary artery disease (CAD), its symptoms and complications, and ways to manage CAD risk factors.

CAD, also called coronary heart disease, is the leading cause of death for both men and women in the United States. CAD occurs if plaque builds up in the arteries of the heart. Plaque narrows the arteries and reduces blood flow to the heart muscle. This can lead to angina (chest pain or discomfort), a heart attack, heart failure, or arrhythmias (irregular heartbeats).

The good news is that lifestyle changes and medicines can help control CAD risk factors and prevent or delay the disease. Lifestyle changes include quitting smoking, following a healthy eating plan, maintaining a healthy weight, and being physically active.

What Causes Coronary Heart Disease?

Research suggests that coronary heart disease (CHD) starts when certain factors damage the inner layers of the coronary arteries. These factors include:

- Smoking
- High levels of certain fats and cholesterol in the blood
- High blood pressure
- High levels of sugar in the blood due to insulin resistance or diabetes

When damage occurs, your body starts a healing process. The healing may cause plaque to build up where the arteries are damaged.

The buildup of plaque in the coronary arteries may start in childhood. Over time, plaque can narrow or block some of your coronary arteries. This reduces the flow of oxygen-rich blood to your heart muscle.

Eventually, an area of plaque can rupture (break open). If this happens, blood cell fragments called platelets (PLATE-lets) will stick to the site of the injury and may clump together to form blood clots. Blood clots narrow the coronary arteries even more and worsen angina or cause a heart attack.

Who Is at Risk for Coronary Heart Disease?

In the United States, coronary heart disease (CHD) is the #1 cause of death for both men and women. Each year, more than half a million Americans die from CHD.

Certain traits, conditions, or habits—known as risk factors—may raise your risk for CHD. The more risk factors you have, the more

likely you are to develop the disease.

You can control many risk factors, which may help prevent or delay CHD.

Major Risk Factors

- **Unhealthy blood cholesterol levels.** This includes high LDL cholesterol (sometimes called "bad" cholesterol) and low HDL cholesterol (sometimes called "good" cholesterol).
- **High blood pressure.** Blood pressure is considered high if it stays at or above 140/90 mmHg over time. If you have diabetes or chronic kidney disease, high blood pressure is defined as 130/80 mmHg or higher. (The mmHg is millimeters of mercury—the units used to measure blood pressure.)
- **Smoking.** Smoking can damage and tighten blood vessels, lead to unhealthy cholesterol levels, and raise blood pressure. Smoking also can limit how much oxygen reaches the body's tissues.
- **Insulin resistance.** This condition occurs if the body can't use its own insulin properly. Insulin is a hormone that helps move blood sugar into cells where it's used as an energy source. Insulin resistance may lead to diabetes.
- **Diabetes.** With this disease, the body's blood sugar level is too high because the body doesn't make enough insulin or doesn't use its insulin properly.
- **Overweight or obesity.** The terms "overweight" and "obesity" refer to body weight that's greater than what is considered healthy for a certain height.
- **Metabolic syndrome.** Metabolic syndrome is the name for a group of risk factors that raises your risk for CHD and other health problems, such as diabetes and stroke.
- **Lack of physical activity.** Lack of physical activity can worsen other risk factors for CHD, such as unhealthy blood cholesterol levels, high blood pressure, diabetes, and overweight or obesity.
- **Unhealthy diet.** An unhealthy diet can raise your risk for CHD. Foods that are high in saturated and *trans* fats, cholesterol, sodium (salt), and sugar can worsen other risk factors for CHD.
- **Older age.** As you get older, your risk for CHD increases. Genetic or lifestyle factors cause plaque to build up in your arteries as you age. By the time you're middle-aged or older, enough plaque has built up to cause signs or symptoms.
  - In men, the risk for CHD increases after age 45.
  - In women, the risk for CHD increases after age 55.
- **Family history of early heart disease.** Your risk increases if your father or a brother was diagnosed with CHD before 55 years of age, or if your mother or a sister was diagnosed with CHD before 65 years of age.

Although older age and a family history of early heart disease are risk factors, it doesn't mean that you'll develop CHD if you have one or both. Controlling other risk factors often can lessen genetic influences and prevent CHD, even in older adults.

Emerging Risk Factors

Researchers continue to study other possible risk factors for CHD:

- High levels of a protein called C-reactive protein (CRP) in the blood may raise the risk for CHD and heart attack. High levels of CRP are a sign of inflammation in the body.
- Inflammation is the body's response to injury or infection. Damage to the arteries' inner walls may trigger inflammation and help plaque grow.

Research is under way to find out whether reducing inflammation and lowering CRP levels also can reduce the risk for CHD and heart attack.

- High levels of triglycerides in the blood also may raise the risk for CHD, especially in women. Triglycerides are a type of fat.

Other Risks Related to Coronary Heart Disease

Other conditions and factors also may contribute to CHD, including:

- **Sleep apnea**. Sleep apnea is a common disorder in which you have one or more pauses in breathing or shallow breaths while you sleep. Untreated sleep apnea can increase your risk for high blood pressure, diabetes, and even a heart attack or stroke.
- **Stress**. Research shows that the most commonly reported "trigger" for a heart attack is an emotionally upsetting event, especially one involving anger.

- **Alcohol**. Heavy drinking can damage the heart muscle and worsen other risk factors for CHD. Men should have no more than two drinks containing alcohol a day. Women should have no more than one drink containing alcohol a day.
- **Preeclampsia**. This condition can develop during pregnancy. The two main signs of preeclampsia are a rise in blood pressure and excess protein in the urine. Preeclampsia is linked to an increased lifetime risk of heart disease, including CHD, heart attack, heart failure, and high blood pressure.

What Are the Signs and Symptoms of Coronary Heart Disease?

A common symptom of coronary heart disease (CHD) is angina. Angina is chest pain or discomfort that occurs if an area of your heart muscle doesn't get enough oxygen-rich blood.

Angina may feel like pressure or squeezing in your chest. You also may feel it in your shoulders, arms, neck, jaw, or back. Angina pain may even feel like indigestion. The pain tends to get worse with activity and go away with rest. Emotional stress also can trigger the pain.

Another common symptom of CHD is shortness of breath. This symptom happens if CHD causes heart failure. When you have heart failure, your heart can't pump enough blood to meet your body's needs. Fluid builds up in your lungs, making it hard to breathe.

The severity of these symptoms varies. They may get more severe as the buildup of plaque continues to narrow the coronary arteries.

Signs and Symptoms of Heart Problems Related to Coronary Heart Disease

Some people who have CHD have no signs or symptoms, a condition called silent CHD. The disease may not be diagnosed until a person has signs or symptoms of a heart attack, heart failure, or an arrhythmia (an irregular heartbeat).

Learning Activity

Watch this short video titled Heart Attack Warning Symptoms. It speaks to the 7 main symptoms of a heart attack. It uses real women's stories to personalize the heart attack experience, and encourages women who experience these symptoms to get checked out.

This video is presented by the NIH's National Heart, Lung, and Blood Institute.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Heart Attack

Each year over a million people in the U.S. have a heart attack. About half of them die. Many people have permanent heart damage or die because they don't get help immediately. It's important to know the symptoms of a heart attack and call 9-1-1 if someone is having them. Those symptoms include

- Chest discomfort—pressure, squeezing, or pain
- Shortness of breath
- Discomfort in the upper body—arms, shoulder, neck, back
- Nausea, vomiting, dizziness, lightheadedness, sweating

These symptoms can sometimes be different in women.

What exactly is a heart attack? Most heart attacks happen when a clot in the coronary artery blocks the supply of blood and oxygen to the heart. Often this leads to an irregular heartbeat—called an arrhythmia—that causes a severe decrease in the pumping function of the heart. A blockage that is not treated within a few hours causes the affected heart muscle to die.

Heart With Muscle Damage and a Blocked Artery

The most common heart attack symptom is chest pain or discomfort. Most heart attacks involve discomfort in the center or left side of the chest that often lasts for more than a few minutes or goes away and comes back.

The discomfort can feel like uncomfortable pressure, squeezing, fullness, or pain. The feeling can be mild or severe. Heart attack pain sometimes feels like indigestion or heartburn.

The symptoms of angina can be similar to the symptoms of a heart attack. Angina pain usually lasts for only a few minutes and goes away with rest.

Chest pain or discomfort that doesn't go away or changes from its usual pattern (for example, occurs more often or while you're resting) can be a sign of a heart attack. If you don't know whether your chest pain is angina or a heart attack, call 911.

All chest pain should be checked by a doctor.

Other common signs and symptoms of a heart attack include:

- Upper body discomfort in one or both arms, the back, neck, jaw, or upper part of the stomach
- Shortness of breath, which may occur with or before chest discomfort
- Nausea (feeling sick to your stomach), vomiting, light-headedness or fainting, or breaking out in a cold sweat
- Sleep problems, fatigue (tiredness), or lack of energy

Heart Failure

Heart failure is a condition in which your heart can't pump enough blood to meet your body's needs. Heart failure doesn't mean that your heart has stopped or is about to stop working.

The most common signs and symptoms of heart failure are shortness of breath or trouble breathing; fatigue; and swelling in the ankles, feet, legs, stomach, and veins in the neck.

All of these symptoms are the result of fluid buildup in your body. When symptoms start, you may feel tired and short of breath after routine physical effort, like climbing stairs.

Arrhythmia

An arrhythmia is a problem with the rate or rhythm of the heartbeat. When you have an arrhythmia, you may notice that your heart is skipping beats or beating too fast.

Some people describe arrhythmias as a fluttering feeling in the chest. These feelings are called palpitations. Some arrhythmias can cause your heart to suddenly stop beating. This condition is called sudden cardiac arrest (SCA). SCA usually causes death if it's not treated within minutes.

How Can Coronary Heart Disease Be Prevented or Delayed?

Taking action to control your risk factors can help prevent or delay coronary heart disease (CHD). Your risk for CHD increases with the number of risk factors you have.

- One step you can take is to adopt a healthy lifestyle. Following a healthy diet is an important part of a healthy lifestyle.
- A healthy diet includes a variety of fruits, vegetables, and whole grains. It also includes lean meats, poultry, fish, beans, and fat-free or low-fat milk or milk products. A healthy diet is low in saturated fat, *trans* fat, cholesterol, sodium (salt), and added sugar.
- If you're overweight or obese, work with your doctor to create a reasonable weight-loss plan. Controlling your weight helps

you control CHD risk factors.
- Be as physically active as you can. Physical activity can improve your fitness level and your health. Talk with your doctor about what types of activity are safe for you.
- If you smoke, quit. Smoking can damage and tighten blood vessels and raise your risk for CHD. Talk with your doctor about programs and products that can help you quit. Also, try to avoid secondhand smoke.
- Know your family history of health problems related to CHD. If you or someone in your family has CHD, be sure to tell your doctor.
- If lifestyle changes aren't enough, you also may need medicines to control your CHD risk factors. Take all of your medicines as prescribed.

Angina

Angina is chest pain or discomfort you get when your heart muscle does not get enough blood. It may feel like pressure or a squeezing pain in your chest. It may feel like indigestion. You may also feel pain in your shoulders, arms, neck, jaw or back.

Angina is a symptom of coronary artery disease (CAD), the most common heart disease. CAD happens when a sticky substance called plaque builds up in the arteries that supply blood to the heart, reducing blood flow.

There are three types of angina: stable, unstable, and variant. Unstable angina is the most dangerous. It does not follow a pattern and can happen without physical exertion. It does not go away with rest or medicine. It is a sign that you could have a heart attack soon.

Not all chest pain or discomfort is angina. If you have chest pain, you should see your health care provider.

Congestive heart failure

Heart failure is a condition in which the heart can't pump enough blood throughout the body. Heart failure does not mean that your heart has stopped or is about to stop working. It means that your heart is not able to pump blood the way it should.

The weakening of the heart's pumping ability causes

- Blood and fluid to back up into the lungs
- The buildup of fluid in the feet, ankles and legs—called edema
- Tiredness and shortness of breath

The leading causes of heart failure are coronary artery disease, high blood pressure, and diabetes.

Treatment includes treating the underlying cause of your heart failure, medicines, and heart transplantation if other treatments fail.

Heart failure is a serious condition. About 5 million people in the U.S. have heart failure. It contributes to 300,000 deaths each year.

Congenital heart disorders

A congenital heart defect is a problem with the structure of the heart. It is present at birth. Congenital heart defects are the most common type of major birth defect.

A baby's heart begins to develop shortly after conception. During development, structural defects can occur. These defects can involve the walls of the heart, the valves of the heart and the arteries and veins near the heart. Congenital heart defects can disrupt the normal flow of blood through the heart. The blood flow can

- Slow down
- Go in the wrong direction or to the wrong place
- Be blocked completely

Treatment for the defect can include medicines, surgery and other medical procedures and heart transplants. The treatment depends on the type and severity of the defect and a child's age, size and general health. Today, many children born with complex

heart defects grow to adulthood and lead productive lives.

Stroke

A stroke is a medical emergency. Strokes happen when blood flow to your brain stops. Within minutes, brain cells begin to die. There are two kinds of stroke. The more common kind, called ischemic stroke, is caused by a blood clot that blocks or plugs a blood vessel in the brain. The other kind, called hemorrhagic stroke, is caused by a blood vessel that breaks and bleeds into the brain. “Mini-strokes” or transient ischemic attacks (TIAs), occur when the blood supply to the brain is briefly interrupted.

Symptoms of stroke are

- Sudden numbness or weakness of the face, arm or leg (especially on one side of the body)
- Sudden confusion, trouble speaking or understanding speech
- Sudden trouble seeing in one or both eyes
- Sudden trouble walking, dizziness, loss of balance or coordination
- Sudden severe headache with no known cause

If you have any of these symptoms, you must get to a hospital quickly to begin treatment. Acute stroke therapies try to stop a stroke while it is happening by quickly dissolving the blood clot or by stopping the bleeding. Post-stroke rehabilitation helps individuals overcome disabilities that result from stroke damage. Drug therapy with blood thinners is the most common treatment for stroke.

Incidence of Stroke

Every 40 seconds, someone in the United States has a stroke. In 2008 alone, more than 133,000 Americans died from stroke—or one person every four minutes—making it the fourth leading cause of death in the United States.

A stroke, sometimes called a brain attack, occurs when a blockage stops the flow of blood to the brain or when a blood vessel in or around the brain bursts. Although many people think of stroke as a condition that affects only older adults, strokes can and do occur in people of all ages. In fact, nearly a quarter of all strokes occur in people younger than age 65.

Each year, almost 800,000 strokes occur in the United States. Strokes often lead to serious, life-changing complications that include:

- Paralysis or weakness on one side of the body.
- Problems with thinking, awareness, attention, learning, judgment, and memory.
- Problems understanding or forming speech.
- Difficulty controlling or expressing emotions.
- Numbness or strange sensations.
- Pain in the hands and feet.
- Depression.

To help protect yourself and your loved ones, learn what steps you can take to prevent a stroke and how to spot a stroke if one occurs.

Lowering Your Risk for Stroke

Demographic factors such as family history, age, sex, and race/ethnicity can all play a role in an individual’s stroke risk. Regardless of your background, however, there are several things you can do to lower your chances of having a stroke.

For example, cigarette smoking contributes to one in every five strokes in the United States. Smoking—and even exposure to second-hand smoke—can thicken the blood and make it more likely to clot. Thicker blood flow can lead to increased plaque buildup in your arteries and damage to the blood vessels leading to the brain, which can cause or worsen a stroke. So, quit smoking—or better yet, don’t start.

In 2011, the Department of Health and Human Services launched the Million Hearts™ initiative to prevent a million heart attacks and strokes by 2017. A primary focus is on the ABCS to prevent cardiovascular disease, including stroke, and contribute to overall

health

- **A**ppropriate Aspirin therapy
  - Ask your doctor if taking aspirin is right for you.
- **B**lood pressure control
  - Keeping your blood pressure under control reduces your risk of heart attack and stroke. More than half of the world's stroke deaths are caused by elevated blood pressure levels.
- **C**holesterol management
  - Get your cholesterol checked regularly and manage it with diet and physical activity or with medication, if needed.
- Smoking cessation
- Exercise regularly.
- Eat a healthy diet that's low in sodium.
- Maintain a healthy weight.
- Prevent or control diabetes.
- Limit your alcohol intake (fewer than two drinks per day for men, or one drink per day for women).

Recognizing the Signs of Stroke

When responding to a stroke, every minute counts. The sooner a patient receives medical treatment, the lower the risk for death or disability. If you or someone you know exhibits the following signs or symptoms, call 9-1-1 immediately:

- Numbness or weakness of the face, arm, or leg, especially on one side of the body
- Confusion, trouble speaking, or difficulty understanding
- Trouble seeing in one or both eyes
- Trouble walking, dizziness, or loss of balance and coordination
- Severe headache with no known cause

Optional Learning Activity

Learn about CPR at Be The Beat, an online Sudden Cardiac Arrest awareness initiative to teach the simple steps that can save a life.

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2.5.3.4: Cancer

Cancer begins in your cells, which are the building blocks of your body. Normally, your body forms new cells as you need them, replacing old cells that die. Sometimes this process goes wrong. New cells grow even when you don't need them, and old cells don't die when they should. These extra cells can form a mass called a tumor. Tumors are abnormal growths in your body. They are made up of extra cells. Normally, old cells die, and new ones take their place. Sometimes, however, this process goes wrong. New cells form even when you don't need them, and old cells don't die when they should. When these extra cells form a mass, it is called a tumor.

Tumors can be either benign or malignant. Benign tumors aren't cancer. Malignant ones are. Benign tumors grow only in one place. They cannot spread or invade other parts of your body. Even so, they can be dangerous if they press on vital organs, such as your brain. Treatment often involves surgery. Benign tumors usually don't grow back.

Cells from malignant tumors can invade nearby tissues. They can also break away and spread to other parts of the body.

Most cancers are named for where they start. For example, lung cancer starts in the lung, and breast cancer starts in the breast. The spread of cancer from one part of the body to another is called metastasis. Symptoms and treatment depend on the cancer type and how advanced it is.

Treatments

Treatment plans may include surgery, radiation and/or chemotherapy.

Radiation is a form of energy released in particles or waves. In high doses, radiation destroys cells or keeps them from multiplying.

Radiation therapy is a cancer treatment. Its goal is to kill cancer cells and shrink tumors. Unlike cancer cells, most of your normal cells recover from radiation therapy. Doctors try to protect normal cells by limiting the radiation dosage and spreading treatment out over time. When they use radiation machines, they shield as much of your body as possible while targeting the cancer.

Normally, your cells grow and die in a controlled way. Cancer cells keep forming without control. Chemotherapy is drug therapy that can kill these cells or stop them from multiplying. However, it can also harm healthy cells, which causes side effects.

During chemotherapy you may have no side effects or just a few. The kinds of side effects you have depend on the type and dose of chemotherapy you get. Side effects vary, but common ones are nausea, vomiting, tiredness, pain and hair loss. Healthy cells usually recover after chemotherapy, so most side effects gradually go away.

Your course of therapy will depend on the cancer type, the chemotherapy drugs used, the treatment goal and how your body responds. You may get treatment every day, every week or every month. You may have breaks between treatments so that your body has a chance to build new healthy cells. You might take the drugs by mouth, in a shot or intravenously.

What Is Risk?

Do you know the four types of risk factors that affect your cancer risk? Or that your level of contact with these risk factors can affect your risk? This section explains the concept of risk and lets you test your knowledge of the subject. Go to this website to understand cancer risk factors.

Can I Lower My Risk?

Here you can explore your risk for 6 cancers: breast, cervical, colon, lung, prostate, and skin. What are the risk factors for each of these cancers? Which risk factors apply to you? And what can you do to reduce your risk?

- Breast Cancer
- Cervical Cancer
- Colorectal Cancer

- Lung Cancer
- Prostate Cancer
- Skin Cancer

Is This News Story True?

You've heard the stories about things like cell phones and deodorants causing cancer. How do you decide if the stories you find in the media are accurate? It is important to analyze what you read in the paper, see on television, hear on the radio, or find on the Internet. A good analysis will help you determine whether the information is likely to be accurate. Below is a list of questions to consider when you hear about new cancer research studies.

- Who is reporting the results?
  - Is the newspaper, radio or TV station, or Internet site a reliable source of medical news? You might want to talk to your health care provider to help you judge the reliability of the source.
- Was the study based in the laboratory, on animals, or on people?
  - The results of research on people are more likely to be meaningful to you.
- How large is the study?
  - In general, when it comes to understanding medical risks, the larger the study the more valid the data will be for the general population.
- Does it include people like you?
  - Check to see if some of the people in the study were the same age, sex, ethnic background, income group as yourself and had the same health concerns.
- Are the results presented in an easy-to-understand way?
  - They should use absolute risk, relative risk, or some other easy-to-understand number.
- Does the report clearly tell what behavior or medical treatment was studied?
  - Information about the study should include what behavior or medical treatment was being studied. It should also include what outcomes, such as lower cancer risk or increased detection, were measured in the study.
- What are other possible explanations for the study results?
  - Researchers should discuss other possible explanations for the results. These may include other risk factors or problems with the research.
- Where was the research done?
  - Scientists at a medical school or large hospital, for example, might be better able to conduct complex experiments or have more experience.
- Has the study been published in a peer-reviewed journal?
  - Medical journals use a peer review process to help ensure the quality of the research. (Peer review is an appraisal of research against accepted standards by professionals in the field.)

Skin Cancer

Skin cancer is the most common form of cancer in the United States. The two most common types of skin cancer—basal cell and squamous cell carcinomas—are highly curable. However, melanoma, the third most common skin cancer, is more dangerous. About 65%–90% of melanomas are caused by exposure to ultraviolet (UV) light.

Each year, more than 68,000 Americans are diagnosed with melanoma, and another 48,000 are diagnosed with an early form of the disease that involves only the top layer of skin. Also, more than 2 million people are treated for basal cell or squamous cell skin cancer each year. Basal cell skin cancer is several times more common than squamous cell skin cancer.

Skin cancers are named for the type of cells that become malignant (cancer). The three most common types are:

- **Melanoma**: Melanoma begins in melanocytes (pigment cells). Most melanocytes are in the skin. See the picture of a melanocyte and other skin cells. Melanoma can occur on any skin surface. In men, it's often found on the skin on the head, on the neck, or between the shoulders and the hips. In women, it's often found on the skin on the lower legs or between the shoulders and the hips.Melanoma is rare in people with dark skin. When it does develop in people with dark skin, it's usually found under the fingernails, under the toenails, on the palms of the hands, or on the soles of the feet.
- **Basal cell skin cancer**: Basal cell skin cancer begins in the basal cell layer of the skin. It usually occurs in places that have been in the sun. For example, the face is the most common place to find basal cell skin cancer.In people with fair skin, basal cell skin cancer is the most common type of skin cancer.

- **Squamous cell skin cancer**: Squamous cell skin cancer begins in squamous cells. In people with dark skin, squamous cell skin cancer is the most common type of skin cancer, and it's usually found in places that are not in the sun, such as the legs or feet.However, in people with fair skin, squamous cell skin cancer usually occurs on parts of the skin that have been in the sun, such as the head, face, ears, and neck.

Unlike moles, skin cancer can invade the normal tissue nearby. Also, skin cancer can spread throughout the body. Melanoma is more likely than other skin cancers to spread to other parts of the body. Squamous cell skin cancer sometimes spreads to other parts of the body, but basal cell skin cancer rarely does.

When skin cancer cells do spread, they break away from the original growth and enter blood vessels or lymph vessels. The cancer cells may be found in nearby lymph nodes. The cancer cells can also spread to other tissues and attach there to form new tumors that may damage those tissues. The spread of cancer is called metastasis.

Symptoms of Melanoma

Often the first sign of melanoma is a change in the shape, color, size, or feel of an existing mole. Melanoma may also appear as a new mole. Thinking of "ABCDE" can help you remember what to look for:

- **Asymmetry**: The shape of one half does not match the other half.
- **Border that is irregular**: The edges are often ragged, notched, or blurred in outline. The pigment may spread into the surrounding skin.
- **Color that is uneven**: Shades of black, brown, and tan may be present. Areas of white, gray, red, pink, or blue may also be seen.
- **Diameter**: There is a change in size, usually an increase. Melanomas can be tiny, but most are larger than the size of a pea (larger than 6 millimeters or about 1/4 inch).
- **Evolving**: The mole has changed over the past few weeks or months.

Melanomas can vary greatly in how they look. Many show all of the ABCDE features. However, some may show changes or abnormal areas in only one or two of the ABCDE features.

In more advanced melanoma, the texture of the mole may change. The skin on the surface may break down and look scraped. It may become hard or lumpy. The surface may ooze or bleed. Sometimes the melanoma is itchy, tender, or painful.

Visit the National Cancer Institute's Symptoms of Melanoma webpage to view photos of an asymmetric melanoma and a dysplastic nevus.

A change on the skin is the most common sign of skin cancer. This may be a new growth, a sore that doesn't heal, or a change in an old growth. Not all skin cancers look the same. Usually, skin cancer is not painful.

Common symptoms of basal cell or squamous cell skin cancer include:

- A lump that is small, smooth, shiny, pale, or waxy
- A lump that is firm and red
- A sore or lump that bleeds or develops a crust or a scab
- A flat red spot that is rough, dry, or scaly and may become itchy or tender
- A red or brown patch that is rough and scaly

Risk Factors

When you're told that you have skin cancer, it's natural to wonder what may have caused the disease. The main risk factor for skin cancer is exposure to sunlight (UV radiation), but there are also other risk factors. A risk factor is something that may increase the chance of getting a disease.

People with certain risk factors are more likely than others to develop skin cancer. Some risk factors vary for the different types of skin cancer.

Risks for Any Type of Skin Cancer

Studies have shown that the following are risk factors for the three most common types of skin cancer:

- **Sunlight**: Sunlight is a source of **UV radiation**. It's the most important risk factor for any type of skin cancer. The sun's rays cause skin damage that can lead to cancer.
- **Severe, blistering sunburns**: People who have had at least one severe, blistering sunburn are at increased risk of skin cancer. Although people who burn easily are more likely to have had sunburns as a child, sunburns during adulthood also increase the risk of skin cancer.
- **Lifetime sun exposure**: The total amount of sun exposure over a lifetime is a risk factor for skin cancer.
- **Tanning**: Although a tan slightly lowers the risk of sunburn, even people who tan well without sunburning have a higher risk of skin cancer because of more lifetime sun exposure.

Sunlight can be reflected by sand, water, snow, ice, and pavement. The sun's rays can get through clouds, windshields, windows, and light clothing.

In the United States, skin cancer is more common where the sun is strong. For example, more people in Texas than Minnesota get skin cancer. Also, the sun is stronger at higher elevations, such as in the mountains.
Doctors encourage people to limit their exposure to sunlight.

- **Sunlamps and tanning booths**: Artificial sources of UV radiation, such as sunlamps and tanning booths, can cause skin damage and skin cancer. Health care providers strongly encourage people, especially young people, to avoid using sunlamps and tanning booths. The risk of skin cancer is greatly increased by using sunlamps and tanning booths before age 30.
- **Personal history**: People who have had melanoma have an increased risk of developing other melanomas. Also, people who have had basal cell or squamous cell skin cancer have an increased risk of developing another skin cancer of any type.
- **Family history**: Melanoma sometimes runs in families. Having two or more close relatives (mother, father, sister, brother, or child) who have had this disease is a risk factor for developing melanoma.
- **Skin that burns easily**: Having fair (pale) skin that burns in the sun easily, blue or gray eyes, red or blond hair, or many freckles increases the risk of skin cancer.
- **Certain medical conditions or medicines**: Medical conditions or medicines (such as some antibiotics, hormones, or antidepressants) that make your skin more sensitive to the sun increase the risk of skin cancer. Also, medical conditions or medicines that suppress the immune system increase the risk of skin cancer.

Other Risk Factors for Melanoma

The following risk factors increase the risk of melanoma:

- **Dysplastic nevus**: A dysplastic nevus is a type of mole that looks different from a common mole. A dysplastic nevus may be bigger than a common mole, and its color, surface, and border may be different. It's usually wider than a pea and may be longer than a peanut. A dysplastic nevus can have a mixture of several colors, from pink to dark brown. Usually, it's flat with a smooth, slightly scaly or pebbly surface, and it has an irregular edge that may fade into the surrounding skin. A dysplastic nevus is more likely than a common mole to turn into cancer. However, most do not change into melanoma. A doctor will remove a dysplastic nevus if it looks like it might have changed into melanoma.
- **More than 50 common moles**: Usually, a common mole is smaller than a pea, has an even color (pink, tan, or brown), and is round or oval with a smooth surface. Having many common moles increases the risk of developing melanoma.

Symptoms of Melanoma

Often the first sign of melanoma is a change in the shape, color, size, or feel of an existing mole. Melanoma may also appear as a new mole. Thinking of "ABCDE" can help you remember what to look for:

- **Asymmetry**: The shape of one half does not match the other half.
- **Border that is irregular**: The edges are often ragged, notched, or blurred in outline. The pigment may spread into the surrounding skin.
- **Color that is uneven**: Shades of black, brown, and tan may be present. Areas of white, gray, red, pink, or blue may also be seen.
- **Diameter**: There is a change in size, usually an increase. Melanomas can be tiny, but most are larger than the size of a pea

(larger than 6 millimeters or about 1/4 inch).
- **Evolving**: The mole has changed over the past few weeks or months.

Melanomas can vary greatly in how they look. Many show all of the ABCDE features. However, some may show changes or abnormal areas in only one or two of the ABCDE features.

In more advanced melanoma, the texture of the mole may change. The skin on the surface may break down and look scraped. It may become hard or lumpy. The surface may ooze or bleed. Sometimes the melanoma is itchy, tender, or painful.

How To Check Your Skin

Your doctor or nurse may suggest that you do a regular skin self-exam to check for the development of a new skin cancer.

The best time to do this exam is after a shower or bath. Check your skin in a room with plenty of light. Use a full-length mirror and a hand-held mirror.

It's best to begin by learning where your birthmarks, moles, and other marks are and their usual look and feel.

Check for anything new:

- A new mole (that looks different from your other moles)
- A new red or darker color flaky patch that may be a little raised
- A new flesh-colored firm bump
- A change in the size, shape, color, or feel of a mole
- A sore that doesn't heal

Check yourself from head to toe:

- Look at your face, neck, ears, and scalp. You may want to use a comb or a blow dryer to move your hair so that you can see better. You also may want to have a relative or friend check through your hair. It may be hard to check your scalp by yourself.
- Look at the front and back of your body in the mirror. Then, raise your arms and look at your left and right sides.
- Bend your elbows. Look carefully at your fingernails, palms, forearms (including the undersides), and upper arms.
- Examine the back, front, and sides of your legs. Also look around your genital area and between your buttocks.
- Sit and closely examine your feet, including your toenails, your soles, and the spaces between your toes.

By checking your skin regularly, you'll learn what is normal for you. It may be helpful to record the dates of your skin exams and to write notes about the way your skin looks. If your doctor has taken photos of your skin, you can compare your skin to the photos to help check for changes. If you find anything unusual, see your doctor.

Learning Activity

Check out your risk of melanoma using the Melanoma Cancer Risk Assessment Tool.

This is an interactive tool that allows doctors to estimate a person's absolute risk of developing invasive melanoma (skin cancer) over the next 5 years for people age 20 to 70 years. The tool allows doctors to identify individuals at higher risk of melanoma in order to plan appropriate screening interventions with them.

What is breast cancer?

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the breast, it is called breast cancer. The breast is made up of three main parts: glands, ducts, and connective tissue. Sometimes, breast cells become abnormal and grow faster than normal cells. These extra cells form a mass called a tumor. Some tumors are "benign," or not cancerous. Other tumors are "malignant," meaning they are cancerous and have the ability to spread to other parts of the breast and body and disrupt normal functions in those areas.
All women are at risk for breast cancer.

Men can also get breast cancer, but this is rare. Breast cancer is the second most common cancer in women. Among Hispanic

women, it is the most common cause of cancer deaths, and it is the second most common cause of cancer deaths among white, black, Asian or Pacific Islander, and American Indian or Alaska Native women. Although more white women get breast cancer, more black women die from it. Each year, approximately 190,000 women are diagnosed with breast cancer and 40,000 women die from the disease.

What puts me at greater risk?

Several factors may affect your risk of developing breast cancer, including:

- Getting older
- Not having children, or having your first child later in life
- Starting your first menstrual period at an early age
- Beginning menopause at a late age
- Having a personal history of breast cancer or certain benign breast diseases, such as atypical ductal hyperplasia
- Having close family relatives (such as a mother, sister, father, or daughter) who have had breast cancer
- Having a genetic condition, such as certain mutations in your BRCA1 or BRCA2 genes
- Having been treated with radiation therapy to the breast or chest
- Being overweight, particularly after menopause
- Using hormone replacement therapy for a long time
- Using oral contraceptives
- Drinking alcohol
- Being physically inactive

What are the symptoms?

When breast cancer starts out, it is too small to feel and does not cause signs and symptoms. As it grows, however, breast cancer can cause changes in how the breast looks or feels. Symptoms may include:

- A new lump in the breast
- A lump that has changed
- A change in the size or shape of the breast
- Pain in the breast or nipple that does not go away
- Flaky, red, or swollen skin anywhere on the breast
- A nipple that is very tender or that turns inward
- Blood or any other type of fluid coming from the nipple that is not milk when nursing a baby

These symptoms may be caused by something other than cancer, but the only way to know is to get checked.

How can I find out if I have breast cancer?

Women should begin to have routine screenings for breast cancer at the age of 50. Women under the age of 50 should talk to their health care provider about when and how often they should be screened. If you have any risk factors or symptoms of breast cancer, talk to a doctor, nurse, or health care professional.

A mammogram is the best test for finding breast cancer early. It is a series of X-ray pictures of the breast that allow doctors to look for early signs of breast cancer, sometimes up to three years before it can be felt. If your mammogram is abnormal or more tests are required, do not panic. An abnormal mammogram does not always mean you have cancer. It does mean that you will need to have some additional X-rays or other tests before your doctor can be sure. Other tests may include an ultrasound (picture taken of the breast using sound waves) or a biopsy (removing tissue samples to be looked at closely under a microscope). You may be referred to a breast specialist or a surgeon, because these doctors are experts in diagnosing breast problems. Treatment is most effective when breast cancer is found early, and many women go on to live long and healthy lives. How can I prevent breast cancer?

Scientists are studying how best to prevent breast cancer. There are things you can do to help lower your risk of getting breast cancer, including:

- Staying physically active with regular exercise

- Maintaining a healthy weight
- Avoiding hormone replacement therapy (HRT), or finding out the risks and benefits of HRT and if it is right for you
- Limiting the amount of alcohol that you drink

Learning Activity

Check out your risk of getting breast cancer using The Breast Cancer Risk Assessment Tool.

This is an interactive tool that allows doctors to estimate a woman's absolute risk of developing invasive breast cancer over the next 5 years for women age 35 to 90 years (lifetime risk) based on the woman's age and the risk factor information provided.

Colorectal Cancer

Colorectal cancer is cancer of the rectum or colon. It's the second leading cause of cancer-related death for both men and women.

People over the age of 50 are at the highest risk for colorectal cancer. Other risk factors include:

- Growths (called polyps) inside the colon
- Family history of colorectal cancer
- Smoking
- Health conditions like Crohn's Disease
- Being African-American

Here's the good news: you can reduce your risk if you get screened for colorectal cancer starting at the age of 50. You can also reduce your risk of colorectal cancer by:

- Getting active
- Eating healthy
- Quitting smoking

Learning Activity

Check out your risk of getting colorectal cancer using the The Colorectal Cancer Risk Assessment Tool.

This is an interactive tool designed to help people and their healthcare providers make informed choices about colorectal screening. The tool uses a respondent's answers to an online questionnaire to calculate that person's 5-year, 10-year, and lifetime risk of developing colorectal cancer.

Lung Cancer

Lung cancer is one of the most common cancers in the world. It is a leading cause of cancer death in men and women in the United States. Cigarette smoking causes most lung cancers. The more cigarettes you smoke per day and the earlier you started smoking, the greater your risk of lung cancer. High levels of pollution, radiation and asbestos exposure may also increase risk.

Common symptoms of lung cancer include

- A cough that doesn't go away and gets worse over time
- Constant chest pain
- Coughing up blood
- Shortness of breath, wheezing, or hoarseness
- Repeated problems with pneumonia or bronchitis
- Swelling of the neck and face
- Loss of appetite or weight loss
- Fatigue

There are many types of lung cancer. Each type of lung cancer grows and spreads in different ways and is treated differently. Treatment also depends on the stage, or how advanced it is. Treatment may include chemotherapy, radiation and surgery.

Ovarian Cancer

The sooner ovarian cancer is found and treated, the better your chance for recovery. But ovarian cancer is hard to detect early. Many times, women with ovarian cancer have no symptoms or just mild symptoms until the disease is in an advanced stage and hard to treat. Symptoms may include:

- Heavy feeling in pelvis
- Pain in lower abdomen
- Bleeding from the vagina
- Weight gain or loss
- Abnormal periods
- Unexplained back pain that gets worse
- Gas, nausea, vomiting, or loss of appetite

Treatment is usually surgery followed by treatment with medicines called chemotherapy.

Prostate Cancer

Prostate cancer is the most common cancer in men. Ask your doctor about the potential benefits and harms of prostate cancer screening tests.

Cancer is a disease in which abnormal cells in the body grow out of control. When cancer starts in the prostate, it is called prostate cancer. The prostate is a walnut-sized organ located just below the bladder and in front of the rectum in men. It produces fluid that makes up a part of semen.

Prostate cancer is the most commonly diagnosed cancer in men, and second only to lung cancer in the number of cancer deaths. In 2007 (the most recent year for which statistics are available), 223,307 men were diagnosed with prostate cancer, and 29,093 men died from it.

Symptoms

Different people have different symptoms for prostate cancer. Some men do not have symptoms at all. Some symptoms of prostate cancer are

- Difficulty in starting urination.
- Weak or interrupted flow of urine.
- Frequent urination, especially at night.
- Difficulty in emptying the bladder completely.
- Pain or burning during urination.
- Blood in the urine or semen.
- Pain in the back, hips, or pelvis that doesn't go away.
- Painful ejaculation.

If you have any symptoms that worry you, be sure to see your doctor right away. These symptoms may be caused by conditions other than prostate cancer.

Risk Factors

There is no way to know for sure if you will get prostate cancer. Men have a greater chance of getting prostate cancer if they are 50 years old or older, are African-American, or have a father, brother, or son who has had prostate cancer.

Screening for Prostate Cancer

Not all medical experts agree that screening for prostate cancer will save lives. Currently, there is not enough credible evidence to decide if the potential benefit of prostate cancer screening outweighs the potential risks. The potential benefit of prostate cancer screening is early detection of cancer, which may make treatment more effective. Potential risks include false positive test results (the test says you have cancer when you do not), treatment of prostate cancers that may never affect your health, and mild to serious side effects from treatment of prostate cancer.

Most organizations recommend that men discuss with their doctors the benefits and risks of prostate cancer screening. CDC supports informed decision making, which encourages men to talk with their doctors to learn the nature and risk of prostate cancer, understand the benefits and risks of the screening tests, and make decisions consistent with their preferences and values.

Tests that are commonly used to screen for prostate cancer are—

- **Digital rectal exam (DRE):** A doctor, nurse, or other health care professional places a gloved finger into the rectum to feel the size, shape, and hardness of the prostate gland.
- **Prostate specific antigen test (PSA):** PSA is a substance made by the prostate. The PSA test measures the level of PSA in the blood, which may be higher in men who have prostate cancer. However, other conditions such as an enlarged prostate, prostate infections, and certain medical procedures also may increase PSA levels.

Sources

Source: Cancer, NIH: National Cancer Institute via MedlinePlus, http://www.nlm.nih.gov/medlineplus/cancer.html

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2.5.3.5: Communicable (Infectious) Diseases

Introduction

Infectious diseases kill more people worldwide than any other single cause. Infectious diseases are caused by germs. Germs are tiny living things that are found everywhere—in air, soil, and water. You can get infected by touching germs.

There are four main kinds of germs:

- Bacteria—one-celled germs that multiply quickly and may release chemicals which can make you sick
- Viruses—capsules that contain genetic material, and use your own cells to multiply
- Fungi—primitive vegetables, like mushrooms or mildew
- Protozoa—one-celled animals that use other living things for food and a place to live

Learning Activity

Watch this video about Infectious Diseases Then and Now:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Bacteria

Bacteria are living things that have only one cell. Under a microscope, they look like balls, rods, or spirals. They are so small that a line of 1,000 could fit across a pencil eraser. Most bacteria won't hurt you—less than 1 percent makes people sick. Many are helpful. Some bacteria help to digest food, destroy disease-causing cells and give the body needed vitamins. Bacteria are also used in making healthy foods like yogurt and cheese.
But infectious bacteria can make you ill. They reproduce quickly in your body. Many give off chemicals called toxins, which can damage tissue and make you sick. Examples of bacteria that cause infections include *Streptococcus*, *Staphylococcus*, and *E. coli*.

Antibiotics are the usual treatment. When you take antibiotics, follow the directions carefully. Each time you take antibiotics, you increase the chances that bacteria in your body will learn to resist them. Later, you could get or spread an infection that those antibiotics cannot cure.

Strep Throat

Streptococcal infections (strep for short) cause a variety of health problems. There are two types: group A and group B. Antibiotics are used to treat both.

Group A strep causes

- Strep throat—a sore, red throat, sometimes with white spots on the tonsils
- Scarlet fever—red rash on the body
- Impetigo—a skin infection
- Toxic shock syndrome
- Cellulitis and necrotizing fasciitis (flesh-eating disease)

Group B strep can cause blood infections, pneumonia and meningitis in newborns. A screening test during pregnancy can tell if

you have it. If you do, I.V. antibiotics during labor can save your baby's life. Adults can also get group B strep infections, especially if they are elderly or already have health problems. Strep B can cause urinary tract infections, blood infections, skin infections and pneumonia in adults.

Tuberculosis (TB)

In developed countries, such as the United States, many people think TB is a disease of the past. TB, however, is still a leading killer of young adults worldwide. Some 2 billion people—one-third of the world's population—are thought to be infected with TB bacteria, *Mycobacterium tuberculosis* (*Mtb*).

TB is a chronic bacterial infection. It is spread through the air and usually infects the lungs, although other organs and parts of the body can be involved as well. Most people who are infected with *Mtb* harbor the bacterium without symptoms (have latent TB), but some will develop active TB disease. According to World Health Organization estimates, each year 8 million people worldwide develop active TB and nearly 2 million die.

One in 10 people who are infected with *Mtb* may develop active TB at some time in their lives. The risk of developing active disease is greatest in the first year after infection, but active disease often does not occur until many years later.

TB in the United States

In 2006, the Centers for Disease Control and Prevention (CDC) reported 13,799 cases of active TB. While the overall rate of new TB cases continues to decline in the United States since national reporting began in 1953, the annual decrease in TB cases has slowed from an average of 7.1 percent (1993–2000) to the current average of 3.8 percent (2001–2005), according to CDC. In addition to those with active TB, an estimated 10 to 15 million people in the United States have latent TB.

Minorities are affected disproportionately by TB, which occurs among foreign-born individuals nearly nine times as frequently as among people born in the United States. This is partially because they were often exposed to *Mtb* in their country of origin before moving to the United States. In 2004, a very high percentage of Asians (95 percent) and Hispanics (75 percent) who were born outside the United States were reported to have TB.

Tuberculosis (TB) is a bacterial infection caused by a germ called *Mycobacterium tuberculosis*. The bacteria usually attack the lungs, but they can also damage other parts of the body. TB spreads through the air when a person with TB of the lungs or throat coughs, sneezes or talks. If you have been exposed, you should go to your doctor for tests. You are more likely to get TB if you have a weak immune system.

Symptoms of TB in the lungs may include

- A bad cough that lasts 3 weeks or longer
- Weight loss
- Coughing up blood or mucus
- Weakness or fatigue
- Fever and chills
- Night sweats

If not treated properly, TB can be deadly. You can usually cure active TB by taking several medicines for a long period of time. People with latent TB can take medicine so that they do not develop active TB.

Viral Infections

Viruses are capsules with genetic material inside. They are very tiny, much smaller than bacteria. Viruses cause familiar infectious diseases such as the common cold, flu and warts. They also cause severe illnesses such as HIV/AIDS, smallpox and hemorrhagic fevers.

Viruses are like hijackers. They invade living, normal cells and use those cells to multiply and produce other viruses like themselves. This eventually kills the cells, which can make you sick.

Viral infections are hard to treat because viruses live inside your body's cells. They are "protected" from medicines, which usually

move through your bloodstream. Antibiotics do not work for viral infections. There are a few antiviral medicines available. Vaccines can help prevent you from getting many viral diseases.

Influenza

Flu is a respiratory infection caused by a number of viruses. The viruses pass through the air and enter your body through your nose or mouth. Between 5% and 20% of people in the U.S. get the flu each year. The flu can be serious or even deadly for elderly people, newborn babies and people with certain chronic illnesses.
Symptoms of the flu come on suddenly and are worse than those of the common cold. They may include

- Body or muscle aches
- Chills
- Cough
- Fever
- Headache
- Sore throat

Is it a cold or the flu? Colds rarely cause a fever or headaches. Flu almost never causes an upset stomach. And “stomach flu” isn’t really flu at all, but gastroenteritis.

The main way to keep from getting the flu is to get a yearly flu vaccine. If you get the flu, your health care provider may prescribe medicine to help your body fight the infection and lessen symptoms.

Learning Activity

Watch this video:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Common Cold

Sneezing, sore throat, a stuffy nose, coughing—everyone knows the symptoms of the common cold. It is probably the most common illness. In the course of a year, people in the United States suffer 1 billion colds.
You can get a cold by touching your eyes or nose after you touch surfaces with cold germs on them. You can also inhale the germs. Symptoms usually begin 2 or 3 days after infection and last 2 to 14 days. Washing your hands and staying away from people with colds will help you avoid colds.However, do not give aspirin to children. And do not give cough medicine to children under four.

There is no cure for the common cold. For relief, try

- Getting plenty of rest
- Drinking fluids
- Gargling with warm salt water
- Using cough drops or throat sprays
- Taking over-the-counter pain or cold medicines

Hepatitis B

Hepatitis B is one type of hepatitis—a liver disease—caused by the hepatitis B virus (HBV). Hepatitis B spreads by contact with an infected person’s blood, semen or other body fluid. An infected woman can give hepatitis B to her baby at birth.

If you get HBV, you may feel as if you have the flu, or you may have no symptoms at all. A blood test can tell if you have it. HBV usually gets better on its own after a few months. If it does not get better, it is called chronic HBV, which lasts a lifetime. Chronic HBV can lead to scarring of the liver, liver failure or liver cancer.
There is a vaccine for HBV. It requires three shots. All babies should get the vaccine, but older children and adults can get it too. If you travel to countries where Hepatitis B is common, you should get the vaccine.

Learning Activity

Are you at risk for viral hepatitis? Take this quick Hepatitis Risk Assessment test to find out.

Infectious mononucleosis

Infectious mononucleosis, or "mono," is an infection caused by the Epstein-Barr virus. The virus spreads through saliva, which is why it's sometimes called "kissing disease." Mono occurs most often in 15- to 17-year-olds. However, you can get it at any age. Symptoms of mono include

- Fever
- Sore throat
- Swollen lymph glands

Sometimes you may also have a swollen spleen. Serious problems are rare.

A blood test can show if you have mono. Most people get better in two to four weeks. However, you may feel tired for a few months afterward. Treatment focuses on helping symptoms and includes medicines for pain and fever, warm salt water gargles and plenty of rest and fluids.

Fungi

If you have ever had athlete's foot or a yeast infection, you can blame a fungus. A fungus is actually a primitive vegetable. Mushrooms, mold and mildew are examples. Fungi live in air, in soil, on plants and in water. Some live in the human body. Only about half of all types of fungi are harmful.

Some fungi reproduce through tiny spores in the air. You can inhale the spores or they can land on you. As a result, fungal infections often start in the lungs or on the skin. You are more likely to get a fungal infection if you have a weakened immune system or take antibiotics.

Fungi can be difficult to kill. For skin and nail infections, you can apply medicine directly to the infected area. Oral antifungal medicines are also available for serious infections.

Yeast Infections (or Candida)

Candida is the scientific name for yeast. It is a fungus that lives almost everywhere, including in your body. Usually, your immune system keeps yeast under control. If you are sick or taking antibiotics, it can multiply and cause an infection.

Yeast infections affect different parts of the body in different ways:

- Thrush is a yeast infection that causes white patches in your mouth
- Esophagitis is thrush that spreads to your esophagus, the tube that takes food from your mouth to your stomach. Esophagitis can make it hard or painful to swallow
- Women can get vaginal yeast infections, causing itchiness, pain and discharge
- Yeast infections of the skin cause itching and rashes
- Yeast infections in your bloodstream can be life-threatening

Antifungal medicines eliminate yeast infections in most people. If you have a weak immune system, treatment might be more difficult.

Parasitic Diseases

Parasites are living things that use other living things—like your body—for food and a place to live. You can get them from contaminated food or water, a bug bite, or sexual contact. Parasitic diseases can cause mild discomfort or be deadly.

Parasites range in size from tiny, one-celled organisms called protozoa to worms that can be seen with the naked eye. Some parasitic diseases happen in the United States. Contaminated water supplies can lead to Giardia infections. Cats can transmit toxoplasmosis, which is dangerous for pregnant women. Others, like malaria, are common in other parts of the world.

If you are traveling, it's important to drink only water you know is safe. Prevention is especially important. There are no vaccines for parasitic diseases. Some medicines are available to treat parasitic infections.

Pneumonia

Pneumonia is an inflammation of the lung, usually caused by an infection. Three common causes are bacteria, viruses and fungi. You can also get pneumonia by accidentally inhaling a liquid or chemical. People most at risk are older than 65 or younger than 2 years of age, or already have health problems.

If you have pneumonia, you may have difficulty breathing and have a cough and a fever. A physical exam and history can help determine if you have pneumonia. Chest x-rays and blood tests can help determine what is wrong. Treatment depends on what made you sick. If bacteria are the cause, antibiotics should help. Viral pneumonia may get better with rest and drinking liquids.

Preventing pneumonia is always better than treating it. The best preventive measures include washing your hands frequently, not smoking, and wearing a mask when cleaning dusty or moldy areas. There is a vaccine for pneumococcal pneumonia, a bacterial infection which accounts for up to a quarter of all pneumonias.

Defining Health Disparities

Despite prevention efforts, some groups of people are affected by HIV/AIDS, viral hepatitis, STDs, and TB more than other groups of people. The occurrence of these diseases at greater levels among certain population groups more than among others is often referred to as a health disparity. Differences may occur by gender, race or ethnicity, education, income, disability, geographic location and sexual orientation among others. Social determinants of health like poverty, unequal access to health care, lack of education, stigma, and racism are linked to health disparities.

Optional Learning Activity

For more information on this topic, see or listen to: What You Need to Know About Infectious Diseases.

Sources

Introduction: NIH: National Institute of Allergy and Infectious Diseases, MedlinePlus, http://www.nlm.nih.gov/medlineplus/infectiousdiseases.html

Strep Throat: NIH: National Institute of Allergy and Infectious Diseases via MedlinePlus.gov

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Parasitic Diseases: National Library of Medicine, National Institutes for Health via MedlinePlus.gov

Pneumonia: MedlinePlus.gov

Defining Health Disparities: Centers for Disease Control and Prevention, http://www.cdc.gov/nchhstp/healthdisparities/

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2.5.3.6: Immunity and Immunizations

In 2010, a pertussis (whooping cough) outbreak in California sickened 9,143 people and resulted in 10 infant deaths: the worst outbreak in 63 years (Centers for Disease Control 2011b). Researchers, suspecting that the primary cause of the outbreak was the waning strength of pertussis vaccines in older children, recommended a booster vaccination for 11–12-year-olds and also for pregnant women (Zacharyczuk 2011). Pertussis is most serious for babies; one in five needs to be hospitalized, and since they are too young for the vaccine themselves, it is crucial that people around them be immunized (Centers for Disease Control 2011b). Several states, including California, have been requiring the pertussis booster for older children in recent years with the hope of staving off another outbreak.

But what of people who do not want their children to have this vaccine, or any other? That question is at the heart of a debate that has been simmering for years. Vaccines are biological preparations that improve immunity against a certain disease. Vaccines have contributed to the eradication and weakening of numerous infectious diseases, including smallpox, polio, mumps, chicken pox, and meningitis.

However, many people express concern about potential negative side effects from vaccines. These concerns range from fears about overloading the child's immune system to controversial reports about devastating side effects of the vaccines. One misapprehension is that the vaccine itself might cause the disease it is supposed to be immunizing against.

Another commonly circulated concern is that vaccinations, specifically the MMR vaccine (MMR stands for measles, mumps, and rubella), are linked to autism. The autism connection has been particularly controversial. In 1998, a British physician named Andrew Wakefield published a study in Great Britain's Lancet magazine that linked the MMR vaccine to autism. The report received a lot of media attention, resulting in British immunization rates decreasing from 91 percent in 1997 to almost 80 percent by 2003, accompanied by a subsequent rise in measles cases (Devlin 2008). A prolonged investigation by the British Medical Journal proved that not only was the link in the study nonexistent, but that Dr. Wakefield had falsified data in order to support his claims (CNN 2011). Dr. Wakefield was discredited and stripped of his license, but the doubt still lingers in many parents' minds.

In the United States, many parents still believe in the now discredited MMR-autism link and refuse to vaccinate their children. Other parents choose not to vaccinate for various reasons like religious or health beliefs. In one instance, a boy whose parents opted not to vaccinate returned home to the U.S. after a trip abroad; no one yet knew he was infected with measles. The boy exposed 839 people to the disease and caused 11 additional cases of measles, all in other unvaccinated children, including one infant who had to be hospitalized. According to a study published in Pediatrics (2010), the outbreak cost the public sector $10,376 per diagnosed case. The study further showed that the intentional non-vaccination of those infected occurred in students from private schools, public charter schools, and public schools in upper-socioeconomic areas (Sugerman et al. 2010).

Consider these questions about immunization:

- Should parents be forced to immunize their children?
- How does this story of vaccines in a high-income region compare to that in a low-income region, like sub-Saharan Africa, where populations are often eagerly seeking vaccines rather than refusing them?
- Do you believe all children should receive vaccinations?

Immunity and Immunizations

Shots may hurt a little... but the diseases they can prevent can hurt a lot more! Immunization shots, or vaccinations, are essential. They protect against things like measles, mumps, rubella, hepatitis B, polio, diphtheria, tetanus and pertussis (whooping cough). Immunizations are important for adults as well as for children. Here's why.

Your immune system helps your body fight germs by producing substances to combat them. Once it does, the immune system "remembers" the germ and can fight it again. Vaccines contain germs that have been killed or weakened. When given to a healthy person, the vaccine triggers the immune system to respond and thus build immunity.

Before vaccines, people became immune only by actually getting a disease and surviving it. Immunizations are an easier and less risky way to become immune.

Optional Learning Activity

Take action to raise awareness of immunizations (e.g., Assist a school nurse to host an immunization education event for parents at a local school)

- Create and distribute an immunization reminder flyers to all the members of your organization, club or place of worship.

Vaccines

Vaccines are the best defense we have against serious, preventable, and sometimes deadly contagious diseases. Vaccines are some of the safest medical products available, but like any other medical product, there may be risks. Accurate information about the value of vaccines as well as their possible side-effects helps people to make informed decisions about vaccination.

Federal law requires that Vaccine Information Statements explaining vaccine benefits and risks be handed out whenever (before each dose) certain vaccinations are given. Vaccine Information Statements are available in Spanish and many different languages. In addition, more detailed information describing the benefits and risks of a particular vaccine is available in the Prescribing Information from the Food and Drug Administration.

The following sections answer common questions asked about vaccines and how vaccines are tested and monitored to ensure they are safe and effective. These sections are currently available in English only.
Vaccines are held to the highest standard of safety. The United States currently has the safest, most effective vaccine supply in history. Vaccines undergo a rigorous and extensive evaluation program to determine a product's safety and effectiveness. If a vaccine does receive approval, it is continuously monitored for safety and effectiveness.

Many partners work together to make sure vaccines are safe. Government health scientists work with manufacturers, health care providers, academia, and global health groups such as the World Health Organization to build a comprehensive vaccine safety system. At the Department of Health and Human Services, primarily three agencies work on vaccine safety:

- Centers for Disease Control and Prevention (CDC)
- National Institutes of Health (NIH)
- Food and Drug Administration (FDA)

Vaccines undergo rigorous and extensive testing to determine their safety and effectiveness prior to approval. Following approval, FDA carefully monitors the quality of vaccines—all manufactured lots must pass tests before they can be used. Vaccine manufacturers also must follow strict manufacturing standards, and FDA conducts routine inspections of manufacturing sites.

Scientists from FDA and CDC work closely to monitor reports of vaccine side effects (adverse events) after they are approved and used widely. FDA and CDC take all reports seriously, and work together to evaluate and address any potential problems.

Learning Activity

Watch this video titled Get The Picture: Childhood Immunizations:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

After talking with parents across the country, CDC put together this short video to help answer the tough questions that real moms had about childhood immunizations.

Understanding the importance of vaccines is crucial for you to protect your children's health. Read the script

- Did watching this video help you decide on whether or not to get your child immunized?
- Interview some parents to find out what they think about this issue.

Potential Side Effects

Vaccines, like all medical products, may cause side effects in some people. Most of these side effects are minor, such as redness or swelling at the injection site. Read further to learn about possible side effects from vaccines.

Any vaccine can cause side effects. For the most part these are minor (for example, a sore arm or low-grade fever) and go away within a few days.

Remember, vaccines are continually monitored for safety, and like any medication, vaccines can cause side effects. However, a decision not to immunize a child also involves risk and could put the child and others who come into contact with him or her at risk of contracting a potentially deadly disease.

How Well Do Vaccines Work?

Vaccines work really well. No medicine is perfect, of course, but most childhood vaccines produce immunity about 90–100% of the time.

What about the argument made by some people that vaccines don't work that well . . . that diseases would be going away on their own because of better hygiene or sanitation, even if there were no vaccines?

That simply isn't true. Certainly better hygiene and sanitation can help prevent the spread of disease, but the germs that cause disease will still be around, and as long as they are they will continue to make people sick.

All vaccines must be licensed (approved) by the Food and Drug Administration (FDA) before being used in the United States, and a vaccine must go through extensive testing to show that it works and that it is safe before the FDA will approve it. Among these tests are clinical trials, which compare groups of people who get a vaccine with groups of people who get a control. A vaccine is approved only if FDA makes the determination that it is safe and effective for its intended use.

If you look at the history of any vaccine-preventable disease, you will virtually always see that the number of cases of disease starts to drop when a vaccine is licensed. Vaccines are the most effective tool we have to prevent infectious diseases.

Prevention

Vaccines help the body's immune system prepare for future attacks. Vaccines consist of killed or modified microbes, parts of microbes, or microbial DNA that trick the body into thinking an infection has occurred. A vaccinated person's immune system attacks the harmless vaccine and prepares for invasions against the kind of microbe the vaccine contained. In this way, the person becomes immunized against the microbe: if re-exposure to the infectious microbe occurs, the immune system will quickly recognize how to stop the infection.

This section explains more in detail about how your immune system works to prevent you from getting sick. Knowing how your immune system works may help you understand how vaccines work with your immune system to protect you.

What is the Immune System?

The immune system is a network of cells, tissues, and organs that work together to defend the body against attacks by "foreign" invaders. These are primarily microbes—tiny organisms such as bacteria, parasites, and fungi that can cause infections. Viruses also cause infections, but are too primitive to be classified as living organisms. The human body provides an ideal environment for many microbes. It is the immune system's job to keep them out or, failing that, to seek out and destroy them.

When the immune system hits the wrong target, however, it can unleash a torrent of disorders, including allergic diseases, arthritis, and a form of diabetes. If the immune system is crippled, other kinds of diseases result.

The immune system is amazingly complex. It can recognize and remember millions of different enemies, and it can produce secretions (release of fluids) and cells to match up with and wipe out nearly all of them.

The secret to its success is an elaborate and dynamic communications network. Millions and millions of cells, organized into sets and subsets, gather like clouds of bees swarming around a hive and pass information back and forth in response to an infection. Once immune cells receive the alarm, they become activated and begin to produce powerful chemicals. These substances allow the cells to regulate their own growth and behavior, enlist other immune cells, and direct the new recruits to trouble spots.

In addition, scientists are rapidly unraveling the genetic blueprints that direct the human immune response, as well as those that dictate the biology of bacteria, viruses, and parasites. The combination of new technology and expanded genetic information will no doubt reveal even more about how the body protects itself from disease.

Mounting an Immune Response

Infections are the most common cause of human disease. They range from the common cold to debilitating conditions like chronic hepatitis to life-threatening diseases such as AIDS. Disease-causing microbes (pathogens) attempting to get into the body must first move past the body's external armor, usually the skin or cells lining the body's internal passageways.

The skin provides an imposing barrier to invading microbes. It is generally penetrable only through cuts or tiny abrasions. The digestive and respiratory tracts—both portals of entry for a number of microbes—also have their own levels of protection. Microbes entering the nose often cause the nasal surfaces to secrete more protective mucus, and attempts to enter the nose or lungs can trigger a sneeze or cough reflex to force microbial invaders out of the respiratory passageways. The stomach contains a strong acid that destroys many pathogens that are swallowed with food.

If microbes survive the body's front-line defenses, they still have to find a way through the walls of the digestive, respiratory, or urogenital passageways to the underlying cells. These passageways are lined with tightly packed epithelial cells covered in a layer of mucus, effectively blocking the transport of many pathogens into deeper cell layers.

Mucosal surfaces also secrete a special class of antibody called IgA, which in many cases is the first type of antibody to encounter an invading microbe. Underneath the epithelial layer a variety of immune cells, including macrophages, B cells, and T cells, lie in wait for any microbe that might bypass the barriers at the surface.

Next, invaders must escape a series of general defenses of the innate immune system, which are ready to attack without regard for specific antigen markers. These include patrolling phagocytes, natural killer T cells, and complement.

Microbes cross the general barriers then confront specific weapons of the adaptive immune system tailored just for them. These specific weapons, which include both antibodies and T cells, are equipped with singular receptor structures that allow them to recognize and interact with their designated targets.

Immunity

Long ago, physicians realized that people who had recovered from the plague would never get it again—they had acquired immunity. This is because some of the activated T and B cells had become memory cells. Memory cells ensure that the next time a person meets up with the same antigen, the immune system is already set to demolish it.

Immunity can be strong or weak, short-lived or long-lasting, depending on the type of antigen it encounters, the amount of antigen, and the route by which the antigen enters the body. Immunity can also be influenced by inherited genes. When faced with the same antigen, some individuals will respond forcefully, others feebly, and some not at all.

An immune response can be sparked not only by infection but also by immunization with vaccines. Some vaccines contain microorganisms—or parts of microorganisms— that have been treated so they can provoke an immune response but not full-blown disease.

Immunity can also be transferred from one individual to another by injections of serum rich in antibodies against a particular microbe (antiserum). For example, antiserum is sometimes given to protect travelers to countries where hepatitis A is widespread. The antiserum induces passive immunity against the hepatitis A virus. Passive immunity typically lasts only a few weeks or months.

Vaccines

For many years, healthcare providers have used vaccination to help the body's immune system prepare for future attacks. Vaccines consist of killed or modified microbes, parts of microbes, or microbial DNA that trick the body into thinking an infection has occurred.

A vaccinated person's immune system attacks the harmless vaccine and prepares for invasions against the kind of microbe the vaccine contained. In this way, the person becomes immunized against the microbe. Vaccination remains one of the best ways to prevent infectious diseases, and vaccines have an excellent safety record. Previously devastating diseases such as smallpox, polio, and whooping cough (pertussis) have been greatly controlled or eliminated through worldwide vaccination programs.

Recommended Vaccines for Young Adults

The transition to adulthood is an exciting time in a young person's life. Starting a career, getting an apartment, entering college, or joining the armed forces all offer unique rewards and challenges.

Yet young adults may not know that some vaccines can make this transitional time a healthier one.

Vaccines recommended for young adults ages 19–24 include:

- Meningococcal conjugate vaccine, which helps prevent meningococcal disease
- Tdap vaccine, which protects against tetanus, diphtheria, and pertussis (also known as whooping cough)
- HPV vaccine, which protects against the viruses that cause most cervical cancers, anal cancer, and genital warts
- Seasonal flu vaccine

There may be other vaccines recommended for young adults because their health, job, or lifestyle may put them at higher risk for certain diseases. Young adults should talk to a doctor or nurse to find out if there are other vaccines that they may need.

Learning Activity

Take this quiz to find out to find out which vaccines **YOU** may need.

Antibiotic / Antimicrobial Resistance

Antibiotics and similar drugs, together called antimicrobial agents, have been used for the last 70 years to treat patients who have infectious diseases. Since the 1940s, these drugs have greatly reduced illness and death from infectious diseases. Antibiotic use has been beneficial and, when prescribed and taken correctly, their value in patient care is enormous.

However, these drugs have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted to them, making the drugs less effective. People infected with antimicrobial-resistant organisms are more likely to have longer, more expensive hospital stays, and may be more likely to die as a result of the infection.

Sexually Transmitted Diseases and HIV

Sexually transmitted diseases (STDs) are infections that you can get from having sex with someone who has the infection. The causes of STDs are bacteria, viruses, and parasites. There are more than 20 types of STDs, including:

- Bacterial
  - Gonorrhea
- Viral
  - Genital herpes
  - HIV/AIDS
  - HPV
  - Syphilis
- Parasitic

- Trichomoniasis

Most STDs affect both men and women, but in many cases the health problems they cause can be more severe for women. If a pregnant woman has an STD, it can cause serious health problems for the baby.

If you have an STD caused by bacteria or parasites, your health care provider can treat it with antibiotics or other medicines. If you have an STD caused by a virus, there is no cure. Sometimes medicines can keep the disease under control. Correct usage of latex condoms greatly reduces, but does not completely eliminate, the risk of catching or spreading STDs.

Gonorrhea

Gonorrhea is a curable sexually transmitted disease. It is most common in young adults. The bacteria that cause gonorrhea can infect the genital tract, mouth or anus.

Gonorrhea does not always cause symptoms, especially in women. In men, gonorrhea can cause pain when urinating and discharge from the penis. If untreated, it can cause epididymitis, which affects the testicles and can lead to infertility. In women, gonorrhea can cause bleeding between periods, pain when urinating and increased discharge from the vagina. If untreated, it can lead to pelvic inflammatory disease, which causes problems with pregnancy and infertility. Gonorrhea can pass from mother to baby during pregnancy.

You can cure gonorrhea with antibiotics prescribed by your health care provider. Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading gonorrhea.

Genital Herpes

Genital herpes is a sexually transmitted disease (STD) caused by a herpes simplex virus (HSV). It can cause sores on your genital or rectal area, buttocks, and thighs. You can get it from having sex, even oral sex. The virus can spread even when sores are not present. Mothers can also infect their babies during childbirth.

Symptoms of herpes are called outbreaks. You usually get sores near the area where the virus has entered the body. They turn into blisters, become itchy and painful, and then heal. Sometimes people do not know they have herpes because they have no symptoms or very mild symptoms. The virus can be more serious in newborn babies or in people with weak immune systems.

Most people have outbreaks several times a year. Over time, you get them less often and the symptoms become milder. The virus stays in your body for life.

Medicines do not cure genital herpes, but they can to help your body fight the virus. This can help lessen symptoms, decrease outbreaks, and lower the risk of passing the virus to others. Correct usage of latex condoms can reduce, but not eliminate, the risk of catching or spreading herpes.

Learning Activity

Watch this video about Molly's story and herpes.

HPV (or genital warts)

Human papillomaviruses (HPV) are common viruses that can cause warts. There are more than 100 types of HPV. Most are harmless, but about 30 types put you at risk for cancer. These types affect the genitals and you get them through sexual contact with an infected partner. They are classified as either low-risk or high-risk. Low-risk HPV can cause genital warts. High-risk HPV can lead to cancers of the cervix, vulva, vagina, and anus in women. In men, it can lead to cancers of the anus and penis.

Although some people develop genital warts from HPV infection, others have no symptoms. Your health care provider can treat or remove the warts. In women, Pap smears can detect changes in the cervix that might lead to cancer.

Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading HPV. A vaccine can

protect against several types of HPV, including some that can cause cancer.

Trichomoniasis

Trichomoniasis is a sexually transmitted disease caused by a parasite. It affects both women and men, but symptoms are more common in women. Symptoms in women include a green or yellow discharge from the vagina, itching in or near the vagina and discomfort with urination. Most men with trichomoniasis don't have any symptoms, but it can cause irritation inside the penis.

You can cure trichomoniasis with antibiotics. In men, the infection usually goes away on its own without causing symptoms. But an infected man can continue to infect or reinfect a woman until he gets treated. So it's important that both partners get treated at the same time. Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading trichomoniasis.

AIDS and HIV

AIDS was first reported in the United States in 1981 and has since become a major worldwide epidemic. AIDS is caused by the human immunodeficiency virus, or HIV. By killing or damaging cells of the body's immune system, HIV progressively destroys the body's ability to fight infections and certain cancers. People diagnosed with AIDS may get life-threatening diseases called opportunistic infections. These infections are caused by microbes such as viruses or bacteria that usually do not make healthy people sick.

Since 1981, more than 980,000 cases of AIDS have been reported in the United States to the Centers for Disease Control and Prevention (CDC). According to CDC, more than 1,000,000 Americans may be infected with HIV, one-quarter of whom are unaware of their infection. The epidemic is growing most rapidly among minority populations and is a leading killer of African-American males ages 25 to 44. According to CDC, AIDS affects nearly seven times more African Americans and three times more Hispanics than whites. In recent years, an increasing number of African-American women and children are being affected by HIV/AIDS.

- The U.S. HIV/AIDS epidemic began in 1981 and continues to disproportionately affect minorities, men who have sex with men of all races, women, and youth.
- More than 1 million people in the United States currently are living with HIV/AIDS.
- About 21 percent of those infected with HIV are unaware of their infection.
- Since the U.S. epidemic began, 617,025 people have died of AIDS.
- In 2008, there were approximately 42,439 new HIV infections, with the highest proportion among African Americans despite the fact that they make up only 12 percent of the U.S. population.

HIV

HIV stands for human immunodeficiency virus. It kills or damages the body's immune system cells. AIDS stands for acquired immunodeficiency syndrome. It is the most advanced stage of infection with HIV.
HIV most often spreads through unprotected sex with an infected person. It may also spread by sharing drug needles or through contact with the blood of an infected person. Women can give it to their babies during pregnancy or childbirth.

The first signs of HIV infection may be swollen glands and flu-like symptoms. These may come and go a month or two after infection. Severe symptoms may not appear until months or years later.

A blood test can tell if you have HIV infection. Your health care provider can perform the test.

There is no cure, but there are many medicines to fight both HIV infection and the infections and cancers that come with it. People can live with the disease for many years.

AIDS Prevention

Currently, there is no vaccine to prevent HIV infection nor is there a cure for HIV/AIDS. To reduce your risk of becoming infected with HIV or transmitting the virus to others

- Get tested regularly for HIV
- Practice abstinence
- Remain faithful to your spouse or partner
- Consistently use male latex or female polyurethane condoms
- Do not share needles

Detection and Treatment in HIV Prevention

Testing and treatment of sexually transmitted diseases (STDs) can be an effective tool in preventing the spread of HIV, the virus that causes AIDS. An understanding of the relationship between STDs and HIV infection can help in the development of effective HIV prevention programs for persons with high-risk sexual behaviors.

What is the link between STDs and HIV infection?

Individuals who are infected with STDs are at least two to five times more likely than uninfected individuals to acquire HIV infection if they are exposed to the virus through sexual contact. In addition, if an HIV-infected individual is also infected with another STD, that person is more likely to transmit HIV through sexual contact than other HIV-infected persons (Wasserheit, 1992).

There is substantial biological evidence demonstrating that the presence of other STDs increases the likelihood of both transmitting and acquiring HIV.

- **Increased susceptibility.** STDs appear to increase susceptibility to HIV infection by two mechanisms. Genital ulcers (e.g., syphilis, herpes, or chancroid) result in breaks in the genital tract lining or skin. These breaks create a portal of entry for HIV. Additionally, inflammation resulting from genital ulcers or non-ulcerative STDs (e.g., chlamydia, gonorrhea, and trichomoniasis) increase the concentration of cells in genital secretions that can serve as targets for HIV (e.g., CD4+ cells).
- **Increased infectiousness.** STDs also appear to increase the risk of an HIV-infected person transmitting the virus to his or her sex partners. Studies have shown that HIV-infected individuals who are also infected with other STDs are particularly likely to shed HIV in their genital secretions. For example, men who are infected with both gonorrhea and HIV are more than twice as likely to have HIV in their genital secretions than are those who are infected only with HIV. Moreover, the median concentration of HIV in semen is as much as 10 times higher in men who are infected with both gonorrhea and HIV than in men infected only with HIV. The higher the concentration of HIV in semen or genital fluids, the more likely it is that HIV will be transmitted to a sex partner.

How can STD treatment slow the spread of HIV infection?

Evidence from intervention studies indicates that detecting and treating STDs may reduce HIV transmission.

- **STD treatment reduces an individual's ability to transmit HIV**. Studies have shown that treating STDs in HIV-infected individuals decreases both the amount of HIV in genital secretions and how frequently HIV is found in those secretions (Fleming, Wasserheit, 1999).
- Herpes can make people more susceptible to HIV infection, and it can make HIV-infected individuals more infectious. It is critical that all individuals, **especially those with herpes**, know whether they are infected with HIV and, if uninfected with HIV, take measures to protect themselves from infection with HIV.
- Among individuals with both herpes and HIV, trials are underway studying if treatment of the genital herpes helps prevent HIV transmission to partners.

Learning Activity

Watch this video about AIDS from PBS.

Illness, Sickness, and Disease

Discussing the complexities of what constitutes a disease requires careful distinction among related, but distinct concepts.

In 1973, Susser, an epidemiologist, proposed some definitions that remain useful. He used “illness” to refer to the subjective sense of feeling unwell; illness does not define a specific pathology, but refers to a person’s subjective experience of it, such as discomfort, tiredness, or general malaise. The way a patient reports symptoms is influenced by his or her cultural background, and Susser applied the term “sickness” to refer to socially and culturally held conceptions of health conditions (e.g., the dread of cancer or the stigma of mental illness), which in turn influence how the patient reacts). The social perceptions of disease that Illich described modify the ways a patient perceives and presents his symptoms.

Cultural conventions likewise affect where the boundary between disease and non-disease is placed: menopause may be considered a health issue in North America, but symptoms are far less commonly reported in Japan. Disease implies a focus on pathological processes that may or may not produce symptoms and that result in a patient’s illness. For example, a patient complains of tiredness and malaise–his illness as he experiences it. He consults a doctor about it–because he believes that he might have a sickness. The doctor might attribute the patient’s symptoms to a thyroid condition–a disease.

This model focuses on pathological processes, and on understanding, diagnosing, and treating the physical and biological aspects of disease. The goal of treatment is to restore the patient’s physiological integrity and function. Diagnosis involves recognizing and applying a label to a pattern of signs and symptoms that is at least partly understood in terms of abnormal structure or function of cells, organs, and systems. This offers a rational basis for the investigation of effective treatments. For instance, a certain pattern of chest pain known as angina pectoris is understood biologically as a disorder of the coronary arteries that causes cardiac ischemia, and the treatments it are geared to the specific causes of restoring cardiac blood flow and reducing cardiac effort.

Early biomedical conceptions supposed that a disease is either present or absent: a bacterium has invaded the body or it has not. However, as medicine increasingly tackled conditions, such as hypertension, which represent deviations from normal values, which themselves have a range and can be debated, it became apparent that there may be no set threshold for defining disease. Thus, instead of being seen as a state that is qualitatively distinct from health, many diseases have to be approached as a quantitative threshold on a continuum of biological variability. Organizations such as the World Health Organization (WHO) and the National Institutes of Health have proposed different classifications of hypertension and have changed how they constitute hypertension over time. Hypertension can be mild, moderate or severe, or defined as pre-hypertension or hypertension stage 1 or stage 2.

Optional: Video Lectures about Epidemics

Epidemics in Western Society is a course taught Frank Snowden at Yale.

This course consists of video lectures with an international analysis of the impact of epidemic diseases on western society and culture from the bubonic plague to HIV/AIDS and the recent experience of SARS and swine flu.

Leading themes include:

- infectious disease and its impact on society
- the development of public health measures
- the role of medical ethics
- the genre of plague literature
- the social reactions of mass hysteria and violence
- the rise of the germ theory of disease
- the development of tropical medicine
- a comparison of the social, cultural, and historical impact of major infectious diseases
- the issue of emerging and re-emerging diseases

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Sexually Transmitted Diseases and HIV: Sexually Transmitted Diseases, Centers for Disease Control and Prevention via MedlinePlus, http://www.nlm.nih.gov/medlineplus/sexuallytransmitteddiseases.html

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2.5.4: INTRODUCTION TO PERSONAL HEALTH

Learning Objectives

Students will be able to:

- Define health
- Demonstrate understanding of the role of health in the practice of health promotion
- Discuss the concepts of health, health education, health promotion and some related terms
- Identify social determinants of health
- List the levels of disease prevention
- Know the two overarching goals of Healthy People 2010
- Identify the dimensions of health disparity as described in Healthy People 2010
- Provide a literal definition of the term “disparity”
- Interpret three definitions of health disparity
- Distinguish between the terms “health inequality” and “health inequity

2.5.4.1: Health and Disease, Influence of Family and Community

2.5.4.2: Three Levels of Health Promotion/Disease Prevention

2.5.4.3: Culture, Beliefs, Attitudes, and Stigmatized Illnesses

2.5.4.4: Determinants of Health, Risk Factors, and Prevention

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- 5: Module 5- Energy and Metabolism has no license indicated.

2.5.4.1: Health and Disease, Influence of Family and Community

Your Own Views on Health

Note down your responses to the following questions:

- What does health mean to you?
- How important is health to you?
- What do you do (if anything) to stay healthy?

Illness and Disease

Although clearly related, the concepts of illness and disease are distinct. People have illness and physicians diagnose and treat disease.

- Disease is an objective term which implies a malfunctioning of the body or part of the body. Disease is pathological and is diagnosed on the basis of recognizable signs and symptoms.
- Illness is the subjective experience of pain, discomfort or disorder.

Although it is mostly safe to say that illness is the subjective experience of disease, it is possible to experience illness without having a disease and it is possible to have a disease and not feel ill.

Learning Activity

Think of a time when you were ill.

- Can you think of an illness experience which is not disease related?
- Can you think of a disease which may not make you feel ill?

Health Education: Basic Principles

In this session you will learn about the nature of health, health education, health promotion and some related concepts. This will help you to understand the social, psychological and physical components of health.

Definition and Concepts of Health

In the Oxford English Dictionary health is defined as: ‘the state of being free from sickness, injury, disease, bodily conditions; something indicating good bodily condition.”

- Now stop for a moment and think about someone you think is healthy and someone else who you would consider to be not healthy.
  - Look at the definition of health again.
  - Is it similar to the things you thought about when you thought of a healthy and an unhealthy person?

This definition of health is a widely publicized one. But you may have thought of someone who has a disability or wondered about someone who looks OK but who you know does no exercise. Clearly health is not quite as simple as the definition implies.
The concept of health is wide and the way we define health also depends on individual perception, religious beliefs, cultural values, norms, and social class. Generally, there are two different perspectives concerning people’s own definitions of health: a narrow perspective and a broader perspective.

Narrow Perspectives of Health

People with a narrow perspective consider health as the absence of disease or disability or biological dysfunction. According to this view (or model), to call someone unhealthy or sick means there should be evidence of a particular illness. Social, emotional and psychological factors are not believed to cause unhealthy conditions. This model is narrow and limits the definition of health to the physical and physiological capabilities that are necessary to perform routine tasks.

According to this definition, the individual is healthy if all the body parts, cells, tissues and organ systems are functioning well and there is no apparent dysfunction of the body.

Using this model people view the human body in the same terms as a computer, or mechanical device when something is wrong you take it to experts who maintain it. Physicians, unlike behavioral experts, often focus on treatment and clinical interventions with medication rather than educational interventions to bring about behavior change.

Serena's Story

- About two months ago Serena lost her six month old twins. She is grief stricken. She was always slender but now she looks very thin. She cannot sleep, she cannot eat and she doesn't want to talk to anyone.
- Do you think the view of health you have just read about applies to Serena?

This view of health ignores many of the social and psychological causes of ill health. Serena's grief is not an illness but it is certainly affecting her health.

In the next section we will discuss the broader perspective of health which includes other factors in addition to physical ones.

Broader Perspectives of Health

In the previous section you read about a narrow definition of health. This section will help you understand the concept of health in a broader and more holistic way.

Defining Health

The most widely used of the broader definitions of health is that within the constitution of the World Health Organization (1948), which defines health as: A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity. This classic definition is important, as it identifies the vital components of health. To more fully understand the meaning of health, it is important to understand each of its individual components.

Serena's Story

Think back to Serena.

- Describe her state of health.
- Serena is mentally distressed. She does not by any means have mental and social well-being.

Physical Health

To understand physical health you need to know what is considered to be physically *unhealthy* so that you can contrast the two. Physical health, which is one of the components of the definition of health, could be defined as the absence of diseases or disability of the body parts. Physical health could be defined as the ability to perform routine tasks without any physical restriction. The following examples can help you to understand someone who is physically unhealthy:

- A person who has been harmed due to a car accident
- A farmer infected by malaria and unable to do their farming duties
- A person infected by tuberculosis and unable to perform his or her tasks.

Think about someone with physical damage, perhaps due to a car accident.

According to the WHO definition, do you see them as healthy?

Also think about someone in your community who you would consider to be physically disabled.

While both of these people may be restricted in their movement and ability to do routine tasks they may still be in a state of physical and mental well-being.

Health is not limited to the biological integrity and the physiological functioning of the human body. Psychological health is also an important aspect of a health definition.

Psychological Health

- Think about people in the community who are showing behavior that may indicate they are going through a period of mental distress in their lives.
- Or think about Serena again.
- Do you think that everyone in distress shows the same sorts of symptoms?

Sometimes it can be really hard from the outside to tell if the person is struggling with mental health issues, but at other times they show symptoms that suggest a lack of self-awareness or personal identity, or an inability of rational and logical decision-making.

At other times it might be apparent that they are not looking after themselves and are without a proper purpose in their life. They may be drinking alcohol and have a non-logical response to any request. You may also notice that they have an inability to maintain their personal autonomy and are unable to maintain good relationships with people around them.

Social component

The social component of health is considered to be the ability to make and maintain 'acceptable' and 'proper' interactions and communicate with other people within the social environment. This component also includes being able to maintain satisfying interpersonal relationships and being able to fulfill a social role. Having a social role is the ability that people have to maintain their own identity while sharing, cooperating, communicating and enjoying the company of others. This is really important when participating in friendships and taking a full part in family and community life.

Which of the following examples could be considered to contribute to social health? Explain your answers.

1. Mourning when a close family member dies
2. Going to a football game or involvement in a community meeting
3. Celebrating traditional cultural events within your community
4. Shopping in the market
5. Creating and maintaining friendship.

In reality all these events could have a social component and help towards building people's social view of health. They all involve interacting with others and gaining support, friendship and in many instances joy from being with other people.

The World Health Organization in its Ottawa Charter said that health promotion is defined as the process of enabling people to increase control over, and to improve, their health. The aim of health promotion is to reduce the underlying causes of ill-health so that there is a long-term reduction in many diseases.

Summary

Health is a broad concept containing several different aspects. Physical and mental health issues are often interrelated and wellness is expressed through the integration of mental, physical, emotional, spiritual and social health components.

Self-Assessment Question

What do you understand by the following terms?

- Health
- Health promotion

Answer available at the end of this section.

Definitions of Health

If there are complexities in defining disease, there are even more in defining health. Definitions have evolved over time. In keeping with the biomedical perspective, early definitions of health focused on the theme of the body's ability to function; health was seen as a state of normal function that could be disrupted from time to time by disease. An example of such a definition of health is: "a state characterized by anatomic, physiologic, and psychological integrity; ability to perform personally valued family, work, and community roles; ability to deal with physical, biologic, psychological, and social stress."

Just as there was a shift from viewing disease as a state to thinking of it as a process, the same shift happened in definitions of health. Again, the WHO played a leading role when it fostered the development of the health promotion movement in the 1980s. This brought in a new conception of health, not as a state, but in dynamic terms of resiliency, in other words, as "a resource for living." The 1984 WHO revised definition of health defined it as "the extent to which an individual or group is able to realize aspirations and satisfy needs, and to change or cope with the environment. Health is a resource for everyday life, not the objective of living; it is a positive concept, emphasizing social and personal resources, as well as physical capacities. Thus, health referred to the ability to maintain homeostasis and recover from insults. Mental, intellectual, emotional, and social health referred to a person's ability to handle stress, to acquire skills, to maintain relationships, all of which form resources for resiliency and independent living.

Wellness

Many practitioners have expanded their focus to include wellness at the positive end of the health continuum. Some distinguish two interacting dimensions: disease versus non-disease and well-being versus ill-being; others expand the number of dimensions to include spiritual, emotional, social, and mental. Last commented that wellness is "a word used by behavioral scientists to describe a state of dynamic physical, mental, social, and spiritual well-being that enables a person to achieve full potential and an enjoyable life."

But with so much disease to treat, should physicians concern themselves with wellness? Is it appropriate for medicine to seek ways to promote positive health states? Some academics distinguish between a medical care system and a health care system, arguing that, to constrain costs, public funding should be limited to treating illness and restoring the patient's functional capacity. Others note that activities such as counseling and educating healthy individuals on diet and exercise promote wellness and resiliency, and so fall within the scope of normal practice as a part of preventive medicine. Some go further and argue that physicians should advocate for improved work and environmental conditions, such as promoting walking and cycling rather than driving, and should advocate for policies that redistribute income, limit access to unhealthy foods, and support children's programs.

As concepts of health and disease continue to broaden, there will no doubt be pressure for physicians to expand their role to include the promotion of positive health states in their patients. Reflecting this trend, clinical trials evaluating new pharmaceuticals must now include improved quality of life as an outcome, which obviously extends beyond simply improving biomedical indicators of pathology.

Discussions of wellness eroded the hold of the biomedical model. In its place, ecological models of health appeared; these recognize the complex interactions among people, their personal characteristics and the environment, and how these influence health.

Questions to Ponder

1. If no symptoms are produced, is it a disease?
2. Are health and disease different entities or merely different points along a continuum?
3. If so, should we abandon the notion of disease and think only of different levels of health, changing from a categorical to a dimensional model?

Disease or Syndrome?

As we learn more about the biological basis for a patient's illness, it may be reclassified as a disease. For example, constant feelings of tiredness became accepted as the medical condition of chronic fatigue syndrome. Sometimes when a doctor formally labels (diagnoses) a patient's complaint, the complaint is legitimized and this may reassure the patient. Often, however, a set of signs and symptoms eludes biomedical understanding. If the set is frequent enough to be a recognized pattern, it is termed a syndrome instead of a disease.

A syndrome refers to a complex of symptoms that occur together more often than would be expected by chance alone. Whereas diseases often receive explanatory labels (such as hemorrhagic stroke), syndromes are often given purely descriptive labels (e.g., Restless Leg Syndrome). Confusingly, the label 'syndrome' often persists long after the cause is discovered, as with Down syndrome, AIDS (Acquired Immunodeficiency Syndrome) or SARS (Severe Acute Respiratory Syndrome). Meanwhile, Chronic Fatigue Syndrome, Fibromyalgia, Irritable Bowel Syndrome, and Restless Leg Syndrome remain syndromic conditions which, so far, are not well explained by conventional biomedical models.

Learning Activity

Watch these videos – Population Health

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

These videos by Vancouver Coastal Health are an exploration of differences in health between people and their relationship to things such as income, education, and the neighborhoods in which we live. Residents share real examples about how the social determinants of health impact their lives.

- How has your belief about the relationship between health and other factors changed as a result of watching these videos?

Well-being Concepts

Well-being is a positive outcome that is meaningful for people and for many sectors of society, because it tells us that people perceive that their lives are going well. Good living conditions (e.g., housing, employment) are fundamental to well-being. Tracking these conditions is important for public policy. However, many indicators that measure living conditions fail to measure what

people think and feel about their lives, such as the quality of their relationships, their positive emotions and resilience, the realization of their potential, or their overall satisfaction with life—i.e., their "well-being." Well-being generally includes global judgments of life satisfaction and feelings ranging from depression to joy.

Why is well-being useful for public health?

- Well-being integrates mental health (mind) and physical health (body) resulting in more holistic approaches to disease prevention and health promotion.
- Well-being is a valid population outcome measure beyond morbidity, mortality, and economic status that tells us how people perceive their life is going from their own perspective.
- Well-being is an outcome that is meaningful to the public.
- Advances in psychology, neuroscience, and measurement theory suggest that well-being can be measured with some degree of accuracy.
- Results from cross-sectional, longitudinal and experimental studies find that well-being is associated with:
    - Self-perceived health
    - Longevity
    - Healthy behaviors
    - Mental and physical illness
    - Social connectedness
    - Productivity
    - Factors in the physical and social environment

Well-being can provide a common metric that can help policy makers shape and compare the effects of different policies (e.g., loss of greenspace might impact well-being more so than commercial development of an area).

Measuring, tracking and promoting well-being can be useful for multiple stakeholders involved in disease prevention and health promotion.

Well-being is associated with numerous health-, job-, family-, and economically-related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities.

Previous research lends support to the view that the negative affect component of well-being is strongly associated with neuroticism and that positive affect component has a similar association with extraversion. This research also supports the view that positive emotions—central components of well-being—are not merely the opposite of negative emotions, but are independent dimensions of mental health that can, and should be fostered. Although a substantial proportion of the variance in well-being can be attributed to heritable factors, environmental factors play an equally if not more important role.

How does well-being relate to health promotion?

Health is more than the absence of disease; it is a resource that allows people to realize their aspirations, satisfy their needs and to cope with the environment in order to live a long, productive, and fruitful life. In this sense, health enables social, economic and personal development fundamental to well-being. Health promotion is the process of enabling people to increase control over, and to improve their health. Environmental and social resources for health can include: peace, economic security, a stable ecosystem, and safe housing. Individual resources for health can include: physical activity, healthful diet, social ties, resiliency, positive emotions, and autonomy. Health promotion activities aimed at strengthening such individual, environmental and social resources may ultimately improve well-being.

How is well-being defined?

There is no consensus around a single definition of well-being, but there is general agreement that at minimum, well-being includes the presence of positive emotions and moods (e.g., contentment, happiness), the absence of negative emotions (e.g., depression, anxiety), satisfaction with life, fulfillment and positive functioning. In simple terms, well-being can be described as judging life positively and feeling good. For public health purposes, physical well-being (e.g., feeling very healthy and full of energy) is also viewed as critical to overall well-being. Researchers from different disciplines have examined different aspects of well-being that include the following:

- Physical well-being
- Economic well-being
- Social well-being
- Development and activity
- Emotional well-being
- Psychological well-being
- Life satisfaction
- Domain specific satisfaction
- Engaging activities and work

How is well-being measured?

Because well-being is subjective, it is typically measured with self-reports. The use of self-reported measures is fundamentally different from using objective measures (e.g., household income, unemployment levels, neighborhood crime) often used to assess well-being. The use of both objective and subjective measures, when available, are desirable for public policy purposes.

There are many well-being instruments available that measure self-reported well-being in different ways, depending on whether one measures well-being as a clinical outcome, a population health outcome, for cost-effectiveness studies, or for other purposes. For example, well-being measures can be psychometrically-based or utility-based. Psychometrically-based measures are based on the relationship between, and strength among, multiple items that are intended to measure one or more domains of well-being. Utility-based measures are based on an individual or group's preference for a particular state, and are typically anchored between 0 (death) to 1 (optimum health). Some studies support use of single items (e.g., global life satisfaction) to measure well-being parsimoniously. Peer reports, observational methods, physiological methods, experience sampling methods, ecological momentary assessment, and other methods are used by psychologists to measure different aspects of well-being.

What are some correlates and determinants of individual-level well-being?

There is no sole determinant of individual well-being, but in general, well-being is dependent upon good health, positive social relationships, and availability and access to basic resources (e.g., shelter, income).
Numerous studies have examined the associations between determinants of individual and national levels of well-being. Many of these studies have used different measures of well-being (e.g., life satisfaction, positive affect, psychological well-being), and different methodologies resulting in occasional inconsistent findings related to well-being and its predictors. In general, life satisfaction is dependent more closely on the availability of basic needs being met (food, shelter, income) as well as access to modern conveniences (e.g., electricity). Pleasant emotions are more closely associated with having supportive relationships.

Note

Optional: Watch this video about how America's culture of consumerism undermines our well-being.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Some general findings on associations between well-being and its associations with other factors are as follows:

Genes and Personality

At the individual level, genetic factors, personality, and demographic factors are related to well-being. For example, positive emotions are heritable to some degree, suggesting that there may be a genetically determined set-point for emotions such as happiness and sadness. However, the expression of genetic effects are often influenced by factors in the environment implying that circumstances and social conditions do matter and are actionable from a public policy perspective. Longitudinal studies have found that well-being is sensitive to life events (e.g., unemployment, marriage). Additionally, genetic factors alone cannot explain

differences in well-being between nations or trends within nations.
Some personality factors that are strongly associated with well-being include optimism, extroversion, and self-esteem. Genetic factors and personality factors are closely related and can interact in influencing individual well-being.
While genetic factors and personality factors are important determinants of well-being, they are beyond the realm of public policy goals.

Age and Gender

Depending on which types of measures are used (e.g., life satisfaction vs. positive affect), age and gender also have been shown to be related to well-being. In general, men and women have similar levels of well-being, but this pattern changes with age, and has changed over time. There is a U-shaped distribution of well-being by age younger and older adults tend to have more well-being compared to middle-aged adults.

Income and Work

The relationship between income and well-being is complex. Depending on which types of measures are used and which comparisons are made, income correlates only modestly with well-being. In general, associations between income and well-being (usually measured in terms of life satisfaction) are stronger for those at lower economic levels, but studies also have found effects for those at higher income levels. Paid employment is critical to the well-being of individuals by conferring direct access to resources, as well as fostering satisfaction, meaning and purpose for some. Unemployment negatively affects well-being, both in the short- and long-term.

Relationships

Having supportive relationships is one of the strongest predictors of well-being, having a notably positive effect.

What are some correlates of well-being at the national level?

Countries differ substantially in their levels of well-being. Societies with higher well-being are those that are more economically developed, have effective governments with low levels of corruption, have high levels of trust, and can meet citizens' basic needs for food and health. Cultural factors (e.g., individualism vs. collectivism, social norms) also play a role in national estimates of well-being.

What is the difference between health-related quality of life, well-being, flourishing, positive mental health, optimal health, happiness, subjective well-being, psychological well-being, life satisfaction, hedonic well-being, and other terms that exist in the literature?

Subjective well-being typically refers to self-reports contrasted with objective indicators of well-being. The term, "positive mental health" calls attention to the psychological components that comprise well-being from the perspective of individuals interested primarily in the mental health domain. From this perspective, positive mental health is a resource, broadly inclusive of psychological assets and skills essential for well-being. But, the latter generally excludes the physical component of well-being. "Hedonic" well-being focuses on the "feeling" component of well-being (e.g., happiness) in contrast to "eudaimonic" well-being which focuses on the "thinking" component of well-being (e.g., fulfillment). People with high levels of positive emotions, and those who are functioning well psychologically and socially are described by some as having complete mental health, or as "flourishing."

In summary, positive mental health, well-being and flourishing refer to the presence of high levels of positive functioning—primarily in the mental health domain (inclusive of social health). However, in its broadest sense, well-being encompasses physical, mental, and social domains.

Learning Activity: Mapping the Nation's Well Being

Go to the Mapping the Nation's Well Being webpage to find out how well being differs by location.

1. Click on each of the items under Composite Index.
2. Roll your cursor over the various places on the map where you have lived.

3. Compare the well-being of all the places where you have lived or visited.

Public and Population Health

While public health is a familiar term, it can be difficult to give it a single precise definition. Its general focus is on preventing disease and protecting health: "Public health is defined as the organized efforts of society to keep people healthy and prevent injury, illness, and premature death." But this definition does not give us a clear picture of what is, and what is not, included. In part the difficulty arises because public health does not concern a specific organ system, type of disease or therapeutic approach, but employs a variety of approaches to address whatever health issues are most pressing in each place and time. The discipline has seen a succession of names as it wrestled with whether environmental factors, or individual behavior, or societal policies should form the main focus of interventions.
This debate gave rise to the population health perspective, which holds that, while fostering individual responsibility for health, we must also address underlying social determinants, such as poverty or lack of access to care, that constrain people's ability to achieve real gains in health.

Blaming the Victim

As population health is a relatively new concept, uncertainties remain over details of how, precisely, it differs from public health. Both are concerned with patterns of health and illness in groups of people rather than in individuals; both monitor health trends, examine their determinants, propose interventions at the population level to protect and promote health, and discuss options for delivering these interventions. The distinction is subtle, but population health is seen as broader, as offering a unifying paradigm that links disciplines from the biological to the sociological. It provides a rational basis for allocating health resources that balances health protection and promotion against illness prevention and treatment, while also making a significant contribution to basic science.
When public health tackles a health issue, its interventions are focused on maintaining health or preventing disease.

- For example, the **public health approach** to childhood obesity might advocate education for parents and children, subsidized healthy school lunch programs, banning soft drinks in school vending machines, tougher regulations on marketing of junk food to children, promoting physical activity, etc.
- A population health approach would tackle childhood obesity in a broader context. A population health approach might be to consider the food system itself: How do agricultural subsidies affect the price of food? Can city planning policies prevent the problem of urban food deserts where significant areas of the population lack access to a grocery store?

Public health focuses on prevention and health protection services, whereas the population health approach is somewhat broader. It still values "health" as a key outcome, but views issues from a broader perspective and tends to include additional considerations, such as economics, environmental sustainability, social justice, etc.

Learning Activity: Influences on Your Health

Draw a circular diagram with yourself at the center. Position the factors that influence your health around the circle.

- If the link to your health is indirect use dotted lines and if there is a direct link use thicker lines.
- Use distance to denote effect: the closer, the stronger the impact.

Does your diagram support the argument that health and ill-health are influenced – or determined – by a wide range of factors and forces?

- How many different influences did you include?
- Are there any patterns in terms of which factors connected directly and which indirectly?

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Learning Activity 1.5: Introducing Public Health, Open Learn, openlearn.open.ac.uk/mod/oucontent/view.php?id=400106§ion=2 (CC-BY-NC-SA)

Answers

Self-Assessment Question

Health: When broadly defined, it is a state of complete physical, mental and social wellbeing not merely the absence of disease or infirmity. According to this definition physical, social and psychological factors all contribute to health.

Health promotion: According to the Ottawa Charter, health promotion is defined as the process of enabling people to increase control over, and to improve, their health. Health promotion is aimed at reducing the underlying causes of ill-health so that there is a long term reduction in many diseases.

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- 6.2: Cellular Respiration (Instructor Materials Preparation) has no license indicated.

2.5.4.2: Three Levels of Health Promotion/Disease Prevention

Levels of Prevention

Three broad categories of determinants of human behavior will be discussed in this study session and you will have an opportunity to learn about the influence of these factors in determining human behavior.

Prevention, as it relates to health, is really about avoiding disease before it starts. It has been defined as the plans for, and the measures taken, to prevent the onset of a disease or other health problem before the occurrence of the undesirable health event. There are three distinct levels of prevention.

Primary prevention—those preventive measures that prevent the onset of illness or injury before the disease process begins.

- Examples include immunization and taking regular exercise.

Secondary prevention—those preventive measures that lead to early diagnosis and prompt treatment of a disease, illness or injury to prevent more severe problems developing. Here health educators such as Health Extension Practitioners can help individuals acquire the skills of detecting diseases in their early stages.

- Examples include screening for high blood pressure and breast self-examination.

Tertiary prevention—those preventive measures aimed at rehabilitation following significant illness. At this level health services workers can work to retrain, re-educate and rehabilitate people who have already developed an impairment or disability.

Read the list of the three levels of prevention again. Think about your experience of health education, whether as an educator or recipient of health education.

- How do you think health education can help with the prevention of disease?
- Do you think it will operate at all these levels?
- Note an example of possible health education interventions at each level where you think health education can be applied.

Health Education can be applied at all three levels of disease prevention and can be of great help in maximizing the gains from preventive behavior**.**

- For example at the primary prevention level — you could educate people to practice some of the preventive behaviors, such as having a balanced diet so that they can protect themselves from developing diseases in the future.
- At the secondary level, you could educate people to visit their local health center when they experience symptoms of illness, such as fever, so they can get early treatment for their health problems.
- At the tertiary level, you could educate people to take their medication appropriately and find ways of working towards rehabilitation from significant illness or disability.

You have learned that:

- Primary prevention includes those preventive measures that come before the onset of illness or injury and before the disease process begins. Examples include immunization and taking regular exercise to prevent health problems developing in the future.
- Secondary prevention includes those preventive measures that lead to early diagnosis and prompt treatment of a disease, illness or injury. This should limit disability, impairment or dependency and prevent more severe health problems developing in the future.
- Tertiary prevention includes those preventive measures aimed at rehabilitation following significant illness. At this level health educators work to retrain, re-educate and rehabilitate the individual who has already had an impairment or disability.

Summary

- Primary prevention includes those measures that prevent the onset of illness *before* the disease process begins. Immunization against infectious disease is a good example.
- Secondary prevention includes those measures that lead to early diagnosis and prompt treatment of a disease. Breast self-examination is a good example of secondary prevention.
- Tertiary prevention involves the rehabilitation of people who have already been affected by a disease, or activities to prevent an established disease from becoming worse.

Make sure that you are comfortable with the difference between primary prevention activities and secondary prevention activities. Remember that primary prevention activities will actually stop the illness happening, while secondary activities stop the illnesses getting worse.

Learning Activity

1. Go to Take a Look at Health to find out the major health issues facing Americans are today.
2. Click on various risk factors, demographics, diseases and conditions to see graphic comparisons.
    - What are some of the most common conditions, and how are they related to one another?
    - What can we do to improve our health?

Sources

Levels of Prevention: Health Education, Advocacy and Community Mobilization Chapter: 4. Human Behaviour and Health: 1, Open Learn, LearnSpace, http://labspace.open.ac.uk/mod/oucontent/view.php?id=452836§ion=20.3

Summary: Health Education, Advocacy and Community Mobilisation, Openlearn, cc-by-nc-sa, http://labspace.open.ac.uk/mod/oucontent/view.php?id=452834&printable=1

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2.5.4.3: Culture, Beliefs, Attitudes, and Stigmatized Illnesses

Cultural Lens and How Culture Influences Your Perceptions

Cultural Awareness, Sensitivity, and Safety

Culture can be defined in terms of the shared knowledge, beliefs, and values that characterize a social group. Humans have a strong drive to maintain the sense of identity that comes from membership in an identifiable group. In primeval and nomadic times, a person's survival likely benefited from establishing strong bonds with an in-group of trusted relatives or clan-mates with whom one co-operated and shared, versus an out-group against which there was competition for scarce resources. Within the intermixing of modern society, many of us seek to retain a sense of cultural identity and may often refer to our cultural roots, or use double-barreled descriptions such as Asian-American. It is important that we are all aware of our own cultural influences and how these may affect our perceptions of others, especially in the doctor-patient encounter. In many subtle ways, the cultural identities of both doctor and patient affect their interaction, and in a diverse country this can form an exciting challenge.

Culture and individual

We all perceive others through the filter or perspective of our own cultural upbringing, often without being aware of it: communication can go wrong without our understanding why. The clinician must become culturally aware and sensitive, then culturally competent so that she or he can practice in a manner that is culturally safe.

Cultural awareness

Cultural competency in medical practice requires that the clinician respects and appreciates diversity in society. Culturally competent clinicians acknowledge differences but do not feel threatened by them. "Culturally competent communication leaves our patients feeling that their concerns were understood, a trusting relationship was formed and, above all, that they were treated with respect." While a clinician will often be unfamiliar with the culture of a particular patient, the direct approach is often the best: ask the patient what you need to understand about her culture and background in order to be able to help her. A direct approach helps establish mutual respect and tailor the best and most appropriate care for each patient.

Awareness of one's own culture is an important step towards awareness of, and sensitivity to, the culture and ethnicity of other people. Clinicians who are not aware of their own cultural biases may unconsciously impose their cultural values on other people. "As physicians, we must make multiple communication adjustments each day when interacting with our patients to provide care that is responsive to the diverse cultural backgrounds of patients in our highly multicultural nation."

Cultural safety refers to a doctor-patient encounter in which the patient feels respected and empowered, and that their culture and knowledge has been acknowledged. Cultural safety refers to the patient's feelings in the health care encounter, while cultural competence refers to the skills required by a practitioner to ensure that the patient feels safe.

To practice in a manner that is culturally safe, practitioners should reflect on the power differentials inherent in health service delivery. Taking a culturally safe approach also implies acting as a health advocate: working to improve access to care; exposing the social, political, and historical context of health care; and interrupting unequal power relations. Given that the patient exists simultaneously within several caring systems, influenced by their family, community, and traditions, the culturally safe practitioner allows the patient to define what is culturally safe for them.
Our culture influences the way we perceive virtually everything around us, often unconsciously. Several useful concepts describe issues that can arise:

- *Ethnocentrism*. The sense that one's own beliefs, values, and ways of life are superior to, and more desirable than, those of others. For example, you may be trained in Western medicine, but your patient insists on taking a herbal remedy. You may be tempted to say "So, why are you consulting me, then?" Ethnocentrism is often unconscious and implicit in a person's behavior. Personal reflection is a valuable tool for physicians to critically examine their own ethnocentric views and behaviors.
- *Cultural blindness*. This refers to attempts (often well-intentioned) to be unbiased by ignoring the fact of a person's race. It is illustrated in phrases such as 'being color blind', or 'not seeing race'. However, ignoring cultural differences may make

people from another culture feel discounted or ignored; what may be transmitted is the impression that race or culture are unimportant, and that values of the dominant culture are universally applicable. Meanwhile, the person who is culturally blind may feel they are being fair and unprejudiced, unaware of how they are making others feel. Cultural blindness becomes, in effect, the opposite of cultural sensitivity.

- *Culture shock*. Most physicians come from middle-class families and have not experienced poverty, homelessness or addictions. Exposure to such realities in their patients therefore requires great adaptations and can be distressing. This is a common experience in those who have visited a slum in a developing country, but may also arise at home in confronting abortion, infanticide, or female circumcision.
- *Cultural conflict*. Conflict generated when the rules of one's own culture are contradicted by the rules of another.
- *Cultural imposition (or cultural assimilation or colonialism)*. The imposition of the views and values of your own culture without consideration of the beliefs of others.
- *Stereotyping and generalization*. What may be true of a group need not apply to each individual. Hence, talking about cultures can lead to dangerously prejudicial generalizations. Prejudice is the tendency to use preconceived notions about a group in pre-judging one of the group's members, so applying cultural awareness to individuals can be hazardous. Yet, on the other hand, ignoring culture (cultural blindness) can be equally detrimental. The key is to acknowledge and be respectful of differences, and to ask patients to explain their perspective when in doubt

The Relevance of Culture for Health

Culture influences health through many channels:

1. *Positive or negative lifestyle behaviors*. While we often focus on the negative influences of lifestyle behavior—such as drug cultures, or the poor diet of some teen cultures, for example—we should not neglect the positive cultural influences on behaviors and practices. For example, Mormons and Seventh Day Adventists have been found to live longer than the general population, in part because of their lifestyle including the avoidance of alcohol and smoking, but also because of enhanced social support.
2. *Health beliefs and attitudes*. These include what a person views as illness that requires treatment, and which treatments and preventive measures he or she will accept, as with the Jehovah's Witness prohibition on using whole blood products.
3. *Reactions to being sick*. A person's adoption of the sick role (and, hence, how he or she or he reacts to being sick) is often guided by his or her cultural roots. For instance, "machismo" may discourage a man from seeking prompt medical attention, and culture may also influence from whom a person will accept advice.
4. *Communication patterns,* including language and modes of thinking. Beyond these, however, culture may constrain some patients from expressing an opinion to the doctor, or may discourage a wife from speaking freely in front of her husband, for example. Such influences can complicate efforts to establish a therapeutic relationship and, thereby, to help the patient.
5. *Status*. The way in which one culture views another may affect the status of entire groups of people, placing them at a disadvantage. The resulting social inequality or even exclusion forms a health determinant. For example, women in some societies have little power to insist on condom use.

What elements of a patient's culture should a health care provider consider when deciding how best to manage a case?

Cultural influences may affect a patient's reaction to the disease, to suggested therapy, and to efforts to help them prevent recurrences by changing risk factors. Therefore, it may be important for health care providers to find out about such possibilities; they can explain that they need them to tell about their family's and community's feelings about health recommendations. Health care providers should explain that they are not familiar with their community and want them to tell if they may have beliefs or obligations that the health care provider should be aware of, such as any restrictions on diet, medications, etc., if these could be relevant.

Difference between cultural competence and cultural safety

Cultural competence is included within cultural safety, but safety goes beyond competence to advocate actively for the patient's perspective, to protect their right to hold the views they do. When a patient knows that you will honor and uphold their perspective and not try to change it, they will be more likely to accept your recommendations. A physician who practices culturally safe care has reflected on her own cultural biases recognizes them and ensures that her biases do not impact the care that the patient receives. This pattern of self-reflection, education and advocacy is also practiced at the organizational level.

Example: Breast Cancer in Asian Women

Asian women, in general, and Vietnamese women, in particular, have been identified as ethnic groups that are not participating in breast cancer screening programs in the U.S. The reasons are complex and Vietnamese women may be especially vulnerable due to cultural variances in beliefs, health practices, language barriers, lack of access to care due to socio-economic factors, as well as the long term effects of the migration that occurred at the close of the Vietnam war.

Learning Activity

Find out about how culture impacts health decisions and access by visiting each of the websites linked in the list below:

- Hispanic-Latino Culture
- Chinese Culture
- Iraqi Culture
- Vietnamese Culture
- Lesbian, Gay, Bisexual, and Transgender Health Issues

What are some of the positive and/or negative ways that culture impacts an individual's health care decisions and access?

Answer available at the end of this section.

Stigmatized Illnesses and Health Care

Being disabled because of a disease or injury can lead to benefits – for example, a parking space that is close by. In some instances, the benefits are very attractive but, in most countries of the world, the disabled have no access to any governmental help, and insurance premiums are so high that only a minority of the population can participate in disability compensations schemes. In some situations, disability due to a war injury or to some other situation that confers hero status can also bring social respect and moral prestige to the disabled person.

For the vast majority of disabled people, however, the disadvantages of disability are much more important than its advantages. A restriction of the possibility of participation in normal social life and limitations in the pursuit of personal happiness are often grave and depressing for the person with an impairment that causes a disability.

When the disease or the situation that has produced impairment is stigmatized, the limitations of functions are aggravated and the possibility of compensating disability is significantly reduced. There are a number of diseases that are stigmatized—mental disorders, AIDS, venereal diseases, leprosy, and certain skin diseases. People who have such diseases are discriminated in the health care system, they usually receive much less social support than those who have non-stigmatizing illnesses and—what is possibly worst—they have grave difficulties in organizing their life if their disease has caused an impairment that can lead to disability and handicaps.

Mental disorders probably carry more stigma (and consequent discrimination) than any other illness. The stigma does not stop at the persons who are suffering from a stigmatized illness. Their immediate and even remote families often experience significant social disadvantages. The institutions that provide mental health care are stigmatized. Stigma reduces the value of the persons who have a mental disorder in the eyes of the community and the government.

Medications that are needed in the treatment of mental disorders, for example, are considered expensive even when their cost is much lower than the cost of drugs used in the treatment of other illnesses: they are not considered expensive because of their cost but because they are meant to be used in the treatment of people who are not considered to be of much value to the society.

The awareness of the fact that stigmatization is one of the major—if not the major—obstacles to the improvement of care for people with stigmatized illnesses is gradually growing. In a number of countries governments, non-governmental organizations, and health institutions have launched campaigns to reduce stigma related to illness. They display posters and distribute leaflets, as well as organize radio and television programs.

There is, however, an important sector employing many individuals that does not participate very actively in the reduction of stigma and in efforts to eliminate the discrimination that follows it. It is the health sector—which, by its definition, could gain

from the reduction of stigma almost as much as the individuals who have the stigmatized illness. The managements of general hospitals, as well as heads of various medical departments often refuse to have a department of psychiatry and, if they accept it, they usually assign the worst accommodation for it—in a remote corner of the hospital grounds, for example, or in the lowest (sometimes partly underground) floor. In the order of priority for maintenance or renovation work departments of psychiatry come last although they are often in a pitiful state. Doctors who are not involved in mental health care participate and sometimes excel in making fun of the mentally ill, of psychiatrists, and of mental illness. They will often refuse to deal with physical illness in a person with a mental disorder and send such patients to their psychiatrist, although they are better placed to deal with the physical illness than the psychiatrist.

Nor are the psychiatrists and other mental health care staff doing as much as they should about the reduction of stigma. They seem unaware of the stigmatizing effects of their use of language—they speak of schizophrenics when they should say a person with schizophrenia and about misbehavior or lack of discipline when they should make it clear that behavioral abnormalities are part of the illness they are supposed to recognize and treat. In some countries they requested and received longer holidays or somewhat higher salaries saying that they deserve this because they deal with dangerous patients—although they have publicly proclaimed that mental illness is a disease like any other. They often disregard complaints about the physical health of people with mental disorders and do not do much about them, thus providing sub-optimal care and contributing to the tendency to dismiss whatever people with mental illness may be saying. In their teaching activities, stigmatization as well as the prevention of discrimination and its other consequences often receive only minimal attention.

Perhaps it is impossible for the health care workers themselves to launch large anti-stigma programs: what, however, they should and can do is to examine their own behavior and activity to ensure that they do not contribute to stigmatization and consequent discrimination. They should also participate in the efforts of others to reduce stigma or initiate such efforts whenever possible. Doing nothing about stigma and discrimination that follows it is no longer an acceptable option.

The Cultural Meaning of Illness

Our culture, not our biology, dictates which illnesses are stigmatized and which are not, which are considered disabilities and which are not, and which are deemed contestable (meaning some medical professionals may find the existence of this ailment questionable) as opposed to definitive (illnesses that are unquestionably recognized in the medical profession) (Conrad and Barker 2010). For instance, sociologist Erving Goffman (1963) described how social stigmas hinder individuals from fully integrating into society. The stigmatization of illness often has the greatest effect on the patient and the kind of care he or she receives. Many contend that our society and even our health care institutions discriminate against certain diseases—like mental disorders, AIDS, venereal diseases, and skin disorders (Sartorius 2007). Facilities for these diseases may be sub-par; they may be segregated from other health care areas or relegated to a poorer environment. The stigma may keep people from seeking help for their illness, making it worse than it needs to be. Contested illnesses are those that are questioned or questionable by some medical professionals. Disorders like fibromyalgia or chronic fatigue syndrome may be either true illnesses or only in the patients' heads, depending on the opinion of the medical professional. This dynamic can affect how a patient seeks treatment and what kind of treatment he or she receives.

In terms of constructing the illness experience, culture and individual personality both play a significant role. For some people, a long-term illness can have the effect of making their world smaller, more defined by the illness than anything else. For others, illness can be a chance for discovery, for re-imaging a new self (Conrad and Barker 2007). Culture plays a huge role in how an individual experiences illness. Widespread diseases like AIDS or breast cancer have specific cultural markers that have changed over the years and that govern how individuals—and society—view them.

Today, many institutions of wellness acknowledge the degree to which individual perceptions shape the nature of health and illness. Regarding physical activity, for instance, the Centers for Disease Control (CDC) recommends that individuals use a standard level of exertion to assess their physical activity. This Rating of Perceived Exertion (RPE) gives a more complete view of an individual's actual exertion level, since heart-rate or pulse measurements may be affected by medication or other issues (Centers for Disease Control 2011a). Similarly, many medical professionals use a comparable scale for perceived pain to help determine pain management strategies.

Example 2.5.4.3.1

Consider these questions:

- What diseases are the most stigmatized?

- Which are the least?
- Is this different in different cultures or social classes?

Solution

Look at these sources to find some answers

Cultural Lens and How Culture Influences Your Perceptions: "The cultural lens and how culture influences your perceptions of others" AFMC Primer on Population Health, The Association of Faculties of Medicine of Canada Public Health Educators' Network, phprimer.afmc.ca/Part1-TheoryThinkingAboutHealth/Chapter3CulturalCompetenceAndCommunication/Culturalawarenesssensitivityandsafety (Accessed March 11, 2012). License: Creative Commons BY-NC-SA

Example: Breast Cancer in Asian Women: Breast Cancer in Asian Women by Denise Little, Ethnomed, CC-BY-NC-ND, http://ethnomed.org/clinical/cancer/breast-cancer-in-asian-women

Stigmatized Illnesses and Health Care: Stigmatized Illnesses and Health Care, Norman Sartorius, Croatian Medical Journal, 2007 June; 48(3): 396–397, CC-BY-NC, www.ncbi.nlm.nih.gov/pmc/articles/PMC2080544/

The Cultural Meaning of Illness: OpenStax College, CC-BY, The Social Construction of Health, Connexions, May 18, 2012, http://cnx.org/content/m42927/1.2/

Sources

Answers

Learning Activity

Some Ethiopians living in the United States may avoid getting treatment if the medical facility is central and visible to their community. This could be due to the social stigma of TB (tuberculosis) in that culture combined with a cultural identity that highly values community participation. So, in order for Ethiopian-Americans to be more likely to get treatment for TB, the medical facility needs to be located in place where patients can come and go without being seen easily.

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2.5.4.4: Determinants of Health, Risk Factors, and Prevention

Determinants of Health

- What makes some people healthy and others unhealthy?
- How can we create a society in which everyone has a chance to live long healthy lives?

Learning Activity

Watch this video about Determinants of Health[1]:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

This video demonstrates some of the factors that make some people healthy and others unhealthy. Two examples in this video serve to illustrate determinants of health, as well as interventions which can change determinants of health and lead to a specific health outcome or outcomes. The video then explains the four phases of the intervention life cycle.

The range of personal, social, economic, and environmental factors that influence health status are known as determinants of health.

Determinants of health fall under several broad categories:

- Social factors
- Health services
- Individual behavior
- Biology and genetics

It is the interrelationships among these factors that determine individual and population health. Because of this, interventions that target multiple determinants of health are most likely to be effective. Determinants of health reach beyond the boundaries of traditional health care and public health sectors; sectors such as education, housing, transportation, agriculture, and environment can be important allies in improving population health.

Policymaking

Policies at the local, State, and Federal level affect individual and population health. Increasing taxes on tobacco sales, for example, can improve population health by reducing the number of people using tobacco products.

Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. For example, the 1966 Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the Federal Government to set and regulate standards for motor vehicles and highways. This led to an increase in safety standards for cars, including seat belts, which in turn, reduced rates of injuries and deaths from motor vehicle accidents.

Social

Social determinants of health reflect social factors and the physical conditions in the environment in which people are born, live, learn, play, work and age. Also known as social and physical determinants of health, they impact a wide range of health,

functioning and quality of life outcomes.

Examples of social determinants include:

- Availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods
- Exposure to crime, violence, and social disorder, such as the presence of trash
- Social support and social interactions
- Exposure to mass media and emerging technologies, such as the Internet or cell phones
- Socioeconomic conditions, such as concentrated poverty
- Quality schools
- Transportation options
- Public safety
- Residential segregation

Examples of physical determinants include:

- Natural environment, such as plants, weather, or climate change
- Built environment, such as buildings or transportation
- Worksites, schools, and recreational settings
- Housing, homes, and neighborhoods
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities
- Aesthetic elements, such as good lighting, trees, or benches

Poor health outcomes are often made worse by the interaction between individuals and their social and physical environment.

For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with State and national averages. Poor air quality can worsen asthma symptoms, especially in children.[2]

Health Services

Both access to health services and the quality of health services can impact health. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas.

Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment.[3]

Barriers to accessing health services include:

- Lack of availability
- High cost
- Lack of insurance coverage
- Limited language access

These barriers to accessing health services lead to:

- Unmet health needs
- Delays in receiving appropriate care
- Inability to get preventive services
- Hospitalizations that could have been prevented

Individual Behavior

Individual behavior also plays a role in health outcomes. For example, if an individual quits smoking, his or her risk of developing heart disease is greatly reduced.

Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and

physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country.

Examples of individual behavior determinants of health include:

- Diet
- Physical activity
- Alcohol, cigarette, and other drug use
- Hand washing

Biology and Genetics

Some biological and genetic factors affect specific populations more than others. For example, older adults are biologically prone to being in poorer health than adolescents due to the physical and cognitive effects of aging.

Sickle cell disease is a common example of a genetic determinant of health. Sickle cell is a condition that people inherit when both parents carry the gene for sickle cell. The gene is most common in people with ancestors from West African countries, Mediterranean countries, South or Central American countries, Caribbean islands, India, and Saudi Arabia.

Examples of biological and genetic social determinants of health include:

- Age
- Sex
- HIV status
- Inherited conditions, such as sickle-cell anemia, hemophilia, and cystic fibrosis
- Carrying the BRCA1 or BRCA2 gene, which increases risk for breast and ovarian cancer
- Family history of heart disease

Social Determinants of Health

Social determinants of health are economic and social conditions that influence the health of people and communities. These conditions are shaped by the amount of money, power, and resources that people have, all of which are influenced by policy choices. Social determinants of health affect factors that are related to health outcomes. Factors related to health outcomes include:

- How a person develops during the first few years of life (early childhood development)
- How much education a persons obtains
- Being able to get and keep a job
- What kind of work a person does
- Having food or being able to get food (food security)
- Having access to health services and the quality of those services
- Housing status
- How much money a person earns
- Discrimination and social support

What are determinants of health and how are they related to social determinants of health?

Determinants of health are factors that contribute to a person's current state of health. These factors may be biological, socioeconomic, psychosocial, behavioral, or social in nature. Scientists generally recognize five determinants of health of a population:

- Genes and biology: for example, sex and age
- Health behaviors: for example, alcohol use, injection drug use (needles), unprotected sex, and smoking
- Social environment or social characteristics: for example, discrimination, income, and gender
- Physical environment or total ecology: for example, where a person lives and crowding conditions
- Health services or medical care: for example, access to quality health care and having or not having insurance

Other factors that could be included are culture, social status, and healthy child development. Scientists do not know the precise contributions of each determinant at this time.

In theory, genes, biology, and health behaviors together account for about 25% of population health. Social determinants of health represent the remaining three categories of social environment, physical environment/total ecology, and health services/medical care. These social determinants of health also interact with and influence individual behaviors as well. More specifically, social determinants of health refer to the set of factors that contribute to the social patterning of health, disease, and illness.

Why is addressing the role of social determinants of health important?

Addressing social determinants of health is a primary approach to achieving health equity. Health equity is "when everyone has the opportunity to 'attain their full health potential' and no one is 'disadvantaged from achieving this potential because of their social position or other socially determined circumstance." Health equity has also been defined as "the absence of systematic disparities in health between and within social groups that have different levels of underlying social advantages or disadvantages—that is, different positions in a social hierarchy." Social determinants of health such as poverty, unequal access to health care, lack of education, stigma, and racism are underlying, contributing factors of health inequities.

Learning Activity

Go to the Your Health Profile webpage and answer the questions.

- What conditions do people with your health profile most frequently experience?
- Are you under- or overweight?

Risk Factors

What is a risk factor?

Risk factors are things in your life that increase your chances of developing a condition or disease. They can include things like family history, exposures to things in the environment, being a certain age or sex, being from a certain ethnic group, or already having a health condition. If you do have risk factors, your doctor or nurse will most likely want you to be screened or immunized at a younger age or more often than what is recommended. Check with your doctor or nurse to find out if you need to have specific health screenings and how often you will need them.

Understanding Risk Factors

Part of learning how to take charge of your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control. You may be born with them or exposed to them through no fault of your own. Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender—male or female
- Ancestry

Some risk factors you can control include

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you use illegal drugs
- Whether you use your seat belt

In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just

three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

Learning Activity: Find Out about Your Own Health Risks

Fill out the questionnaire at Keep Me Well to get the following results:

- Scorecard: An easy-to-read summary of your results that will show you where to focus your efforts to best improve your health.
- My Report: A more detailed report that provides feedback and links to trusted health information websites that will help you take action to lower your risk for chronic disease.
- Local Community Supports and Programs: A list of resources in your area that can help you take action to improve your health.

Having more than one risk factor

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

Inheriting risk—your family health history

Rarely, you can inherit a mutated gene that alone causes you to get a disease. Genes control chemical reactions in our bodies. If you inherit a faulty gene, your body may not be able to carry out an important chemical reaction. For instance, a faulty gene may make your blood unable to clot. This problem is at the root of a rare bleeding disorder. More often, you can inherit genes from one or both of your parents that put you at higher risk of certain diseases. But having a gene for a certain disease does not always mean you will get it. There are many unknown factors that may raise or lower your chances of getting the disease. People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early.

People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run. Your family's health history could be important for determining health risks for you and your children. Learn more about how to document your family's health history and share it with your doctor. It is important to talk to your doctor or nurse about your individual health risks, even if you have to bring it up yourself. And it's important for your doctor to know not just about your health, but your family health history as well. Come to health care visits armed with information about you, your children, siblings, parents, grandparents, aunts and uncles, and nieces and nephews, including

- Major medical conditions and causes of death
- Age of disease onset and age at death
- Ethnic background
- General lifestyle information like heavy drinking and smoking

Family Health History

Family health history can help your doctor make a diagnosis if you or your children shows signs of a disorder. It can reveal whether you or your children have an increased risk for a disease; if so, the doctor might suggest screening tests. Many genetic disorders first become obvious in childhood, and knowing about a family health history of a genetic condition can help find and treat the condition early.

Update your family health history information regularly and share new information with your doctor. Remember that relatives can be newly diagnosed with conditions between doctor's visits.

The best way to learn about your family health history is to ask questions. Talk at family gatherings and record your family's health information—it could make a difference in your child's life.

Learning Activity: My Family Health Portrait

Use the US Surgeon General's online tool for collecting family health histories, called My Family Health Portrait. (If you are not able to do this activity with your own birth family, you can do this activity for someone else who does know his/her family health history.)

- Enter your family health history.
- Record the names of your close relatives from both sides of the family: parents, siblings, grandparents, aunts, uncles, nieces, and nephews. Include conditions each relative has or had and at what age the conditions were first diagnosed.
- For relatives who are deceased, include the cause of death and the age at death.
- Print your family health history to share with family or your health care worker.
- Save your family health history so you can update it over time.
- Talk with your health care worker about your family health history

Optional Learning Activity: Healthier You

Complete a personal health risk assessment and family health history. Determine what you can do to enhance your own health and decrease your health risks.

Check out these resources to find out more about Family Health History

- NIH Senior Health: Creating a Family Health History
- Family Health History

Examples of actions to take:

- Bring your weight and BMI to normal levels
- Stop smoking
- Bring your cholesterol levels to a healthy level
- Increase your aerobic, muscle-strengthening, and bone-strengthening activities
- Reduce your consumption of alcohol

Factors Affecting Human Health

Risk factors are those inherited, environmental and behavioral influences which are considered to increase the likelihood of physical or mental health problems in the future. After studying this session you will be able to describe health risk factors and explain their association with human health.

Health and human behavior

Behavior is an action that has a specific frequency, duration and purpose whether conscious or unconscious. It is what we do and how we act.

Health behaviors are those personal behavior patterns, actions and habits that people perform in order to stay healthy, in order to restore their health when they get sick and in order to improve their health status.

Types of health behaviors

In this section, you will learn about six different types of health behavior that people may perform — from the initial stages of

preventing diseases up to their actions that may be associated with attempts to rehabilitate themselves after a bout of illness.

- *Preventive health behaviors*: These are actions that healthy people undertake to keep themselves or others healthy and prevent disease or detect illness when there are no symptoms. Examples include handwashing with soap, using insecticide treated mosquito nets and exclusive breastfeeding to age six months.
- *Illness behaviors:* These include any activities undertaken by individuals who perceive themselves to be ill. This would include recognition of early symptoms and prompt self referral for treatment.
- *Sick-role behaviors:* These include any activity undertaken by individuals who consider themselves to be ill, for the purpose of getting well. It includes receiving treatment from medical providers and generally involves a whole range of potentially dependent behaviors. It may lead to some degree of exemption from one's usual responsibilities. For example a person who feels that he is ill might visit the nearby health center and receive tablets to be taken home, and might then not do as much work as normal.
- *Compliance behaviors:* This means the person will be following a course of prescribed treatment according to the instructions that the health worker has given them.
- *Utilization behaviors:* This is the sort of behavior that is described when people use their health services such as antenatal care, family planning, immunization, taking a sick person for treatment, etc.
- *Behavior* is an action that has a specific frequency, duration and purpose whether conscious or unconscious. It is what we do and how we act. People stay healthy or become ill often as a result of their own actions or behavior.

Preventive health behaviors are actions that healthy people undertake to keep themselves or others healthy. Examples include good nutrition and exclusive breastfeeding until the age of six months.

- *Illness behaviors* include any activities undertaken by an individual who perceives him or herself to be ill.
- *Compliance behaviors* are to do with following a course of prescribed treatment regimes.
- *Utilization behaviors* involve the utilization of health services such as antenatal care or family planning.
- *Rehabilitation behaviors* are the ways that people behave after a serious illness to get themselves better again.
- *Determinants of health* are the biological, environmental, behavioral, organizational, political and social factors that contribute either positively or negatively to the health status of individuals, groups and communities.
- *Risk factors* are those inherited, environmental and behavioral influences which are known or thought to increase the likelihood of physical or mental health problems. Risk factors increase the probability of morbidity and premature mortality, but do not guarantee that people with the risk factors will suffer the consequences.
- *Non-modifiable (non-changeable or non-controllable) risk factors* include factors such as age, sex and inherited genes — things that individuals cannot change or do not have control over.

Learning Activity

Choose one healthy lifestyle habit that you would like to adopt or improve.

- What habit do you want to change or improve?
- Why did you choose this habit?
- Try using the online Health Month game to track your progress.

Sources

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2.5.5: NUTRITIONAL HEALTH

Learning Objectives

- List the dietary guidelines for Americans
- List the health risks of obesity
- Describe eating disorders

2.5.5.1: Nutritional Guidelines- Carbohydrates, Fats, and Proteins

2.5.5.2: Myths and Misconceptions about Nutrition

2.5.5.3: Ethnic Foods

2.5.5.4: Dietary Supplements

2.5.5.5: Body Composition

2.5.5.6: Obesity

2.5.5.7: Diet and Weight Control

2.5.5.8: Eating Disorders

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2.5.5.1: Nutritional Guidelines- Carbohydrates, Fats, and Proteins

A healthy diet can reduce the risk of major chronic diseases such as heart disease, diabetes, osteoporosis, and some cancers.

The Dietary Guidelines for Americans, 2010 provides evidence-based nutrition information and advice for people age 2 and older. They serve as the basis for Federal food and nutrition education programs.
They emphasize three major goals for Americans:

- Balance calories with physical activity to manage weight
- Consume more of certain foods and nutrients such as fruits, vegetables, whole grains, fat-free and low-fat dairy products, and seafood
- Consume fewer foods with sodium (salt), saturated fats, trans fats, cholesterol, added sugars, and refined grains

The Dietary Guidelines for Americans, 2010 include 23 key recommendations for the general population and 6 additional key recommendations for specific population groups, such as pregnant women. The recommendations are intended to help people choose an overall healthy diet.

Dietary Guidelines recommendations traditionally have been intended for healthy Americans ages 2 years and older. However, Dietary Guidelines for Americans, 2010 is being released at a time of rising concern about the health of the American population. Poor diet and physical inactivity are the most important factors contributing to an epidemic of overweight and obesity affecting men, women, and children in all segments of our society. Even in the absence of overweight, poor diet and physical inactivity are associated with major causes of morbidity and mortality in the United States. Therefore, the Dietary Guidelines for Americans, 2010 is intended for Americans ages 2 years and older, including those at increased risk of chronic disease.

Poor diet and physical inactivity are the most important factors contributing to an epidemic of overweight and obesity in this country. The most recent data indicate that 72 percent of men and 64 percent of women are overweight or obese, with about one-third of adults being obese. Even in the absence of overweight, poor diet and physical inactivity are associated with major causes of morbidity and mortality. These include cardiovascular disease, hypertension, type 2 diabetes, osteoporosis, and some types of cancer. Some racial and ethnic population groups are disproportionately affected by the high rates of overweight, obesity, and associated chronic diseases. These diet and health associations make a focus on improved nutrition and physical activity choices ever more urgent. These associations also provide important opportunities to reduce health disparities through dietary and physical activity changes.

Dietary Guidelines for Americans, 2010 also recognizes that in recent years nearly 15 percent of American households have been unable to acquire adequate food to meet their needs. This dietary guidance can help them maximize the nutritional content of their meals. Many other Americans consume less than optimal intake of certain nutrients even though they have adequate resources for a healthy diet. This dietary guidance and nutrition information can help them choose a healthy, nutritionally adequate diet. The intent of the Dietary Guidelines is to summarize and synthesize knowledge about individual nutrients and food components into an interrelated set of recommendations for healthy eating that can be adopted by the public.

Taken together, the Dietary Guidelines recommendations encompass two over-arching concepts:

Maintain calorie balance over time to achieve and sustain a healthy weight.

- People who are most successful at achieving and maintaining a healthy weight do so through continued attention to consuming only enough calories from foods and beverages to meet their needs and by being physically active. To curb the obesity epidemic and improve their health, many Americans must decrease the calories they consume and increase the calories they expend through physical activity.

Focus on consuming nutrient-dense foods and beverages.

- Americans currently consume too much sodium and too many calories from solid fats, added sugars, and refined grains. These replace nutrient-dense foods and beverages and make it difficult for people to achieve recommended nutrient intake while controlling calorie and sodium intake. A healthy eating pattern limits intake of sodium, solid fats, added sugars, and refined grains and emphasizes nutrient-dense foods and beverages;vegetables, fruits, whole grains, fat-free or low-fat milk

and milk products, seafood, lean meats and poultry, eggs, beans and peas, and nuts and seeds. A basic premise of the Dietary Guidelines is that nutrient needs should be met primarily through consuming foods. In certain cases, fortified foods and dietary supplements may be useful in providing one or more nutrients that otherwise might be consumed in less than recommended amounts.

A healthy eating pattern needs to not only to promote health and help to decrease the risk of chronic diseases, but it also should prevent foodborne illness. Four basic food safety principles (Clean, Separate, Cook, and Chill) work together to reduce the risk of foodborne illnesses. In addition, some foods (such as milks, cheeses, and juices that have not been pasteurized, and undercooked animal foods) pose high risk for foodborne illness and should be avoided.

Dietary Guidelines for Americans key recommendations are the most important in terms of their implications for improving public health.

To get the full benefit, individuals should carry out the Dietary Guidelines recommendations in their entirety as part of an overall healthy eating pattern.

Dietary Guidelines For Americans, 2010

Individuals should meet the following recommendations as part of a healthy eating pattern while staying within their calorie needs.

- Increase vegetable and fruit intake. Eat a variety of vegetables, especially dark-green and red and orange vegetables and beans and peas.
- Consume at least half of all grains as whole grains. Increase whole-grain intake by replacing refined grains with whole grains.
- Increase intake of fat-free or low-fat milk and milk products, such as milk, yogurt, cheese, or fortified soy beverages.
- Choose a variety of protein foods, which include seafood, lean meat and poultry, eggs, beans and peas, soy products, and unsalted nuts and seeds. Increase the amount and variety of seafood consumed by choosing seafood in place of some meat and poultry. Replace protein foods that are higher in solid fats with choices that are lower in solid fats and calories and/or are sources of oils.
- Use oils to replace solid fats where possible. Choose foods that provide more potassium, dietary fiber, calcium, and vitamin D, which are nutrients of concern in American diets. These foods include vegetables, fruits, whole grains, and milk and milk products.

Balancing Calories to Manage Weight

- Prevent and/or reduce overweight and obesity through improved eating and physical activity behaviors. Control total calorie intake to manage body weight. For people who are overweight or obese, this will mean consuming fewer calories from foods and beverages.
- Increase physical activity and reduce time spent in sedentary behaviors. Maintain appropriate calorie balance during each stage of life; childhood, adolescence, adulthood, pregnancy and breastfeeding, and older age.
- Reduce daily sodium intake to less than 2,300 milligrams (mg) and further reduce intake to 1,500 mg among persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease. The 1,500 mg recommendation applies to about half of the U.S. population, including children, and the majority of adults.
- Consume less than 10 percent of calories from saturated fatty acids by replacing them with monounsaturated and polyunsaturated fatty acids. Consume less than 300 mg per day of dietary cholesterol. Keep trans fatty acid consumption as low as possible by limiting foods that contain synthetic sources of trans fats, such as partially hydrogenated oils, and by limiting other solid fats. Reduce the intake of calories from solid fats and added sugars.
- Limit the consumption of foods that contain refined grains, especially refined grain foods that contain solid fats, added sugars, and sodium.
- If alcohol is consumed, it should be consumed in moderation up to one drink per day for women and two drinks per day for men and only by adults of legal drinking age.

Foods and Food Components to Reduce

- Reduce daily sodium intake to less than 2,300 milligrams (mg) and further reduce intake to 1,500 mg among persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease. The 1,500 mg recommendation applies to about half of the U.S. population, including children, and the majority of adults.
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- Consume less than 300 mg per day of dietary cholesterol.
- Keep trans fatty acid consumption as low as possible by limiting foods that contain synthetic sources of trans fats, such as partially hydrogenated oils, and by limiting other solid fats.
- Reduce the intake of calories from solid fats and added sugars.
- Limit the consumption of foods that contain refined grains, especially refined grain foods that contain solid fats, added sugars, and sodium.
- If alcohol is consumed, it should be consumed in moderation—up to one drink per day for women and two drinks per day for men—and only by adults of legal drinking age.

Building Healthy Eating Patterns

- Select an eating pattern that meets nutrient needs over time at an appropriate calorie level.
- Account for all foods and beverages consumed and assess how they fit within a total healthy eating pattern.
- Follow food safety recommendations when preparing and eating foods to reduce the risk of foodborne illnesses.

Recommendations for Specific Population Groups

Women capable of becoming pregnant

- Choose foods that supply heme iron, which is more readily absorbed by the body, additional iron sources, and enhancers of iron absorption such as vitamin C-rich foods.
- Consume 400 micrograms (mcg) per day of synthetic folic acid (from fortified foods and/or supplements) in addition to food forms of folate from a varied diet.

Women who are pregnant or breastfeeding

- Consume 8 to 12 ounces of seafood per week from a variety of seafood types.
- Due to their high methyl mercury content, limit white (albacore) tuna to 6 ounces per week and do not eat the following four types of fish: tilefish, shark, swordfish, and king mackerel.
- If pregnant, take an iron supplement, as recommended by an obstetrician or other health care provider. Individuals ages 50 years and older Consume foods fortified with vitamin B12, such as fortified cereals, or dietary supplements.

Building Healthy Eating Patterns

- Select an eating pattern that meets nutrient needs over time at an appropriate calorie level.
- Account for all foods and beverages consumed and assess how they fit within a total healthy eating pattern.
- Follow food safety recommendations when preparing and eating foods to reduce the risk of foodborne illnesses.
- Reduce daily sodium intake to less than 2,300 milligrams (mg) and further reduce intake to 1,500 mg among persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease.

Individuals ages 50 years and older

- Consume foods fortified with vitamin B12, such as fortified cereals, or dietary supplements.

Children

Children are a particularly important focus of the Dietary Guidelines for Americans because of the growing body of evidence documenting the vital role that optimal nutrition plays throughout the lifespan. Today, too many children are consuming diets with

too many calories and not enough nutrients and are not getting enough physical activity. Approximately 32 percent of children and adolescents ages 2 to 19 years are overweight or obese, with 17 percent of children being obese. In addition, risk factors for adult chronic diseases are increasingly found in younger ages. Eating patterns established in childhood often track into later life, making early intervention on adopting healthy nutrition and physical activity behaviors a priority. 81.1 million Americans, 37 percent of the population, have cardiovascular disease.

Diet-related Chronic Disease

Major risk factors include high levels of blood cholesterol and other lipids, type 2 diabetes, hypertension (high blood pressure), metabolic syndrome, overweight and obesity, physical inactivity, and tobacco use. 16 percent of the U.S. adult population has high 14 total blood cholesterol.

Cardiovascular Disease

81.1 million Americans—37 percent of the 13 population—have cardiovascular disease. Major risk factors include high levels of blood cholesterol and other lipids, type 2 diabetes, hypertension (high blood pressure), metabolic syndrome, overweight and obesity, physical inactivity, and tobacco use. 16 percent of the U.S. adult population has high 14 total blood cholesterol.

Hypertension

74.5 million Americans, 34 percent of U.S. 15 adults, have hypertension. Hypertension is a major risk factor for heart disease, stroke, congestive heart failure, and kidney disease. Dietary factors that increase blood pressure include excessive sodium and insufficient potassium intake, overweight and obesity, and excess alcohol consumption. 36 percent of American adults have prehypertension, blood pressure numbers that are higher than normal, but not yet in the 16 hypertension range. Nearly 24 million people, almost 11 percent of the population, ages 20 years and older have diabetes. The vast majority of cases are type 2 diabetes, which is heavily influenced by diet and physical activity. About 78 million Americans, 35 percent of the U.S. adult population ages 20 years or 18older, have pre-diabetes. Pre-diabetes (also called impaired glucose tolerance or impaired fasting glucose) means that blood glucose levels are higher than normal, but not high enough to be called diabetes.

Cancer

Almost one in two men and women, approximately 41 percent of the population, will be 19 diagnosed with cancer during their lifetime.Dietary factors are associated with risk of some types of cancer, including breast (post-menopausal), endometrial, colon, kidney, mouth, pharynx, larynx, and esophagus.

Osteoporosis

One out of every two women and one in four men ages 50 years and older will have an 20 osteoporosis-related fracture in their lifetime. About 85 to 90 percent of adult bone mass is acquired by the age of 18 in girls and the age 21of 20 in boys.

Optional Learning Activity

Implement a nutritionally healthy workplace (e.g., form a potluck lunch group that emphasizes health foods; organize an event where people can taste test a variety of healthy foods that they may not have ever eaten before such as kale)

Food Safety Advice

Clean: Wash Hands and Surfaces Often

Bacteria can be spread throughout the kitchen and get onto hands, cutting boards, utensils, counter tops, and food. Wash your hands with warm water and soap for at least 20 seconds before and after handling food and after using the bathroom or changing diapers. Wash your hands after playing with pets or visiting petting zoos. Wash your cutting boards, dishes, utensils, and counter

tops with hot soapy water after preparing each food item and before you go on to the next food. Consider using paper towels to clean up kitchen surfaces. If you use cloth towels wash them often in the hot cycle of your washing machine. Rinse fresh fruits and vegetables under running tap water, including those with skins and rinds that are not eaten. Rub firm-skinned fruits and vegetables under running tap water or scrub with a clean vegetable brush while rinsing with running tap water. Keep books, backpacks, or shopping bags off the kitchen table or counters where food is prepared or served.

Separate: Don't Cross Contaminate

Cross-contamination is how bacteria can be spread. When handling raw meat, poultry, seafood, and eggs, keep these foods and their juices away from ready-to-eat foods. Always start with a clean scene — wash hands with warm water and soap. Wash cutting boards, dishes, countertops, and utensils with hot soapy water. Separate raw meat, poultry, seafood, and eggs from other foods in your grocery shopping cart, grocery bags, and in your refrigerator. Use one cutting board for fresh produce and a separate one for raw meat, poultry, and seafood. Use a food thermometer, which measures the internal temperature of cooked meat, poultry, and egg dishes, to make sure that the food is cooked to a safe internal temperature.

Cook: Cook to Proper Temperatures

Food is safely cooked when it reaches a high enough internal temperature to kill the harmful bacteria that cause foodborne illness. Use a food thermometer to measure the internal temperature of cooked foods.

- Use a food thermometer, which measures the internal temperature of cooked meat, poultry, and egg dishes, to make sure that the food is cooked to a safe internal temperature.
- Cook beef roasts and steaks to a safe minimum internal temperature of 145°F. Cook pork to a minimum of 160°F. All poultry should reach a safe minimum internal temperature of 165°F throughout the bird, as measured with a food thermometer.
- Cook ground meat to 160°F. Information from the Centers for Disease Control and Prevention (CDC) links eating undercooked ground beef with a higher risk of illness. Remember, color is not a reliable indicator of doneness. Use a food thermometer to check the internal temperature of your burgers.
- Cook eggs until the yolk and white are firm, not runny. Don't use recipes in which eggs remain raw or only partially cooked. Casseroles and other dishes containing eggs should be cooked to 160°F.
- Cook fish to 145°F or until the flesh is opaque and separates easily with a fork.
- Make sure there are no cold spots in food (where bacteria can survive) when cooking in a microwave oven. For best results, cover food, stir and rotate for even cooking. If there is no turntable, rotate the dish by hand once or twice during cooking.
- Bring sauces, soups and gravy to a boil when reheating. Heat other leftovers thoroughly to 165°F.
- Use microwave-safe cookware and plastic wrap when cooking foods in a microwave oven.

Chill: Refrigerate Promptly!

Refrigerate foods quickly because cold temperatures slow the growth of harmful bacteria. Do not over-stuff the refrigerator. Cold air must circulate to help keep food safe. Keeping a constant refrigerator temperature of 40°F or below is one of the most effective ways to reduce the risk of foodborne illness. Use an appliance thermometer to be sure the temperature is consistently 40°F or below. The freezer temperature should be 0°F or below.

- Refrigerate or freeze meat, poultry, eggs, and other perishables as soon as you get them home from the store.
- Never let raw meat, poultry, eggs, cooked food, or cut fresh fruits or vegetables sit at room temperature more than two hours before putting them in the refrigerator or freezer (one hour when the temperature is above 90°F).
- Never defrost food at room temperature. Food must be kept at a safe temperature during thawing. There are three safe ways to defrost food: in the refrigerator, in cold water, and in the microwave using the defrost setting. Food thawed in cold water or in the microwave should be cooked immediately.
- Always marinate food in the refrigerator.
- Divide large amounts of leftovers into shallow containers for quicker cooling in the refrigerator.
- Use or discard refrigerated food on a regular basis.

Some food is safe without a cold source. Items that don't require refrigeration include whole fruits and vegetables, hard cheese, unopened canned meat and fish, chips, breads, crackers, peanut butter, jelly, mustard, and pickles.

Use an insulated container to keep food like soup, chili, and stew hot. Fill the container with boiling water, let stand for a few minutes, empty, and then put in the piping hot food. Keep the insulated container closed until lunchtime to keep the food hot

—140°F or above.

Sources

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2.5.5.2: Myths and Misconceptions about Nutrition

> Lose 30 pounds in 30 days!
>
> Eat as much as you want and still lose weight!
>
> Try the thigh buster and lose inches fast!

And so on, and so on. With so many products and weight-loss theories out there, it is easy to get confused.

Read the following Myths and Facts to help clear up confusion about weight loss, nutrition, and physical activity.

Myth: Fad diets work for permanent weight loss.

Fact: Fad diets are not the best way to lose weight and keep it off. Fad diets often promise quick weight loss or tell you to cut certain foods out of your diet. You may lose weight at first on one of these diets. But diets that strictly limit calories or food choices are hard to follow. Most people quickly get tired of them and regain any lost weight. Fad diets may be unhealthy because they may not provide all of the nutrients your body needs. Also, losing weight at a very rapid rate (more than 3 pounds a week after the first couple of weeks) may increase your risk for developing gallstones (clusters of solid material in the gallbladder that can be painful). Diets that provide less than 800 calories per day also could result in heart rhythm abnormalities, which can be fatal. Research suggests that losing 1/2 to 2 pounds a week by making healthy food choices, eating moderate portions, and building physical activity into your daily life is the best way to lose weight and keep it off. By adopting healthy eating and physical activity habits, you may also lower your risk for developing type 2 diabetes, heart disease, and high blood pressure.

Myth: High-protein or low-carbohydrate diets are a healthy way to lose weight.

Fact: The long-term health effects of a high-protein/low-carbohydrate diet are unknown. But getting most of your daily calories from high-protein foods like meat, eggs, and cheese is not a balanced eating plan. You may be eating too much fat and cholesterol, which may raise heart disease risk. You may be eating too few fruits, vegetables, and whole grains, which may lead to constipation due to lack of dietary fiber. Following a high-protein/low-carbohydrate diet may also make you feel nauseous, tired, and weak. Eating fewer than 130 grams of carbohydrate a day can lead to the buildup of ketones in your blood. Ketones are partially broken-down fats. A buildup of these in your blood (called ketosis) can cause your body to produce high levels of uric acid, which is a risk factor for gout (a painful swelling of the joints) and kidney stones. Ketosis may be especially risky for pregnant women and people with diabetes or kidney disease. Be sure to discuss any changes in your diet with a health care professional, especially if you have health conditions such as cardiovascular disease, kidney disease, or type 2 diabetes.

Tip: High-protein/low-carbohydrate diets are often low in calories because food choices are strictly limited, so they may cause short-term weight loss. But a reduced-calorie eating plan that includes recommended amounts of carbohydrate, protein, and fat will also allow you to lose weight. By following a balanced eating plan, you will not have to stop eating whole classes of foods, such as whole grains, fruits, and vegetables—and miss the key nutrients they contain. You may also find it easier to stick with a diet or eating plan that includes a greater variety of foods.

Myth: Starches are fattening and should be limited when trying to lose weight.

Fact: Many foods high in starch, like bread, rice, pasta, cereals, beans, fruits, and some vegetables (like potatoes and yams) are low in fat and calories. They become high in fat and calories when eaten in large portion sizes or when covered with high-fat toppings like butter, sour cream, or mayonnaise. Foods high in starch (also called complex carbohydrates) are an important source of energy for your body.

Tip: A healthy eating plan includes the following elements:

- It emphasizes fruits, vegetables, whole grains, and fat-free or low-fat milk and milk products.
- It includes lean meats, poultry, fish, beans, eggs, and nuts.
- It is low in saturated fats, *trans* fat, cholesterol, salt (sodium), and added sugars.

Myth: Certain foods, like grapefruit, celery, or cabbage soup, can burn fat and make you lose weight.

Fact: No foods can burn fat. Some foods with caffeine may speed up your metabolism (the way your body uses energy, or calories) for a short time, but they do not cause weight loss.

Tip: The best way to lose weight is to cut back on the number of calories you eat and be more physically active.

Myth: Natural or herbal weight-loss products are safe and effective.

Fact: A weight-loss product that claims to be natural or herbal is not necessarily safe. These products are not usually scientifically tested to prove that they are safe or that they work. For example, herbal products containing ephedra (now banned by the U.S. Government) have caused serious health problems and even death. Newer products that claim to be ephedra-free are not necessarily danger-free, because they may contain ingredients similar to ephedra.

Tip: Talk with your health care provider before using any weight-loss product. Some natural or herbal weight-loss products can be harmful.

Myth: I can lose weight while eating whatever I want.

Fact: To lose weight, you need to use more calories than you eat. It is possible to eat any kind of food you want and lose weight. You need to limit the number of calories you eat every day and/or increase your daily physical activity. Portion control is the key. Try eating smaller amounts of food and choosing foods that are low in calories.

Tip: When trying to lose weight, you can still eat your favorite foods—as long as you pay attention to the **total number of calories** that you eat.

Myth: Low-fat or fat-free means no calories.

Fact: A low-fat or fat-free food *is* often lower in calories than the same size portion of the full-fat product. But many processed low-fat or fat-free foods have just as many calories as the full-fat versions of the same foods or even more calories. They may contain added sugar, flour, or starch thickeners to improve flavor and texture after fat is removed. These ingredients add calories. Myth: Fast foods are always an unhealthy choice and you should not eat them when dieting.

Fact: Fast foods can be part of a healthy weight-loss program with a little bit of know-how.

Tip: Avoid supersized combo meals, or split one with a friend. Sip on water or fat-free milk instead of soda. Choose salads and grilled foods, like a grilled chicken breast sandwich or small hamburger. Try a “fresco” taco (with salsa instead of cheese or sauce) at taco stands. Fried foods, like french fries and fried chicken, are high in fat and calories, so order them only once in a while, order a small portion, or split an order with a friend. Also, use only small amounts of high-fat, high-calorie toppings, like regular mayonnaise, salad dressings, bacon, and cheese.

Myth: Skipping meals is a good way to lose weight.

Fact: Studies show that people who skip breakfast and eat fewer times during the day tend to be heavier than people who eat a healthy breakfast and eat four or five times a day. This may be because people who skip meals tend to feel hungrier later on, and eat more than they normally would. It may also be that eating many small meals throughout the day helps people control their appetites.

Tip: Eat small meals throughout the day that include a variety of healthy, low-fat, low-calorie foods.

Myth: Eating after 8 p.m. causes weight gain.

Fact: It does not matter what time of day you eat. It is what and how much you eat and how much physical activity you do during the whole day that determines whether you gain, lose, or maintain your weight. No matter when you eat, your body will store extra calories as fat.

Tip: If you want to have a snack before bedtime, think first about how many calories you have eaten that day. And try to avoid snacking in front of the TV at night—it may be easier to overeat when you are distracted by the television.

Myth: Nuts are fattening and you should not eat them if you want to lose weight.

Fact: In small amounts, nuts can be part of a healthy weight-loss program. Nuts are high in calories and fat. However, most nuts contain healthy fats that do not clog arteries. Nuts are also good sources of protein, dietary fiber, and minerals including magnesium and copper.

Tip: Enjoy small portions of nuts. One-half ounce of mixed nuts has about 84 calories.

Myth: Eating red meat is bad for your health and makes it harder to lose weight.

Fact: Eating lean meat in small amounts can be part of a healthy weight-loss plan. Red meat, pork, chicken, and fish contain some cholesterol and saturated fat (the least healthy kind of fat). They also contain healthy nutrients like protein, iron, and zinc.

Tip: Choose cuts of meat that are lower in fat and trim all visible fat. Lower fat meats include pork tenderloin and beef round steak, tenderloin, sirloin tip, flank steak, and extra lean ground beef. Also, pay attention to portion size. Three ounces of meat or poultry is the size of a deck of cards.

Myth: Dairy products are fattening and unhealthy.

Fact: Low-fat and fat-free milk, yogurt, and cheese are just as nutritious as whole-milk dairy products, but they are lower in fat and calories. Dairy products have many nutrients your body needs. They offer protein to build muscles and help organs work properly, and calcium to strengthen bones. Most milk and some yogurt are fortified with vitamin D to help your body use calcium.

Tip: If you cannot digest lactose (the sugar found in dairy products), choose low-lactose or lactose-free dairy products, or other foods and beverages that offer calcium and vitamin D (listed below).

- **Calcium:** soy-based beverage or tofu made with calcium sulfate; canned salmon; dark leafy greens like collards or kale
- **Vitamin D:** soy-based beverage or cereal (getting some sunlight on your skin also gives you a small amount of vitamin D)

Myth: “Going vegetarian” means you are sure to lose weight and be healthier.

Fact: Research shows that people who follow a vegetarian eating plan, on average, eat fewer calories and less fat than nonvegetarians. They also tend to have lower body weights relative to their heights than nonvegetarians. Choosing a vegetarian eating plan with a low fat content may be helpful for weight loss. But vegetarians—like nonvegetarians—can make food choices that contribute to weight gain, like eating large amounts of high-fat, high-calorie foods or foods with little or no nutritional value. Vegetarian diets should be as carefully planned as nonvegetarian diets to make sure they are balanced. Nutrients that nonvegetarians normally get from animal products, but that are not always found in a vegetarian eating plan, are iron, calcium, vitamin D, vitamin B12, zinc, and protein.

Tip: Choose a vegetarian eating plan that is low in fat and that provides all of the nutrients your body needs. Food and beverage sources of nutrients that may be lacking in a vegetarian diet are listed below.

- **Iron:** cashews, spinach, lentils, garbanzo beans, fortified bread or cereal
- **Calcium:** dairy products, fortified soy-based beverages, tofu made with calcium sulfate, collard greens, kale, broccoli
- **Vitamin D:** fortified foods and beverages including milk, soy-based beverages, or cereal Vitamin B12 eggs, dairy products, fortified cereal or soy-based beverages, tempeh, miso (tempeh and miso are foods made from soybeans)
- **Protein:** eggs, dairy products, beans, peas, nuts, seeds, tofu, tempeh, soy-based burgers

Sources

Source: Weight-loss and Nutrition Myths, NIDDK, NIH, win.niddk.nih.gov/publications/myths.htm

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2.5.5.3: Ethnic Foods

Tipsheet: Eating Healthy Ethnic Food

Trying different ethnic cuisines to give yourself a taste treat is possible while counting calories and fat. Many ethnic cuisines offer lots of low-fat, low-calorie choices.

So if you want to eat healthy and still have lots of different choices, take a taste adventure with ethnic foods. Here's a sample of healthy food choices (lower in calories and fat) and terms to look for when making your selection:

Chinese

- Zheng (steamed)
- Jum (poached)
- Kao (roasted)
- Shao (barbecued)
- Steamed rice
- Dishes without MSG added

Italian

- Red sauces
- Primavera (no cream)
- Piccata (lemon)
- Sun-dried tomatoes
- Crushed tomatoes
- Lightly sauteed
- Grilled

Mexican

- Spicy chicken
- Rice and black beans
- Salsa or picante
- Soft corn tortillas

Learning Activity

Try some of the healthy food recipes in these cookbooks –

- **Heart Healthy Home Cooking African American Style—With Every Heartbeat is Life:** Prepare your favorite African American dishes in ways that protect you and your family from heart disease and stroke. This cookbook provides recipes for 26 tested and tasty favorite African American dishes. Recipes give nutrient analyses that include carbohydrates and protein. Also covers heart healthy food substitutions and food safety.
- **Delicious Heart Healthy Latino Recipes:** Provides recipes for 26 popular easy to prepare taste-tested Latino dishes created in a heart healthy style (lower in fat and sodium than traditional versions). Includes heart healthy food substitutions, food safety, a glossary of international terms

Sources

Tipsheet: Eating Healthy Ethnic Food: Eating Healthy Ethnic Food, NHIBI, NIH, http://www.nhlbi.nih.gov/health/public/heart/

obesity/lose_wt/eth_dine.htm

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2.5.5.4: Dietary Supplements

What are the benefits and risks of dietary supplements?

Many people take dietary supplements in an effort to be well and stay healthy. With so many dietary supplements available and so many claims made about their health benefits, how can a consumer decide what's safe and effective? This fact sheet provides a general overview of dietary supplements, discusses safety considerations, and suggests sources for additional information.

Key Points

- Federal regulations for dietary supplements are very different from those for prescription and over-the-counter drugs. For example, a dietary supplement manufacturer does not have to prove a product's safety and effectiveness before it is marketed.
- If you are thinking about using a dietary supplement, first get information on it from reliable sources. Keep in mind that dietary supplements may interact with medications or other dietary supplements and may contain ingredients not listed on the label.
- Tell your health care providers about any complementary and alternative practices you use, including dietary supplements. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

About Dietary Supplements

Dietary supplements were defined in a law passed by Congress in 1994 called the Dietary Supplement Health and Education Act (DSHEA). According to DSHEA, a dietary supplement is a product that:

- Is intended to supplement the diet
- Contains one or more dietary ingredients (including vitamins, minerals, herbs or other botanicals, amino acids, and certain other substances) or their constituents
- Is intended to be taken by mouth, in forms such as tablet, capsule, powder, softgel, gelcap, or liquid
- Is labeled as being a dietary supplement.

Herbal supplements are one type of dietary supplement. An herb is a plant or plant part (such as leaves, flowers, or seeds) that is used for its flavor, scent, and/or therapeutic properties. "Botanical" is often used as a synonym for "herb." An herbal supplement may contain a single herb or mixtures of herbs.

Research has shown that some uses of dietary supplements are effective in preventing or treating diseases. For example, scientists have found that folic acid (a vitamin) prevents certain birth defects, and a regimen of vitamins and zinc can slow the progression of the age- related eye disease macular degeneration. Also, calcium and vitamin D supplements can be helpful in preventing and treating bone loss and osteoporosis (thinning of bone tissue).

Research has also produced some promising results suggesting that other dietary supplements may be helpful for other health conditions (e.g., omega-3 fatty acids for coronary disease), but in most cases, additional research is needed before firm conclusions can be drawn.

Dietary Supplement Use in the United States

A national survey conducted in 2007 found that 17.7 percent of American adults had used "natural products" (i.e., dietary supplements other than vitamins and minerals) in the past 12 months. The most popular products used by adults for health reasons in the past 30 days were fish oil/omega 3/DHA (37.4 percent), glucosamine (19.9 percent), echinacea (19.8 percent), flaxseed oil or pills (15.9 percent), and ginseng (14.1 percent). In another, earlier national survey covering all types of dietary supplements, approximately 52 percent of adult respondents said they had used some type of supplement in the last 30 days; the most commonly reported were multivitamins/multiminerals (35 percent), vitamins E and C (12–13 percent), calcium (10 percent),

and B-complex vitamins (5 percent).

Federal Regulation of Dietary Supplements

The Federal Government regulates dietary supplements through the U.S. Food and Drug Administration (FDA). The regulations for dietary supplements are not the same as those for prescription or over-the-counter drugs. In general, the regulations for dietary supplements are less strict.

- A manufacturer does not have to prove the safety and effectiveness of a dietary supplement before it is marketed. A manufacturer is permitted to say that a dietary supplement addresses a nutrient deficiency, supports health, or is linked to a particular body function (e.g., immunity), if there is research to support the claim. Such a claim must be followed by the words "This statement has not been evaluated by the U.S. Food and Drug Administration (FDA). This product is not intended to diagnose, treat, cure, or prevent any disease."
- Manufacturers are expected to follow certain "good manufacturing practices" (GMPs) to ensure that dietary supplements are processed consistently and meet quality standards. Requirements for GMPs went into effect in 2008 for large manufacturers and are being phased in for small manufacturers through 2010.
- Once a dietary supplement is on the market, the FDA monitors safety. If it finds a product to be unsafe, it can take action against the manufacturer and/or distributor, and may issue a warning or require that the product be removed from the marketplace.

Also, once a dietary supplement is on the market, the FDA monitors product information, such as label claims and package inserts. The Federal Trade Commission (FTC) is responsible for regulating product advertising; it requires that all information be truthful and not misleading.

The Federal Government has taken legal action against a number of dietary supplement promoters or Web sites that promote or sell dietary supplements because they have made false or deceptive statements about their products or because marketed products have proven to be unsafe.

Sources of Science-Based Information for Dietary Supplements

It's important to look for reliable sources of information on dietary supplements so you can evaluate the claims that are made about them. The most reliable information on dietary supplements is based on the results of rigorous scientific testing.

To get reliable information on a particular dietary supplement:

- Ask your health care providers. Even if they do not know about a specific dietary supplement, they may be able to access the latest medical guidance about its uses and risks.
- Look for scientific research findings on the dietary supplement. The National Center for Complementary and Alternative Medicine (NCCAM) and the National Institutes of Health (NIH) Office of Dietary Supplements (ODS), as well as other Federal agencies, have free publications, clearinghouses, and information on their Web sites.

Safety Considerations of Dietary Supplements

If you are thinking about or are using a dietary supplement, here are some points to keep in mind.
Tell your health care providers about any complementary and alternative practices you use, including dietary supplements. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care. For tips about talking with your health care providers about complementary and alternative medicine (CAM), see NCCIH's "Be an Informed Consumer" page.

It is especially important to talk to your health care provider if you are

- Thinking about replacing your regular medication with one or more dietary supplements.
- Taking any medications (whether prescription or over-the-counter), as some dietary supplements have been found to interact with medications.
- Planning to have surgery. Certain dietary supplements may increase the risk of bleeding or affect the response to anesthesia.
- Pregnant or nursing a baby, or are considering giving a child a dietary supplement. Most dietary supplements have not been

tested in pregnant women, nursing mothers, or children.

If you are taking a dietary supplement, **read the label instructions.** Talk to your health care provider if you have any questions, particularly about the best dosage for you to take. If you experience any side effects that concern you, stop taking the dietary supplement, and contact your health care provider.

Keep in mind that although many dietary supplements (and some prescription drugs) come from natural sources, **"natural" does not always mean "safe."** For example, the herbs comfrey and kava can cause serious harm to the liver. Also, a manufacturer's use of the term "standardized" (or "verified" or "certified") does not necessarily guarantee product quality or consistency.

Be aware that **an herbal supplement may contain dozens of compounds** and that its active ingredients may not be known. Researchers are studying many of these products in an effort to identify active ingredients and understand their effects in the body. Also consider the possibility that what's on the label may not be what's in the bottle. Analyses of dietary supplements sometimes find differences between labeled and actual ingredients.

For example:

- An herbal supplement may not contain the correct plant species.
- The amount of the active ingredient may be lower or higher than the label states. That means you may be taking less—or more—of the dietary supplement than you realize.
- The dietary supplement may be contaminated with other herbs, pesticides, or metals, or even adulterated with unlabeled ingredients such as prescription drugs.

Learning Activity

Watch this short video from the U.S. Food and Drug Administration, Warning on Body Building Products:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Optional Video: Dietary Supplements: Health or Hype?

Much of the information provided in Chapter 6, Lesson 4: Dietary Supplements is also presented in a 16 minute video titled: Dietary Supplements: Health or Hype?

- "Walk down the aisle of any supermarket or pharmacy and you are bound to be confronted by shelves full of nutrient supplements, from vitamin A to zinc. But are they worth the staggering prices many people pay for them? What exactly are supplements, and when should they be avoided? This program looks at a wide range of supplements that are currently available and examines their potential impact on elderly consumers, high performance athletes, and pregnant women. Also spotlighting issues of product labeling and celebrity endorsement, this is a much-needed look at an industry which, despite public concerns, is only getting bigger." (from Films Media Group, 1994. Films On Demand,© 2011)

To view this video:

1. Click on Dietary Supplements: Health or Hype?
2. Enter your Foothill College Student ID Number
3. Click on Login

- Click on the Expand icon (left of Speaker Volume icon) to expand the image to fill the screen.
- Click on the Play button in the center of the screen or in the bottom left corner.
- At any time you can press the ESC key on your computer to return to the browser window or you can move your cursor to the bottom of the screen to make the toolbar visible again; then you can pause or adjust the volume.

- Closed captioning is available for this video. You'll see a "Turn CC On" button in the upper right hand of the video player. Click on this button to toggle captions on/off

Sources

Source: *Wise Use, NCCAM, NIH, http://nccam.nih.gov/health/supplements/wiseuse.htm*

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2.5.5.5: Body Composition

Body Mass Index (BMI)

BMI is a useful measure of overweight and obesity. It is calculated from your height and weight. BMI is an estimate of body fat and a good gauge of your risk for diseases that can occur with more body fat. The higher your BMI, the higher your risk for certain diseases such as heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems, and certain cancers.

Although BMI can be used for most men and women, it does have some limits:

- It may overestimate body fat in athletes and others who have a muscular build.
- It may underestimate body fat in older persons and others who have lost muscle.

How is obesity measured?

Measuring the exact amount of a person's body fat is not easy. The most accurate measures are to weigh a person underwater or in a chamber that uses air displacement to measure body volume, or to use an X-ray test called Dual Energy X-ray Absorptiometry, also known as DEXA. These methods are not practical for the average person, and are done only in research centers with special equipment.

There are simpler methods to estimate body fat. One is to measure the thickness of the layer of fat just under the skin in several parts of the body. Another involves sending a harmless amount of electricity through a person's body. Results from these methods, however, can be inaccurate if done by an inexperienced person or on someone with extreme obesity.

Because measuring a person's body fat is difficult, health care professionals often rely on other means to diagnose obesity. Weight-for-height tables, used for decades, have a range of acceptable weights for a person of a given height. One problem with these tables is that there are many versions, all with different weight ranges. Another problem is that they do not distinguish between excess fat and muscle. According to the tables, a very muscular person may be classified obese when he or she is not. The Body Mass Index (BMI) is less likely to misidentify a person's appropriate weight-for-height range.

Body Mass Index

The BMI is a tool used to assess overweight and obesity and monitor changes in body weight. Like the weight-for-height tables, BMI has its limitations because it does not measure body fat or muscle directly. It is calculated by dividing a person's weight in pounds by height in inches squared and multiplied by 703.

Men and women can have the same BMI but different body fat percentages. As a rule, women usually have more body fat than men. A bodybuilder with a large muscle mass and low percentage of body fat may have the same BMI as a person who has more body fat. However, a BMI of 30 or higher usually indicates excess body fat.

A BMI of 25 to 29.9 is considered overweight. A person with a BMI of 30 or higher is considered obese. Please review your findings with your health care provider if your BMI is outside of the normal range.

Waist Circumference

Measuring waist circumference helps screen for possible health risks that come with overweight and obesity. If most of your fat is around your waist rather than at your hips, you're at a higher risk for heart disease and type 2 diabetes. This risk goes up with a waist size that is greater than 35 inches for women or greater than 40 inches for men. To correctly measure your waist, stand and place a tape measure around your middle, just above your hipbones. Measure your waist just after you breathe out.

The table Risks of Obesity-Associated Diseases by BMI and Waist Circumference provides you with an idea of whether your BMI combined with your waist circumference increases your risk for developing obesity-associated diseases or conditions.

Body Fat Distribution

Health care professionals are concerned not only with how much fat a person has, but also where the fat is located on the body. Women typically collect fat in their hips and buttocks, giving them a “pear” shape. Men usually build up fat around their bellies, giving them more of an “apple” shape. Of course, some men are pear-shaped and some women become apple-shaped, especially after menopause.

Excess abdominal fat is an important, independent risk factor for disease. Research has shown that waist circumference is directly associated with abdominal fat and can be used in the assessment of the risks associated with obesity or overweight. If you carry fat mainly around your waist, you are more likely to develop obesity-related health problems.

Women with a waist measurement of more than 35 inches and men with a waist measurement of more than 40 inches may have more health risks than people with lower waist measurements because of their body fat distribution.

Learning Activity

The BMI Calculator is an easy-to-use online tool to help you estimate body fat. The higher your BMI, the higher your risk of obesity-related disease.

Use the BMI Calculator or BMI Tables to estimate your body fat. The BMI score means the following:

BMI Score	
Underweight	Below 18.5
Normal	18.5–24.9
Overweight	25.0–29.9
Obesity	30.0 and Above

Sources

Body Mass Index (BMI): Assessing Your Weight and Health Risk, NHIBI, NIH, http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/risk.htm

How is obesity measured?: Understanding Adult Obesity, WIN, NIDDK, NIH, win.niddk.nih.gov/publications/understanding.htm

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2.5.5.6: Obesity

Overweight and obesity is a serious health problem that affects millions of Americans. These conditions substantially increase the risk of morbidity from hypertension; dyslipidemia; type 2 diabetes; coronary heart disease; stroke; gallbladder disease; osteoarthritis; sleep apnea and respiratory problems; and endometrial, breast, prostate, and colon cancers. Higher body weights also are associated with increases in all-cause mortality.

Adults

According to the National Health and Nutrition Examination Survey (NHANES) data from 2007–08, the overall prevalence of overweight and obesity for adults was 68 percent (approximately 72 percent among men and 64 percent among women).

- Among women, the overall prevalence of obesity was 35.5 percent.
- Among men, the overall prevalence of obesity was 32.2 percent.

Children and Teens

This rate, though, remains alarmingly high. Statistics show about 17 percent of American children ages 2 to 19, or 1 in 6, are obese. Further, the latest data continue to suggest that overweight and obesity are having a greater effect on minorities, including blacks and Hispanics.

Understanding Adult Obesity

Today, 66 percent of adults in the United States are considered overweight or obese. Obesity puts people at increased risk for chronic diseases such as heart disease, type 2 diabetes, high blood pressure, stroke, and some forms of cancer.

The large number of people considered to be obese and the serious health risks that come with it make understanding its causes and treatment crucial. This fact sheet provides basic information about obesity: What is it? How is it measured? What causes it? What are the health risks? What can you do about it?

What is obesity? Obesity specifically refers to an excessive amount of body fat. “Overweight” refers to an excessive amount of body weight that includes muscle, bone, fat, and water. There are few studies in humans that link direct measurements of total body fat to morbidity and mortality. There are also no official standards identified by the National Institutes of Health (NIH) that define obesity based on the amount or percentage of a person’s total body fat.

What causes obesity?

Obesity occurs when a person consumes more calories from food than he or she burns. Our bodies need calories to sustain life and be physically active, but to maintain weight we need to balance the energy we eat with the energy we use. When a person eats more calories than he or she burns, the energy balance is tipped toward weight gain and obesity. This imbalance between calories-in and calories-out may differ from one person to another. Genetic, environmental, and other factors may all play a part.

Genetic Factors

Obesity tends to run in families, suggesting a genetic cause. However, families also share diet and lifestyle habits that may contribute to obesity. Separating genetic from other influences on obesity is often difficult. Even so, science does show a link between obesity and heredity.

Environmental and Social Factors

Environment strongly influences obesity. Consider that most people in the United States alive today were also alive in 1980, when obesity rates were lower. Since this time, our genetic make-up has not changed, but our environment has.

Environment includes lifestyle behaviors such as what a person eats and his or her level of physical activity. Too often Americans eat out, consume large meals and high-fat foods, and put taste and convenience ahead of nutrition. Also, most people in the United States do not get enough physical activity.

Environment also includes the world around us—our access to places to walk and healthy foods, for example. Today, more people drive long distances to work instead of walking, live in neighborhoods without sidewalks, tend to eat out or get "take out" instead of cooking, or have vending machines with high-calorie, high-fat snacks at their workplace. Our environment often does not support healthy habits.

In addition, social factors including poverty and a lower level of education have been linked to obesity. One reason for this may be that high-calorie processed foods cost less and are easier to find and prepare than healthier foods, such as fresh vegetables and fruits. Other reasons may include inadequate access to safe recreation places or the cost of gym memberships, limiting opportunities for physical activity. However, the link between low socioeconomic status and obesity has not been conclusively established, and recent research shows that obesity is also increasing among high-income groups.

Cultural Factors

An individual's cultural background may also play a role in his or her weight. For instance, foods specific to certain cultures that are prepared with a lot of fat or salt may hamper one's weight-loss efforts. Similarly, family gatherings offering large amounts of food may make it difficult to pay attention to proper portion control and serving sizes. Lastly, research has shown that individuals originally from countries other than the United States have difficulty adjusting to the calorie-rich foods offered here. These individuals may not be able to prepare food with the ingredients they would use in their native countries.

Although you cannot change your genetic makeup, you can work on changing your eating habits, levels of physical activity, and other environmental factors. Try these ideas:

- Learn to choose sensible portions of nutritious meals that are lower in fat.
- Learn healthier ways to make your favorite foods.
- Learn to recognize and control environmental cues (like inviting smells or a package of cookies on the counter) that make you want to eat when you are not hungry.
- Have a healthy snack an hour or two before a social gathering to prevent overeating. Mingle and talk between bites to prevent eating too much too quickly.
- Engage in at least 30 minutes of moderate-intensity physical activity (like brisk walking) on most, preferably all, days of the week.
- Take a walk instead of watching television.
- Eat meals and snacks at a table, not in front of the TV.
- Pay attention to why you are eating. Determine if you are eating because you are actually hungry or because you are bored, depressed, or lonely.
- Keep records of your food intake and physical activity.

Other Causes of Obesity

Some illnesses may lead to or are associated with weight gain or obesity. These include:

- Hypothyroidism, a condition in which the thyroid gland fails to produce enough thyroid hormone. It often results in lowered metabolic rate and loss of vigor.
- Cushing's syndrome, a hormonal disorder caused by prolonged exposure of the body's tissues to high levels of the hormone cortisol. Symptoms vary, but most people have upper body obesity, rounded face, increased fat around the neck, and thinning arms and legs.
- Polycystic ovary syndrome, a condition characterized by high levels of androgens (male hormone), irregular or missed menstrual cycles, and in some cases, multiple small cysts in the ovaries. Cysts are fluid-filled sacs.

A doctor can tell whether there are underlying medical conditions that are causing weight gain or making weight loss difficult.

Lack of sleep may also contribute to obesity. Recent studies suggest that people with sleep problems may gain weight over time. On the other hand, obesity may contribute to sleep problems due to medical conditions such as sleep apnea, where a person briefly stops breathing at multiple times during the night. (Visit Health Risks for more information on the relationship between sleep apnea and obesity.) You may wish to talk with your health care provider if you have difficulty sleeping.

Certain drugs such as steroids, some antidepressants, and some medications for psychiatric conditions or seizure disorders may cause weight gain. These drugs may slow the rate at which the body burns calories, stimulate appetite, or cause the body to hold on to extra water. Be sure your doctor knows all the medications you are taking (including over-the-counter medications and dietary supplements). He or she may recommend a different medication that has less effect on weight gain.

What are the consequences of obesity?

Health Risks

Obesity is more than a cosmetic problem. Many serious medical conditions have been linked to obesity, including type 2 diabetes, heart disease, high blood pressure, and stroke. Obesity is also linked to higher rates of certain types of cancer. Esophageal cancer has also been associated with obesity.

- Men who are considered obese are more likely than nonobese men to develop cancer of the colon, rectum, or prostate.
- Women who are considered obese are more likely than nonobese women to develop cancer of the gallbladder, uterus, cervix, or ovaries.

Other diseases and health problems linked to obesity include:

- Gallbladder disease and gallstones.
- Fatty liver disease (also called nonalcoholic steatohepatitis or NASH).
- Gastroesophageal reflux, or what is sometimes called GERD. This problem occurs when the lower esophageal sphincter does not close properly and stomach contents leak back—or reflux—into the esophagus.
- Osteoarthritis, a disease in which the joints deteriorate. This is possibly the result of excess weight on the joints.
- Gout, another disease affecting the joints.
- Pulmonary (breathing) problems, including sleep apnea, which causes a person to stop breathing for a short time during sleep.
- Reproductive problems in women, including menstrual irregularities and infertility.

Health care professionals generally agree that the more obese a person is, the more likely he or she is to develop health problems.

Emotional suffering may be one of the most painful parts of obesity. American society emphasizes physical appearance and often equates attractiveness with slimness, especially for women. Such messages may make people considered overweight feel unattractive.

Many people think that individuals who are considered obese are gluttonous, lazy, or both. This is not true. As a result, people who are considered obese often face prejudice or discrimination in the job market, at school, and in social situations. Feelings of rejection, shame, or depression may occur.

Risk Factors for Health Associated With Obesity

Along with being overweight or obese, the following conditions will put you at greater risk for heart disease and other conditions:

- High blood pressure (hypertension)
- High LDL cholesterol (“bad” cholesterol)
- High triglycerides
- Family history of premature heart disease
- Physical inactivity
- Cigarette smoking

For people who are considered obese (BMI greater than or equal to 30) or those who are overweight (BMI of 25 to 29.9) and have two or more risk factors, it is recommended that you lose weight. Even a small weight loss (between 5 and 10 percent of your current weight) will help lower your risk of developing diseases associated with obesity. People who are overweight, do not have a high waist measurement, and have fewer than two risk factors may need to prevent further weight gain rather than lose weight.

Talk to your doctor to see whether you are at an increased risk and whether you should lose weight. Your doctor will evaluate your BMI, waist measurement, and other risk factors for heart disease.

How is obesity treated?

The method of treatment depends on your level of obesity, overall health condition, and readiness to lose weight. Treatment may include a combination of diet, exercise, behavior modification, and sometimes weight-loss drugs. In some cases of extreme obesity, bariatric surgery may be recommended. (Visit NIDDKfor more information on bariatric surgery.)

Remember, weight control is a life-long effort, and having realistic expectations about weight loss is an important consideration. Eating healthier foods and getting at least 30 minutes of moderate-intensity physical activity on most, preferably all, days of the week have important health benefits. Sixty minutes of physical activity a day may be required to prevent gradual weight gain in adulthood. Individuals who were previously considered overweight and obese individuals are encouraged to get 60 to 90 minutes of exercise a day to sustain weight loss.

Although most adults do not need to see their health care professional before starting a moderate-intensity physical activity program, men older than 40 years and women older than 50 years who plan a vigorous program, or who have either chronic disease or risk factors for chronic illnesses, should speak with their health care provider before starting a physical activity program.

Stigma of Obesity

What is your reaction to this photo of a man and girl at the beach? Compassion? Fear? Disgust? Many people will look at this picture and make negative assumptions about the man based on his weight. According to a study from the Yale Rudd Center for Food Policy and Obesity, large people are the object of “widespread negative stereotypes that overweight and obese persons are lazy, unmotivated, lacking in self-discipline, less competent, noncompliant, and sloppy” (Puhl and Heuer 2009).

Historically, both in the United States and elsewhere, it was considered acceptable to discriminate against people based on prejudiced opinions. Even after slavery was abolished in 1865, the next 100 years of American history saw institutionalized racism and prejudice against black people. In an example of stereotype interchangeability, the same insults that are flung today at the overweight and obese population (lazy, for instance), have been flung at various racial and ethnic groups in earlier history. Of course, no one gives voice to these kinds of views in public now, except when talking about obese people.Why is it considered acceptable to feel prejudice toward—even to hate—obese people? Puhl and Heuer suggest that these feelings stem from the perception that obesity is preventable through self-control, better diet, and more exercise. Highlighting this contention is the fact that studies have shown that people’s perceptions of obesity are more positive when they think the obesity was caused by non-controllable factors like biology (a thyroid condition, for instance) or genetics.

Even with some understanding of non-controllable factors that might affect obesity, obese people are still subject to stigmatization. Puhl and Heuer’s study is one of many that document discrimination at work, in the media, and even in the medical profession. Obese people are less likely to get into college than thinner people, and they are less likely to succeed at work.

Stigmatization of obese people comes in many forms, from the seemingly benign to the potentially illegal. In movies and television show, overweight people are often portrayed negatively, or as stock characters who are the butt of jokes. One study found that in children’s movies “obesity was equated with negative traits (evil, unattractive, unfriendly, cruel) in 64 percent of the most popular children’s videos. In 72 percent of the videos, characters with thin bodies had desirable traits, such as kindness or happiness” (Hines and Thompson 2007). In movies and television for adults, the negative portrayal is often meant to be funny. “Fat suits”—inflatable suits that make people look obese—are commonly used in a way that perpetuates negative stereotypes. Think about the way you have seen obese people portrayed in movies and on television; now think of any other subordinate group being openly denigrated in such a way. It is difficult to find a parallel example.

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2.5.5.7: Diet and Weight Control

Who should lose weight?

Health care professionals generally agree that people who have a BMI of 30 or greater can improve their health through weight loss.This is especially true for people with a BMI of 40 or greater, who are considered extremely obese.

Preventing additional weight gain is recommended if you have a BMI between 25 and 29.9, unless you have other risk factors for obesity-related diseases. Obesity experts recommend you try to lose weight if you have two or more of the following:

- **Family history of certain chronic diseases.** If you have close relatives who have had heart disease or diabetes, you are more likely to develop these problems if you are obese.
- **Preexisting medical conditions.** High blood pressure, high LDL cholesterol levels, low HDL cholesterol levels, high triglycerides, and high blood glucose are all warning signs of some obesity-associated diseases.
- **Large waist circumference.** Men who have waist circumferences greater than 40 inches, and women who have waist circumferences greater than 35 inches, are at higher risk of diabetes, dyslipidemia (abnormal amounts of fat in the blood), high blood pressure, and heart disease.

Fortunately, a weight loss of 5 to 10 percent of your initial body weight can do much to improve health by lowering blood pressure and other risk factors for obesity-related diseases. In addition, research shows that a 5- to 7-percent weight loss brought about by moderate diet and exercise can delay or possibly prevent type 2 diabetes in people at high risk for the disease. In a recent study, participants who were considered overweight and had pre-diabetes—a condition in which a person's blood glucose level is higher than normal, but not high enough to be classified as diabetes—were able to delay or prevent the onset of type 2 diabetes by adopting a low-fat, low-calorie diet and exercising for 30 minutes a day, 5 days a week.

Selecting a Weight Loss Program

Some people lose weight on their own; others like the support of a structured program. Overweight people who are successful at losing weight, and keeping it off, can reduce their risk factors for heart disease. If you decide to join any kind of weight-control program, here are some questions to ask before you join.

- Does the program provide counseling to help you change your eating activity and personal habits?
  The program should teach you how to change permanently those eating habits and lifestyle factors, such as lack of physical activity, that have contributed to weight gain.
- Is the staff made up of a variety of qualified counselors and health professionals such as nutritionists, registered dietitians, doctors, nurses, psychologists, and exercise physiologists?
  You need to be evaluated by a physician if you have any health problems, are currently taking any medicine or plan on taking any medicine, or plan to lose more than 15 to 20 pounds. If your weight-control plan uses a very low-calorie diet (a special liquid formula that replaces all food for 1 to 4 months), an exam and followup visits by a doctor also are needed.
- Is training available on how to deal with times when you may feel stressed and slip back to old habits?
  The program should provide long-term strategies to deal with weight problems you may have in the future. These strategies might include things like setting up a support system and establishing a physical activity routine.
- Is attention paid to keeping the weight off? How long is this phase? Choose a program that teaches skills and techniques to make permanent changes in eating habits and levels of physical activity to prevent weight gain.
- Are food choices flexible and suitable? Are weight goals set by the client and the health professional?
  The program should consider your food likes and dislikes and your lifestyle when your weight-loss goals are planned.

There are other questions you can ask about how well a weight-loss program works. Because many programs don't gather this information, you may not get answers. But it's still important to ask them:

- What percentage of people complete the program?
- What is the average weight loss among people who finish the program?
- What percentage of people have problems or side effects? What are they?
- Are there fees or costs for additional items, such as dietary supplements?

Remember, quick weight loss methods don't provide lasting results. Weight-loss methods that rely on diet aids like drinks, prepackaged foods, or diet pills don't work in the long run. Whether you lose weight on your own or with a group, remember that the most important changes are long term. No matter how much weight you have to lose, modest goals and a slow course will increase your chances of both losing the weight and keeping it off.

Guide to Behavior Change

Your Weight Is Important

Over the past few years it has become clear that weight is an important health issue. Some people who need to lose weight for their health don't recognize it, while others who don't need to lose weight want to get thinner for cosmetic reasons. We understand that in some ways your weight is different from, for example, your cholesterol level or your blood pressure, because you can't see what these are by looking at someone. Many patients have had health care providers who approached their weight in a less-than-sensitive or helpful manner. Some patients may have had health care encounters in which they felt blamed, but not helped. Successful weight management is a long-term challenge.

Weight can affect a person's self-esteem. Excess weight is highly visible and evokes some powerful reactions, however unfairly, from other people and from the people who carry the excess weight. The amount of weight loss needed to improve your health may be much less than you wish to lose, when you consider how you evaluate your weight. Research has shown that your health can be greatly improved by a loss of 5–10 percent of your starting weight. That doesn't mean you have to stop there, but it does mean that an initial goal of losing 5–10 percent of your starting weight is both realistic and valuable.

Behaviors That Will Help You Lose Weight and Maintain It

Set the Right Goals

Setting the right goals is an important first step. Most people trying to lose weight focus on just that one goal: weight loss. However, the most productive areas to focus on are the dietary and physical activity changes that will lead to long-term weight change. Successful weight managers are those who select two or three goals at a time that are manageable.

Useful goals should be (1) specific; (2) attainable (doable); and (3) forgiving (less than perfect). "Exercise more" is a great goal, but it's not specific. "Walk 5 miles every day" is specific and measurable, but is it doable if you're just starting out? "Walk 30 minutes every day" is more attainable, but what happens if you're held up at work one day and there's a thunderstorm during your walking time another day? "Walk 30 minutes, 5 days each week" is specific, doable, and forgiving. In short, a great goal!

Nothing Succeeds Like Success

Shaping is a behavioral technique in which you select a series of short-term goals that get closer and closer to the ultimate goal (e.g., an initial reduction of fat intake from 40 percent of calories to 35 percent of calories, and later to 30 percent). It is based on the concept that "nothing succeeds like success." Shaping uses two important behavioral principles: (1) consecutive goals that move you ahead in small steps are the best way to reach a distant point; and (2) consecutive rewards keep the overall effort invigorated.

Reward Success (But Not With Food)

An effective reward is something that is desirable, timely, and dependent on meeting your goal. The rewards you choose may be material (e.g., a movie or music download, or a payment toward buying a more costly item) or an act of self-kindness (e.g., an afternoon off from work or just an hour of quiet time away from family). Frequent small rewards, earned for meeting smaller goals, are more effective than bigger rewards that require a long, difficult effort.

Balance Your Food Checkbook

"Self-monitoring" refers to observing and recording some aspect of your behavior, such as calorie intake, servings of fruits and

vegetables, amount of physical activity, etc., or an outcome of these behaviors, such as weight. Self-monitoring of a behavior can be used at times when you're not sure how you're doing, and at times when you want the behavior to improve. Self-monitoring of a behavior usually moves you closer to the desired direction and can produce "real-time" records for review by you and your health care provider. For example, keeping a record of your physical activity can let you and your provider know quickly how you're doing. When the record shows that your activity is increasing, you'll be encouraged to keep it up. Some patients find that specific self-monitoring forms make it easier, while others prefer to use their own recording system.

While you may or may not wish to weigh yourself frequently while losing weight, regular monitoring of your weight will be essential to help you maintain your lower weight. When keeping a record of your weight, a graph may be more informative than a list of your weights. When weighing yourself and keeping a weight graph or table, however, remember that one day's diet and exercise patterns won't have a measurable effect on your weight the next day. Today's weight is not a true measure of how well you followed your program yesterday, because your body's water weight will change from day to day, and water changes are often the result of things that have nothing to do with your weight-management efforts.

Avoid a Chain Reaction

Stimulus (cue) control involves learning what social or environmental cues seem to encourage undesired eating, and then changing those cues. For example, you may learn from reflection or from self-monitoring records that you're more likely to overeat while watching television, or whenever treats are on display by the office coffee pot, or when around a certain friend. You might then try to change the situation, such as by separating the association of eating from the cue (don't eat while watching television), avoiding or eliminating the cue (leave the coffee room immediately after pouring coffee), or changing the circumstances surrounding the cue (plan to meet your friend in a nonfood setting). In general, visible and reachable food items are often cues for unplanned eating.

Get the Fullness Message

Changing the way you go about eating can make it easier to eat less without feeling deprived. It takes 15 or more minutes for your brain to get the message that you've been fed. Eating slowly will help you feel satisfied. Eating lots of vegetables and fruits can make you feel fuller. Another trick is to use smaller plates so that moderate portions do not appear too small. Changing your eating schedule, or setting one, can be helpful, especially if you tend to skip, or delay, meals and overeat later.

Learning Activity 7.1

Find out about Weight Loss Fraud.

- How can you protect yourself?
- What should you keep in mind when buying supplements?
- How do you spot fraud?

Optional Learning Activity

Read this article—How Sweet It Isn't

- Should excess sugar consumption be regulated?

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2.5.5.8: Eating Disorders

Anorexia Nervosa

Anorexia nervosa, or anorexia, is a type of eating disorder that mainly affects adolescent girls and young women. A person with this disease has an intense fear of gaining weight and limits the food she eats. She:

- Has a low body weight
- Refuses to keep a normal body weight
- Is extremely afraid of becoming fat
- Believes she is fat even when she's very thin
- Misses three (menstrual) periods in a row (for girls/women who have started having their periods)

Anorexia affects your health because it can damage many parts of your body. A person with anorexia will have many of these signs:

- Loses a lot of weight
- Talks about weight and food all the time
- Moves food around the plate; doesn't eat it
- Weighs food and counts calories
- Follows a strict diet
- Won't eat in front of others
- Ignores/denies hunger
- Uses extreme measures to lose weight (self-induced vomiting, laxative abuse, diuretic abuse, diet pills, fasting, excessive exercise)
- Thinks she's fat when she's too thin
- Gets sick a lot
- Weighs self several times a day
- Feels depressed
- Feels irritable
- Doesn't socialize
- Wears baggy clothes to hide appearance

Treatment

A health care team of doctors, nutritionists, and therapists will help the patient get better. They will:

- Help bring the person back to a normal weight
- Treat any psychological issues related to anorexia
- Help the person get rid of any actions or thoughts that cause the eating disorder

Some research suggests that the use of medicines—such as antidepressants, antipsychotics, or mood stabilizers—may sometimes work for anorexic patients. It is thought that these medicines help the mood and anxiety symptoms that often co-exist with anorexia. Other recent studies, however, suggest that antidepressants may not stop some patients with anorexia from relapsing. Also, no medicine has shown to work 100 percent of the time during the important first step of restoring a patient to healthy weight. So, it is not clear if and how medications can help anorexic patients get better, but research is still happening.

Some forms of psychotherapy can help make the psychological reasons for anorexia better. Psychotherapy is sometimes known as "talk therapy." It uses different ways of communicating to change a patient's thoughts or behavior. This kind of therapy can be useful for treating eating disorders in young patients who have not had anorexia for a long time.

Individual counseling can help someone with anorexia. If the patient is young, counseling may involve the whole family. Support groups may also be a part of treatment. In support groups, patients, and families meet and share what they've been through.

Some researchers point out that prescribing medicines and using psychotherapy designed just for anorexic patients works better

at treating anorexia than just psychotherapy alone. Whether or not a treatment works, though, depends on the person involved and his or her situation. Unfortunately, no one kind of psychotherapy always works for treating adults with anorexia.

Anorexia Nervosa Fact Sheet

This fact sheet explains anorexia's causes, signs and symptoms, and its effects on the body. It also provides information for pregnant women who have or have had anorexia.

Bulimia Nervosa

Bulimia nervosa, or bulimia, is a type of eating disorder. Someone with bulimia eats a lot of food in a short amount of time (bingeing) and then tries to get rid of the calories by purging. Purging might be done in these ways:

- Making oneself throw up
- Taking laxatives (pills or liquids that increase how fast food moves through your body and leads to a bowel movement)

A person with bulimia may also use these ways to prevent weight gain:

- Exercising a lot (more than normal)
- Restricting her eating or not eating at all (like going without food for a day)
- Taking diuretics (pills that make you urinate)

Bulimia is more than just a problem with food. It's a way of using food to feel in control of other feelings that may seem overwhelming. Purging and other behaviors to prevent weight gain are ways for people with bulimia to feel more in control of their lives and to ease stress and anxiety.

Unlike anorexia, when people are severely underweight, people with bulimia may be underweight, overweight, or have a normal weight. This makes it harder to know if someone has this disease. However, someone with bulimia may have these signs:

- Thinks about food a lot
- Binges (normally in secret)
- Throws up after bingeing
- Uses laxatives, diet pills, or diuretics to control weight
- Is depressed
- Is unhappy and/or thinks a lot about her body shape and weight
- Eats large amounts of food quickly
- Goes to the bathroom all the time after she eats (to throw up)
- Exercises a lot, even during bad weather, fatigue, illness, or injury
- Unusual swelling of the cheeks or jaw area
- Cuts and calluses on the back of the hands and knuckles from making herself throw up
- White enamel of teeth wears away making teeth look clear
- Doesn't see friends or participate in activities as much
- Has rules about food — has "good" foods and "bad" foods

Video

Much of the information provided in **Chapter 6, Lesson 8: Eating Disorders** is also presented in a 46 minute video titled: **The Silent Hunger: Anorexia and Bulimia**.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

- *"This program answers two important questions: what are eating disorders, and what causes them? The program specifically examines anorexia nervosa, bulimia nervosa, and binge eating syndrome. Seven females who have all suffered from eating disorders, the father of a woman who died as a result of her disorder, and health professionals offer their insights and knowledge. These interviews are highlighted by dramatic sequences designed to encourage a greater understanding of the issues and emotions associated with eating disorders."*
- (from Films Media Group, 1994. Films On Demand © 1994)To view this video, click on The Silent Hunger: Anorexia and Bulimia

Instructions

- Click on the **Expand** icon (left of Speaker Volume icon) to expand the image to fill the screen.
- Click on the **Play** button in the center of the screen or in the bottom left corner.
- At any time you can press the **ESC key** on your computer to return to the browser window or you can move your cursor to the bottom of the screen to make the toolbar visible again; then you can pause or adjust the volume.
- Closed captioning is available for this video. You'll see a "**Turn CC On**" button in the upper right hand of the video player. Click on this button to toggle captions on/off.
- To view specific segments from this video, click on **Segments** button then click on the title of the segment that interests you.

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2.5.6: PERSONAL RELATIONSHIPS AND VIOLENCE

Learning Objectives

- Examine the health benefits of a healthy marriage.
- Describe the characteristics of a healthy marriage.

2.5.6.1: Communication

2.5.6.2: Sexuality and Intimacy

2.5.6.3: Marriage and Relationships

2.5.6.4: Loss

2.5.6.5: Parenting

2.5.6.6: Family and Societal Violence

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2.5.6.1: Communication

Communication among Couples

Learning and Practicing New Habits

Effective communication isn't easy. Teaching and learning new communication skills take patience, patience, patience, as well as practice, practice, practice.

Taking the time to talk is important. Your relationship provides a safe place to share feelings, thoughts, fears, dreams, and hopes. Make a special effort to find time to talk to your partner more frequently.

In tough times, people feel overwhelmed with worries and responsibilities. Time together as a couple is often the last thing on our minds as we deal with the hassles of daily life. Although you may be busy, stressed, and worried, take the time to focus on your partners' needs and spend quality time together without interruption. Even a few minutes a day talking about what has occurred can be a relief from stress. Be thoughtful by considering whether those difficult or problem-solving discussions could be reserved for other times when you and your partner are not tired or distracted.

You may need to be the one who starts conversations. It is worth it to be the one who initiates conversations. You can find many ways to open the door for communication if you are sensitive to changes in your partner's feelings and needs. Taking the time to listen keeps the lines of communication open and improves your relationship.

Finding Time to Talk

- Spend time talking with limited interruptions.
- Make a date to talk to your partner.
- Plan at least one routine family time each week.
- Talk instead of watching TV.
- Talk when you take a walk together.
- Talk while you work together on household chores.
- Talk in the car while traveling to activities.

Summary

In good times and bad, couples need each other. Good communication does not mean that your family won't have any problems, or that your partner will always like what you have to say. Good communication means the chances of solving problems are much higher if you and your partner can express yourselves openly and freely with each other.

Marriage and Relationships

For couples today, there is an abundance of information on how to sustain healthy, happy marital relationships. From how-to books to advice given on television and radio, couples are bombarded with strategies, tips, and techniques focused on "what to do" in their relationships. Most of this information assumes that if couples follow a few short rules, then they can have happy relationships. What most fail to realize is that these new, positive practices won't work without recognizing and addressing what has been done and what is not working. Most information available to couples falls short on giving examples of "what not to do" in a relationship. Communication is the key, but it is difficult to apply effective strategies to harmful interactions.

Four negative patterns of interaction have been demonstrated as major destroyers of marital relationships:

- Criticism
- Contempt

- Defensiveness
- Stonewalling

Criticism

Criticism is using hurtful or judgmental comments aimed at your partner's character or personality. With criticism, the blame is placed on the person and not the problematic behavior. Criticism tends to be a repetitive cycle—a single critical moment can end up in a continued exchange. Most critical statements can be recognized by the phrases, "you always" or "you never." The following are some examples of criticism:

- You never finish any project that you start. You're so lazy.
- When we go out to eat, you always embarrass me with your table manners.

Contempt

Contempt is a more complex negative interaction. It is an effort to psychologically abuse your partner through disrespectful statements and actions. Contempt has both verbal and non-verbal deliveries. Verbal examples of contempt include sarcasm, hostile humor, and mockery. For example, nonverbal displays of contempt include rolling of the eyes and sucking of the teeth during conflict. Contempt sends your partner a message of scorn—that they are inferior and worthless.

Defensiveness

Defensiveness is often a natural response to receiving criticism and contempt. When faced with criticism and contempt, most people find a need to defend themselves. However, couples can be defensive even when criticism is constructive. Defensiveness may be a response to previous, current, and/or future attacks. If one or both persons are acting defensively, it is most likely the case they are not listening. Defensiveness may take many forms including:

- Making excuses for behavior
- Repeating a statement for effect
- Denying responsibility for actions
- Answering a complaint with another complaint

Stonewalling

The final negative pattern of interaction is stonewalling. As the name implies, this occurs when partners "put a wall" around themselves, either physically or psychologically. Stonewalling is often used to decrease conflict, and when delivered in moderation, can be healthy. On the other hand, continual failure to respond and/or engage in conversation escalates rather than reduces conflict. Examples of stonewalling include:

- Leaving the room
- Putting a physical barrier between you and your partner (newspaper, book, child)
- Focusing intently on something other than your partner during a discussion
- Failure to actively listen
- Responding with a blank stare

What can be done

All of the above become patterns of interaction in which couples may find themselves trapped. One negative interaction leads to another, often in a repetitive cycle. Researchers have determined that couples caught in this vicious cycle may be headed for divorce (Gottman, 1994; Gottman & Levenson, 2000). If you or a couple you know are experiencing any of these problems in a relationship, don't be discouraged. Although these may seem like a death sentence, there are ways that couples can break these patterns and start having more positive interactions. What is most important is to mimic the behaviors of pre-maritial couples and newlyweds. The following suggestions promote a healthy marriage, regardless of whether you're newlyweds or nearing your golden anniversary.

1. Eliminate criticism. Use complaints. It is okay to complain about troublesome behaviors. Discussing your feelings about the

behavior is okay as long as there are no personal attacks. Use the word I instead of you and describe how the behavior makes you feel. Talk about the behavior and not the person.
    - **Example**: "When we go out to eat, you always embarrass me," becomes "I feel hurt and ashamed when you make fun of me in public.
2. Build on your friendship base.Validate your partner and his/her feelings, thoughts, needs, and desires, etc.
    - **Example:** "I recognize that you need to talk more about our relationship. What is on your mind?"
3. Take accountability and responsibility for your own actions. Do not make excuses. Apologize and correct the behavior (if possible).
    - **Example**: "I'm sorry that I yelled at you earlier. I've been under a lot of pressure at work, but it is unfair to take it out on you."
4. Use reflective listening. Repeat what your partner has stated and then respond. Show them that you are listening and hearing them.
    - **Example**:
      Partner 1: I would appreciate it if you would talk to me before you discipline the kids. That way we can be a united front."
      Partner 2: What I'm hearing is that you would like for us to talk about disciplining the kids before I make any decisions. I think that is a good idea.
5. Continue dating. Make a point to rekindle the dating aspect of your relationship.
    - **Example:** Go for walks, hold hands, act silly, etc. Find ways to show appreciation to your partner throughout the day (i.e., e-mails, notes, phone calls, etc.)
6. Seek help if needed. If you can identify these negative interactions in your relationship or you think you may need help, see a licensed marriage and family therapist or other professional. Do not try and fix everything on your own.
    - **Example**: Talk to a trusted family member, friend, or your local extension agent in order to find resources in your area.

Summary

Before a couple can learn and/or practice new routines in their relationship, they must rid themselves of the old ways that aren't working. It is important to first identify negative patterns and destructive behaviors and target them for change. At that point, the couple can begin rebuilding their relationship.

Effective Communication

Effective communication is critical to successful relationships. Researchers and therapists have found at least nine skills that can help couples learn to talk effectively about important issues (Gottman 1994; Markman, Stanley, and Blumberg 2010; Schramm and Harris 2011). How we interact about issues such as time spent together/apart, money, health, gender differences, children, family, friends, commitment, trust, and intimacy affects our ability to develop and maintain lasting marital friendships. If learned well, these nine skills can help put our relationships on a positive trajectory for success. (Note: The word "marriage" is interchangeable with "relationship," if you are not married.)

Helpful Information about Communication

What do couples talk about?

- **Time Together/Apart.** Both the quantity and quality of time we spend together influence the well-being of our marital friendships. Spending time apart participating in other activities also influences the well-being of our relationships.
- **Money.** How we think and talk about money, our spending habits, and our ability to budget, invest, and plan for the future impact couple financial management processes and practices.
- **Health.** Couples must talk about many health-related issues, including nutrition, exercise, illness, disease, accidents, health care, mortality, and death.
- **Men/Women.** Because men tend to be more task-oriented in their communication styles and women tend to be more process-oriented, men tend to want to solve issues immediately, while women tend to want to talk about them more and come to a consensus about what should be done.
- **Children.** How children develop physically, socially, emotionally, intellectually, and spiritually are often topics of discussion. Focusing on the best ways to consistently meet children's needs is considered being child-centered.
- **Family/In-Laws/Friends.** Couples often talk about situations and circumstances surrounding the interactions they have with

their closest relationships.

What do couples communicate when they are communicating?

- **Commitment.** How we "hang in there" and contribute to our marital friendship, even when things aren't going particularly well, is a sign of how committed we are to our relationship. Loyalty and fidelity are aspects of commitment and trust.
- **Trust.** Trusting relationships are relationships in which both partners are dependable, available to support each other, and responsive to each other's needs. An ability to negotiate conflict and a positive outlook about the future of the relationship are also components of trust.
- **Intimacy.** The social, intellectual, emotional, spiritual, and physical connections we make with each other determine the levels of intimacy we experience in our relationships.

What do couples argue about?

Because the items listed above are some of the major topics couples talk about, it follows that they are also the same topics that can spur disagreements. For instance, it is a familiar joke that people can have difficulties in their relationships with in-laws. Take for example, "What is the difference between in-laws and outlaws? Answer: One is 'Wanted!'" Sayings such as these underscore the importance of knowing how your relationships with others can affect your marriage and could potentially become the topic of a marital conflict.

- **Control and Power.** Control and power are highly associated with the topics couples argue about. Indeed, control and power issues are the foundation of most conflicts. Typically, one person (or each person) is bent on having his or her own way. The saying "my way or the highway" is a common phrase used by someone with an inflexible perspective. If we see an issue one way and expect everyone else to see it the same way we do, then we are more likely to try to exert power and control over others and sway them to our perspective. Attempting to exert control and power over our partner typically results in win/lose or lose/lose outcomes for our marital friendships.

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2.5.6.2: Sexuality and Intimacy

Understanding Healthy Relationships

Learning Activity

Watch these two short videos:

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Are you satisfied with the depths of the relationships in your life?

Sexuality and Intimacy

The idea that sex can be an addiction is new to many people.

The term “addiction” has become a popular metaphor to describe any form of self-destructive behavior that one is unable to stop despite known and predictable adverse consequences. For some people, sexual behavior fits that description. It involves frequent self-destructive or high risk activity that is not emotionally fulfilling, that one is ashamed of, and that one is unable to stop despite it causing repeated problems in the areas of marriage, social relationships, health, employment, finances, or the law.

Recognition that self-destructive sexual behavior can be an addiction has spawned the rapid growth of four nationwide self-help organizations for persons trying to recover from this problem. All are 12-step recovery programs patterned after Alcoholics Anonymous.

One might ask how sex can be an addiction when it is doing what comes naturally and does not involve abuse of a psychoactive substance like drugs or alcohol. The scientific argument for addiction is based, in part, on recent advances in neurochemistry that suggest we carry within us our own source of addictive chemicals.

When pleasure centers in the human brain are stimulated, chemicals called endorphins are released into the blood stream. Endorphins are believed to be associated with the mood changes that follow sexual release. Any chemical that causes mood changes can be addictive, with repeated exposure altering brain chemistry to the point that more of the chemical is “required” in order to feel “normal.”

For example, experiments with hamsters have shown that the level of endorphins in their blood increases dramatically after several ejaculations. Experimental rats habituated to endorphins will go through much pain in order to obtain more. In rats, the addiction to endorphins is even stronger than the addiction to morphine or heroin.

The sex addict uses sex as a quick fix, or as a form of medication for anxiety, pain, loneliness, stress, or sleep. Sex addicts often

refer to sex as their “pain reliever” or “tension reliever.” In a popular novel, the heroine describes sex as “the thinking women’s Valium.”

Other indicators that sexual behavior may be out of control include: an obsession with sex that dominates one’s life, including sexual fantasies that interfere with work performance; so much time devoted to planning sexual activity that it interferes with other activities; strong feelings of shame about one’s sexual behavior; a feeling of powerlessness or inability to stop despite predictable adverse consequences; inability to make a commitment to a loving relationship; extreme dependence upon a relationship as a basis for feelings of self-worth; or little emotional satisfaction gained from the sex act.

Compulsive or addictive sexual behavior may take various forms, including what many regard as “normal” heterosexual behavior. The type of sexual activity and even the frequency or number of partners are not of great significance in diagnosing this problem. Some individuals have a naturally stronger sex drive than others, and the range of human sexual activity is so broad that it is difficult to define “normal” sexual behavior. What is significant is a pattern of self-destructive or high risk sexual behavior that is unfulfilling and that a person is unable to stop.

The roots of out-of-control sexual behavior may be quite varied. It may be caused by an underlying personality disorder, an “addiction” to sex, or a physical disorder. The traditional disorders of exaggerated sexuality, nymphomania in the female and satyriasis in the male, are believed to be caused by a disorder of the pituitary gland or irritation of the brain cortex by a tumor, arteriosclerosis or epilepsy. These physical disorders are rare.

Compulsive or addictive sexual behavior is a concern because it may lead to poor judgment or lack of discretion, indicate a serious emotional or mental problem, open one to exploitation, manipulation, or extortion.

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2.5.6.3: Marriage and Relationships

What is a “healthy marriage?

There are at least two characteristics that all healthy marriages have in common.

- First, they are mutually enriching, and
- Second, both spouses have a deep respect for each other.

It is a mutually satisfying relationship that is beneficial to the husband, wife and children (if present). It is a relationship that is committed to ongoing growth, the use of effective communication skills and the use of successful conflict management skills.

Healthy Marriage Matters

Research suggests that children who grow up in healthy married, two-parent families do better on a host of outcomes than those who do not. Further, many social problems affecting children, families, and communities could be prevented if more children grew up in healthy, married families.

Examples of social science findings include:

- Married couples seem to build more wealth, on average, than singles or cohabiting couples, thus decreasing the likelihood that their children will grow up in poverty.
- Children who live in a two-parent, married household enjoy better physical health, on average, than children in non-married households.
- Healthy marriages reduce the risk of adults and children either perpetrating, or being victimized by, crime.Benefits of Healthy Marriages

For Children and Youth

Researchers have found many benefits for children and youth who are raised by parents in healthy marriages, compared to unhealthy marriages, including the following:

1. More likely to attend college
2. Demonstrate less behavioral problems in school
3. Less likely to be a victim of physical or sexual abuse
4. Less likely to abuse drugs or alcohol
5. Less likely to commit delinquent behaviors
6. More likely to succeed academically
7. Physically healthier
8. Emotionally healthier
9. Less likely to attempt or commit suicide
10. Decreases their chances of divorcing when they get married
11. Less likely to become pregnant as a teenager, or impregnate someone.
12. Less likely to be sexually active as teenagers
13. Less likely to contract STD’s
14. Less likely to be raised in poverty

For Women

Researchers have found many benefits for women who are in healthy marriages, compared to unhealthy marriages, including the following:

1. More satisfying relationship

2. Emotionally healthier
3. Wealthier
4. Less likely to be victims of domestic violence, sexual assault, or other violent crimes
5. Less likely to attempt or commit suicide
6. Decrease risk of drug and alcohol abuse
7. Less likely to contract STD's
8. Less likely to remain or end up in poverty
9. Have better relationships with their children
10. Physically healthier

For Men

Researchers have found many benefits for men who are in healthy marriages, compared to unhealthy marriages, including the following:

1. Physically healthier
2. Wealthier
3. Increase in the stability of employment
4. Higher wages
5. Emotionally healthier
6. Decrease risk of drug and alcohol abuse
7. Have better relationships with their children
8. Less likely to commit violent crimes
9. Less likely to contract STD's
10. Less likely to attempt or commit suicide

For Communities

Researchers have found many benefits for communities when they have a higher percentage of couples in healthy marriages, compared to unhealthy marriages, including the following:

1. Higher rates of physically healthy citizens
2. Higher rates of emotionally healthy citizens
3. Higher rates of educated citizens
4. Lower domestic violence rates
5. Lower crime statistics
6. Lower teen age pregnancy rates
7. Lower rates of juvenile delinquency
8. Higher rates of home ownership
9. Lower rates of migration
10. Higher property values
11. Decreased need for social services

Marital Status and Health: United States, 1999–2002

A report from the Centers for Disease Control and Prevention suggests that married adults are healthier than divorced, widowed or never married adults.
The report, "Marital Status and Health: United States, 1999-2002," was based on interviews with 127,545 adults aged 18 and over as part of the National Health Interview Survey, conducted by CDC's National Center for Health Statistics. The study looked at health status and limitations, health conditions, health related behaviors according to marital status and also by age, race/ethnicity and socioeconomic factors such as education and poverty status.

Among the findings in the report:

- Nearly 60% of adults are married, 10.4% are separated or divorced, 6.6% are widowed, 19% are never married and 5.7% are living with a partner. Marital status varies greatly among race/ethnic groups: approximately 61 percent of white adults, 58 percent of Hispanic adults, and 38 percent of black adults are married, according to the survey.

- Married adults are less likely than other adults to be in fair or poor health, and are less likely to suffer from health conditions such as headaches and serious psychological distress.
- Married adults are less likely be limited in various activities, including work and other activities of daily living.
- Married adults are less likely to smoke, drink heavily or be physically inactive. However, married men are more likely to be overweight or obese than other men.
- Adults who live in cohabiting relationships are more likely to have health problems than married adults and more closely resemble divorced and separated adults.
- The association between marital status and health is most striking in the youngest age group although it persists throughout the age groups studied.

While the results show that married adults are generally in better health than unmarried adults, the reasons for better health status among married adults cannot be determined with cross-sectional data collected in the National Health Interview Survey.

The Effects of Marriage on Health

Understanding the Marriage-Health Connection

The relationship between marriage and health is complex. Marital status can both affect health outcomes and be affected by them. Healthier people may have a better chance of marrying and staying married because they may be viewed as more desirable marriage partners based on their physical attractiveness, earnings potential, mental well-being, degree of self-sufficiency, or likely longevity. Social scientists describe this pattern as the selection of healthy people into marriage. If this is the only reason for the correlation between marriage and health, then marriage is not causing better health. Instead, the observed health differences between married and unmarried people are the result of healthier people being more likely to marry.

Alternatively, there may be a true causal link between marriage and better health. Marriage could improve health outcomes in a variety of ways. It may result in two incomes, as well as economies of scale, improving economic well-being.

Having more income could, in turn, improve health outcomes by enhancing access to health care or lowering stress. In addition, a spouse may play an important role in monitoring and encouraging healthy behaviors (such as good eating habits and regular exercise), as well as in discouraging unhealthy ones (such as smoking or heavy drinking). Marriage may also provide an emotionally fulfilling, intimate relationship, satisfying the need for social connection, which could have implications for both physical and mental health. Most researchers conclude that the association between marriage and health represents a combination of the selection of healthier people into marriage and true health benefits from marriage.

Measuring the Effects of Marriage

Because marriage is likely to be both a cause and a consequence of health outcomes, research must disentangle the influence of selection from the true causal influence of marriage. Distinguishing between these two factors requires careful analysis and advanced statistical methods that have been absent from many studies.

The studies providing the strongest evidence use longitudinal data and examine the association between changes in health outcomes and transitions into and out of marriage. Studies of this type provide more convincing evidence of a causal relationship between marriage and health because sample members serve as their own control group, and the effect of marriage is measured by comparing their outcomes before and after marriage. This method avoids comparing two groups that may have different background characteristics in particular, people who marry and people who do not which may lead to misleading and inaccurate results.

Some health outcomes are not well suited for this type of analysis, however. For example, many physical health outcomes cannot be examined in this way, because changes can unfold over a long time and may not be apparent immediately after a marital transition.

Effects on Health Behaviors

Marriage may influence health through its effect on behaviors such as alcohol consumption, drug use, cigarette smoking, diet, and exercise. Recent research suggests that marriage has significant effects on the health behaviors of both men and women, but the pattern is mixed marriage is associated with healthier behaviors in some cases and less healthy behaviors in others.

Studies consistently indicate that marriage reduces heavy drinking and overall alcohol consumption, and that effects are similar for young men and young women, and for both African Americans and whites. Although the research is less extensive, marriage is also associated with reduced marijuana use for young men, but less so for women. Less is known about the effects of marriage on the substance use of older adults. Studies of marriage and smoking reveal no consistent pattern of results, suggesting that marriage may have little or no influence on this behavior.

In contrast to studies of alcohol and drug use, studies of the effect of marriage on weight and physical activity suggest that marriage may have negative effects on healthy behaviors and may encourage a more sedentary lifestyle. Several rigorous studies find that marriage leads to modest weight increases for both men and women; typically averaging less than five pounds. The research on the effects of marriage on physical activity is less conclusive because it is not based on longitudinal analysis and does not fully adjust for differences between those who marry and those who do not. The evidence that is available suggests marriage may lead to reductions in physical activity, particularly for men.

For certain health behaviors in particular, substance use among younger adults and weight gain among all adults the influence of marriage has been well studied and is well understood. For other behaviors, less is known and additional research is needed before stronger conclusions can be drawn.

Effects on Health Care Access, Use, and Costs

Marriage may influence physical health through its effects on health care access and use. Studies of the link between marriage and health insurance suggest that by offering access to coverage through a spouse's policy marriage increases the likelihood of having insurance and reduces the likelihood of becoming uninsured after a job loss or other major life event. Limited evidence also suggests that marriage may increase the use of preventive care such as cancer screenings.

Because of its effects on health care use, marriage is also associated with lower health care costs among older adults. For example, studies show that, because marriage reduces the risk of nursing home admission, marriage may also lead to reduced nursing home costs. The effect of marriage in shortening hospital stays may also lead to reductions in health care costs. Research indicates that the effect of marriage on health care costs exists independent of the effect of marriage on physical health. Specifically, many married people rely on their spouses for informal care, and thus require fewer long hospital stays and nursing home admissions, resulting in lower health care costs even if married and unmarried older adults are equally likely to get sick. These studies find that wives are especially likely to provide informal care for their husbands at home, so the effect of marriage on health care costs may be larger for men.

Effects on Mental Health

Marriage may affect many aspects of mental health. The most recent rigorous research suggests that marriage reduces depressive symptoms for both men and women. In particular, these studies find that getting married decreases depressive symptoms, while getting divorced increases them. Research has also documented that increases in depressive symptoms after divorce are long-lasting and that the prevalence of these symptoms remains elevated years after the marital breakup. In addition, studies comparing the mental health of stably married adults to those who remain unmarried find that those who are stably married have fewer depressive symptoms (and smaller increases in these symptoms as they grow older), even after controlling for baseline mental health.

Effects on Physical Health and Longevity

Many studies have documented that people who marry live longer and enjoy better physical health than those who do not marry. However, methodological issues require caution in interpreting this pattern, because most of the research in this area relies on descriptive methods that do not adequately control for the possible selection of healthier people into marriage. Although central to the overall assessment of the link between marriage and health, rigorous research evidence concerning the effect of marriage on specific physical health outcomes is limited, and few solid conclusions can be drawn.

The rigorous research currently available provides limited evidence of an effect of marriage on physical health. Recent research finds a significant positive effect of marriage on how men rate their overall physical health status; however, it finds no such effect for women. Researchers find a positive effect on women's physical health, as measured by the prevalence of specific health conditions and illnesses. However, no recent rigorous studies based on U.S. samples have examined whether a similar marriage effect on the frequency of health conditions or illnesses exists among men. Similarly, little evidence exists on the links between marriage and specific health conditions or diseases. One exception is a recent study that suggests a possible link between

marriage and the risk of cardiovascular disease for women; however, the study finds no such effect for men. Overall, the existing research evidence on the links between marriage and physical health is limited to a narrow range of health measures and does not offer a complete picture of the influence of marriage on physical health.

Many studies have pointed to a strong relationship between marriage and longevity, but this research also has limitations. In particular, these studies are typically limited to simple descriptive comparisons of married and unmarried adults that do not adequately distinguish the effect of marriage from the possible effects of healthier people selecting into marriage. As noted, the most reliable studies of links between marriage and health examine measures directly before and after marital transitions. However, because longevity is determined only at the end of life, it is not possible to observe how a marital transition changes longevity.

Intergenerational Health Effects

An emerging literature on the possible intergenerational health effects of marriage suggests that marriage also has potential long-term consequences for the physical health of a couple's children. In particular, studies show that growing up with married parents is associated with better physical health in adulthood and increased longevity. Research suggests that such intergenerational health effects are especially strong for men and operate equally for African American and white men. There is less evidence examining possible differences in this relationship for African American and white women.

There are many possible reasons why parental marital status may have long-term health consequences for children. However, existing research provides limited evidence on the pathways by which childhood family structure affects adult physical health and longevity. Several studies suggest that the effects work mostly through the role of childhood family structure in shaping children's future socioeconomic attainment, and through adult health risk behaviors, such as smoking and heavy drinking. On average, children raised in two-parent families obtain more education and exhibit healthier adult behaviors than children from other types of families. These differences, in turn, have consequences for adult health and longevity.

Research on intergenerational health effects has focused on trends for people born in the late 19th and early 20th centuries, a period when patterns of marriage, divorce, and single parenthood were much different from today. It is possible that the apparent benefits of marriage for children's health have weakened as single parenthood and divorce have become more common and less stigmatizing. In addition, much of the research is limited to data for small nonrepresentative samples. The available nationally representative evidence is based on data sets that began tracking sample members as adults, which limits the ability to control for differences in the background characteristics of those who grew up in a two-parent family and those who did not.

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2.5.6.4: Loss

Bereavement is the period of grief and mourning after a death. When you grieve, it's part of the normal process of reacting to a loss. You may experience grief as a mental, physical, social or emotional reaction. Mental reactions can include anger, guilt, anxiety, sadness, and despair. Physical reactions can include sleeping problems, changes in appetite, physical problems, or illness.

How long bereavement lasts can depend on how close you were to the person who died, if the person's death was expected and other factors. Friends, family, and faith may be sources of support. Grief counseling or grief therapy is also helpful to some people.

Grief

What is grief?

Grief is the normal response of sorrow, emotion, and confusion that comes from losing someone or something important to you. It is a natural part of life. Grief is a typical reaction to death, divorce, job loss, a move away from family and friends, or loss of good health due to illness.

How does grief feel?

Just after a death or loss, you may feel empty and numb, as if you are in shock. You may notice physical changes such as trembling, nausea, trouble breathing, muscle weakness, dry mouth, or trouble sleeping and eating.

You may become angry—at a situation, a particular person, or just angry in general. Almost everyone in grief also experiences guilt. Guilt is often expressed as "I could have, I should have, and I wish I would have" statements.

People in grief may have strange dreams or nightmares, be absent-minded, withdraw socially, or lack the desire to return to work. While these feelings and behaviors are normal during grief, they will pass.

How long does grief last?

Grief lasts as long as it takes you to accept and learn to live with your loss. For some people, grief lasts a few months. For others, grieving may take years.

The length of time spent grieving is different for each person. There are many reasons for the differences, including personality, health, coping style, culture, family background, and life experiences. The time spent grieving also depends on your relationship with the person lost and how prepared you were for the loss.

How will I know when I'm done grieving?

Every person who experiences a death or other loss must complete a four-step grieving process:

1. Accept the loss.
2. Work through and feel the physical and emotional pain of grief.
3. Adjust to living in a world without the person or item lost.
4. Move on with life. The grieving process is over only when a person completes the four steps.

People cope with the loss of a loved one in different ways. Most people who experience grief will cope well. Others will have severe grief and may need treatment. There are many things that can affect the grief process of someone who has lost a loved one. They include:

- The personality of the person who is grieving.
- The relationship with the person who died.

- The loved one's cancer experience and the way the disease progressed.
- The grieving person's coping skills and mental health history.
- The amount of support the grieving person has.
- The grieving person's cultural and religious background.
- The grieving person's social and financial position.

This summary defines grief and bereavement and describes the different types of grief reactions, treatments for grief, important issues for grieving children, and cultural responses to grief and loss.

Bereavement is the period of sadness after losing a loved one through death.

Grief and mourning occur during the period of bereavement. Grief and mourning are closely related. Mourning is the way we show grief in public. The way people mourn is affected by beliefs, religious practices, and cultural customs. People who are grieving are sometimes described as bereaved.

Grief is the normal process of reacting to the loss.

Grief is the emotional response to the loss of a loved one. Common grief reactions include the following:

- Feeling emotionally numb.
- Feeling unable to believe the loss occurred.
- Feeling anxiety from the distress of being separated from the loved one.
- Mourning along with depression.
- A feeling of acceptance.

Normal Grief

Normal or common grief begins soon after a loss and symptoms go away over time.

During normal grief, the bereaved person moves toward accepting the loss and is able to continue normal day-to-day life even though it is hard to do. Common grief reactions include:

- Anxiety over being separated from the loved one. The bereaved may wish to bring the person back and become lost in thoughts of the deceased. Images of death may occur often in the person's everyday thoughts.
- Distress that leads to crying; sighing; having dreams, illusions, and hallucinations of the deceased; and looking for places or things that were shared with the deceased.
- Anger.
- Periods of sadness, loss of sleep, loss of appetite, extreme tiredness, guilt, and loss of interest in life. Day-to-day living may be affected.

In normal grief, symptoms will occur less often and will feel less severe as time passes. Recovery does not happen in a set period of time. For most bereaved people having normal grief, symptoms lessen between 6 months and 2 years after the loss. Many bereaved people will have grief bursts or pangs. Grief bursts or pangs are short periods (20–30 minutes) of very intense distress. Sometimes these bursts are caused by reminders of the deceased person. At other times they seem to happen for no reason. Grief is sometimes described as a process that has stages.

There are several theories about how the normal grief process works. Experts have described different types and numbers of stages that people go through as they cope with loss. At this time, there is not enough information to prove that one of these theories is more correct than the others. Although many bereaved people have similar responses as they cope with their losses, there is no typical grief response. The grief process is personal.

Complicated Grief

There is no right or wrong way to grieve, but studies have shown that there are patterns of grief that are different from the most common. This has been called complicated grief.
Complicated grief reactions that have been seen in studies include:

- Minimal grief reaction: A grief pattern in which the person has no, or only a few, signs of distress or problems that occur with

other types of grief.
- Chronic grief: A grief pattern in which the symptoms of common grief last for a much longer time than usual. These symptoms are a lot like ones that occur with major depression, anxiety, or post-traumatic stress.

Cultures have different ways of coping with death

Grief felt for the loss of loved ones occurs in people of all ages and cultures. Different cultures, however, have different myths and mysteries about death that affect the attitudes, beliefs, and practices of the bereaved.
Individual, personal experiences of grief are similar in different cultures.

The ways in which people of all cultures feel grief personally are similar. This has been found to be true even though different cultures have different mourning ceremonies and traditions to express grief.

Cultural issues that affect people who are dealing with the loss of a loved one include rituals, beliefs, and roles.

Helping family members cope with the death of a loved one includes showing respect for the family's culture and the ways they honor the death. The following questions may help caregivers learn what is needed by the person's culture:

- What are the cultural rituals for coping with dying, the deceased person's body, and honoring the death?
- What are the family's beliefs about what happens after death?
- What does the family feel is a normal expression of grief and the acceptance of the loss?
- What does the family consider to be the roles of each family member in handling the death?
- Are certain types of death less acceptable (for example, suicide), or are certain types of death especially hard for that culture (for example, the death of a child)?

Death, grief, and mourning are normal life events. All cultures have practices that best meet their needs for dealing with death. Caregivers who understand the ways different cultures respond to death can help patients of these cultures work through their own normal grieving process.

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Grief: Grief, SAMHSA, www.samhsa.gov/MentalHealth/Anxiety_Grief.pdf.

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2.5.6.5: Parenting

If you're a parent, you get plenty of suggestions on how to raise your child. From experts to other parents, people are always ready to offer advice. Parenting tips, parents' survival guides, dos, don'ts, shoulds and shouldn'ts—new ones come out daily.

The truth is there is more than one "right" way to be a good parent. Good parenting includes

- Keeping your child safe
- Showing affection and listening to your child
- Providing order and consistency
- Setting and enforcing limits
- Spending time with your child
- Monitoring your child's friendships and activities
- Leading by example

There are many different kinds of families. Some have two parents, while others have a single parent. Sometimes there is no parent and grandparents raise grandchildren. Some children live in foster families, adoptive families, or in stepfamilies.

Families are much more than groups of people who share the same genes or the same address. They should be a source of support and encouragement. This does not mean that everyone gets along all the time. Conflicts are a part of family life. Many issues can lead to conflict, such as illness, disability, addiction, job loss, school difficulties and marital problems. Listening to each other and working to resolve conflicts are important in strengthening the family.

Learning Activity

Watch this video—Baby Steps: Learn the Signs. Act Early:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Early recognition of developmental disabilities such as autism is key for parents and providers. CDC realized the impact on families and invested in a campaign to help parents measure their children's progress by monitoring how they play, learn, speak and act.

Sources

Source: Parenting, Medline Plus, http://www.nlm.nih.gov/medlineplus/parenting.html.

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2.5.6.6: Family and Societal Violence

Violence Prevention

Violence is a serious public health problem in the United States. From infants to the elderly, it affects people in all stages of life. In the United States, violence accounts for approximately 51,000 deaths annually. In 2007, more than 18,000 people were victims of homicide and more than 34,000 took their own life.

Estimating the size of this economic burden is helpful in understanding the resources that could be saved if cost-effective violence prevention efforts were applied. The cost of these deaths totaled to $47.2 billion ($47 billion in work loss costs and $215 million in medical treatment).

The number of violent deaths tells only part of the story. Many more survive violence and are left with permanent physical and emotional scars. Violence also erodes communities by reducing productivity, decreasing property values, and disrupting social services.Violence is a serious public health problem in the United States. From infants to the elderly, it affects people in all stages of life. In 2007, more than 18,000 people were victims of homicide and more than 34,000 took their own life.

Understanding Violence

Interpersonal violence is defined as the actual or threatened intentional use of force—physical, sexual, or emotional—against another person, group, or community. It may result in physical injury, psychological harm, or even death. Violence also includes suicide and nonfatal acts of self-harm.

Unfortunately, violence is a part of our daily life. It exists in all corners of our nation. It affects us all regardless of our age, gender, race, ethnicity, or socio-economic status. More than 50,000 violent deaths occur each year in the United States. The deaths only tell part of the story. Millions of others are left with debilitating physical and emotional injuries. These injuries negatively affect the health of victims for the rest of their lives.

Violence also erodes the fabric of our communities. It can threaten productivity in the workplace, decrease the value of our homes and businesses, and disrupt essential public and social services. The economic cost of violence is staggering. In 2000, the medical costs and productivity losses associated with nonfatal violence-related injuries and deaths were estimated at more than $70 billion each year. The total burden to society is far greater.

The good news is that violence is a problem with a solution. It can be prevented by using a thoughtful and systematic approach. While the field of violence prevention is still developing, our knowledge of “what works” increases every day.

Types of Violence

- Child Maltreatment (e.g., child abuse and neglect)
- Intimate Partner Violence (e.g., violence by a current or former spouse, boy/girlfriend)
- Sexual Violence (e.g., rape, sexual assault, sexual harassment)
- Suicide (e.g., fatal and nonfatal suicide behavior)
- Youth Violence (e.g., bullying, gang violence, peer violence)

Learning Activity

Complete the Understanding Violence tutorial including each of the pop quizzes.

Sexual Violence

Sexual Violence (SV) refers to sexual activity where consent is not obtained or freely given. Anyone can experience SV, but most

victims are female. The person responsible for the violence is typically male and is usually someone known to the victim. The person can be, but is not limited to, a friend, coworker, neighbor, or family member.

There are many types of SV. Not all include physical contact between the victim and the perpetrator (person who harms someone else)—for example, sexual harassment, threats, and peeping. Other SV, including unwanted touching and rape, includes physical contact.

SV can impact health in many ways. Some ways are serious and can lead to long-term health problems. These include chronic pain, headaches, stomach problems, and sexually transmitted diseases.

SV can have an emotional impact as well. Victims often are fearful and anxious. They may replay the attack over and over in their minds. They may have problems with trust and be wary of becoming involved with others. The anger and stress that victims feel may lead to eating disorders and depression. Some even think about or attempt suicide.

SV is also linked to negative health behaviors. For example, victims are more likely to smoke, abuse alcohol, use drugs, and engage in risky sexual activity.

Why is sexual violence a public health problem?

SV is a significant problem in the United States:

- Among high school students surveyed nationwide, about 8% reported having been forced to have sex. The percentage of those having been forced to ever have sex was higher among female (11%) than male (5%) students.
- An estimated 20% to 25% of college women in the United States have experienced an attempted or complete rape during their college career
- Nearly 1 in 5 women and 1 in 71 men in the United States have been raped at some time in their lives.

These numbers underestimate the problem. Many cases are not reported because victims are afraid to tell the police, friends, or family about the abuse.Victims also think that their stories of abuse will not be believed and that police cannot help them.They may be ashamed or embarrassed. Victims may also keep quiet because they have been threatened with further harm if they tell anyone.

Certain factors can increase the risk for SV. However, the presence of these factors does not mean that SV will occur.

Risk factors for perpetration (harm to someone else):

- Being male
- Having friends that are sexually aggressive
- Witnessing or experiencing violence as a child
- Alcohol or drug use
- Being exposed to social norms, or shared beliefs, that support sexual violence.

Definitions

It is important to understand what factors protect people or put them at risk for experiencing or perpetrating violence. Why are risk and protective factors useful? They help identify where prevention efforts need to be focused.

Risk factors do not cause violence. The presence of a risk factor does not mean that a person will always experience violence. Victims are never responsible for the harm inflicted upon them.

- Risk Factor—Characteristic that increases the likelihood of a person becoming a victim or perpetrator of violence.
- Protective Factor—Characteristic that decreases the likelihood of a person becoming a victim or perpetrator of violence because it provides a buffer against risk.

How can we prevent sexual violence?

The ultimate goal is to stop SV before it begins. Efforts at many levels are needed to accomplish this. Some examples include:

- Engaging high school students in mentoring programs or other skill-based activities that address healthy sexuality and dating relationships.
- Helping parents identify and address violent attitudes and behaviors in their kids.
- Creating policies at work, at school, and in other places that address sexual harassment.
- Developing mass media (e.g., radio, TV, magazines, newspapers) messages that promote norms, or shared beliefs, about healthy sexual relationships.

For more examples, see Sexual Violence Prevention: Beginning the Dialogue.

Sexual Violence: Risk and Protective Factors

Risk factors are associated with a greater likelihood of sexual violence (SV) perpetration. They are contributing factors and may or may not be direct causes. Not everyone who is identified as “at risk” becomes a perpetrator of violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming a perpetrator of SV. Understanding these multilevel factors can help identify various opportunities for prevention.

Risk Factors for Perpetration

Individual Risk Factors

- Alcohol and drug use
- Coercive sexual fantasies
- Impulsive and antisocial tendencies
- Preference for impersonal sex
- Hostility towards women
- Hypermasculinity
- Childhood history of sexual and physical abuse
- Witnessed family violence as a child

Relationship Factors

- Association with sexually aggressive and delinquent peers
- Family environment characterized by physical violence and few resources
- Strong patriarchal relationship or familial environment
- Emotionally unsupportive familial environment

Community Factors

- Lack of employment opportunities
- Lack of institutional support from police and judicial system
- General tolerance of sexual violence within the community
- Weak community sanctions against sexual violence perpetrators

Societal Factors

- Poverty
- Societal norms that support sexual violence
- Societal norms that support male superiority and sexual entitlement
- Societal norms that maintain women’s inferiority and sexual submissiveness
- Weak laws and policies related to gender equity
- High tolerance levels of crime and other forms of violence

Sexual Violence: Prevention Strategies

Sexual violence is a serious problem that can have lasting, harmful effects on victims and their family, friends, and communities. The goal of sexual violence prevention is simple—to stop it from happening in the first place. However, the solutions are just as complex as the problem.

Prevention efforts should ultimately decrease the number of individuals who perpetrate sexual violence and the number of individuals who are sexual violence victims. Many prevention approaches aim to reduce risk factors and promote protective factors for sexual violence. In addition, comprehensive prevention strategies should address factors at each of the levels that influence sexual violence—the individual, relationship, community, and society.

The most common prevention strategies currently focus on the victim, the perpetrator, or bystanders.

- Strategies that aim to equip the victim with knowledge, awareness, or self-defense skills are referred to as risk reduction techniques.
- Strategies targeting the perpetrator attempt to change risk and protective factors for sexual violence in order to reduce the likelihood that an individual will engage in sexually violent behavior.
- The goal of bystander prevention strategies is to change social norms supporting sexual violence and empower men and women to intervene with peers to prevent an assault from occurring.
- Other prevention strategies may target social norms, policies, or laws in communities to reduce the perpetration of sexual violence across the population.

Effective and Promising Programs

Unfortunately, little is known about what works to prevent sexual violence. To date, only one prevention program, Safe Dates, has been shown in a randomized controlled trial to prevent or interrupt sexual violence perpetration. Other programs are accumulating evidence for effectiveness and are moving towards or are currently conducting rigorous evaluations. Until more is known about what works and for whom, program planners can use prevention principles to strengthen their approach and evaluation to determine the effectiveness of new or existing programs.

Understanding Intimate Partner Violence

Intimate partner violence (IPV) occurs between two people in a close relationship. The term “intimate partner” includes current and former spouses and dating partners. IPV exists along a continuum from a single episode of violence to ongoing battering.IPV includes four types of behavior:

- **Physical violence** is when a person hurts or tries to hurt a partner by hitting, kicking, or other type of physical force.
- **Sexual violence** is forcing a partner to take part in a sex act when the partner does not consent.
- **Threats of physical or sexual violence** include the use of words, gestures, weapons, or other means to communicate the intent to cause harm.
- **Emotional abuse** is threatening a partner or his or her possessions or loved ones, or harming a partner’s sense of self-worth. Examples are stalking, name-calling, intimidation, or not letting a partner see friends and family.

Often, IPV starts with emotional abuse. This behavior can progress to physical or sexual assault. Several types of IPV may occur together.

Why is IPV a public health problem?

- Nearly 3 in 10 women and 1 in 10 men in the US have experienced rape, physical violence, and/or stalking by a partner with IPV-related impact.
- IPV resulted in 2,340 deaths in 2007. Of these deaths, 70% were females and 30% were males.
- The medical care, mental health services, and lost productivity (e.g., time away from work) cost of IPV was an estimated $5.8 billion in 1995. Updated to 2003 dollars, that’s more than $8.3 billion.

These numbers underestimate the problem. Many victims do not report IPV to police, friends, or family. Victims may think others will not believe them or that the police cannot help.

How does IPV affect health?

IPV can affect health in many ways. The longer the violence goes on, the more serious the effects.

Many victims suffer physical injuries. Some are minor like cuts, scratches, bruises, and welts. Others are more serious and can cause death or disabilities. These include broken bones, internal bleeding, and head trauma.

Not all injuries are physical. IPV can also cause emotional harm. Victims may have trauma symptoms. This includes flashbacks, panic attacks, and trouble sleeping. Victims often have low self-esteem. They may have a hard time trusting others and being in relationships. The anger and stress that victims feel may lead to eating disorders and depression. Some victims even think about or commit suicide.

Who is at risk for IPV?

Several factors can increase the risk that someone will hurt his or her partner. However, having these risk factors does not always mean that IPV will occur.

- Being violent or aggressive in the past
- Seeing or being a victim of violence as a child
- Using drugs or alcohol, especially drinking heavily
- Not having a job or other life events that cause stress

Am I being abused?

It can be hard to know if you're being abused. You may think that your husband is allowed to make you have sex. That's not true. Forced sex is rape, no matter who does it. You may think that cruel or threatening words are not abuse. They are. And sometimes emotional abuse is a sign that a person will become physically violent.
Below is a list of possible signs of abuse. Some of these are illegal. All of them are wrong. You may be abused if your partner:

- Monitors what you're doing all the time
- Unfairly accuses you of being unfaithful all the time
- Prevents or discourages you from seeing friends or family
- Prevents or discourages you from going to work or school
- Gets very angry during and after drinking alcohol or using drugs
- Controls how you spend your money
- Controls your use of needed medicines
- Decides things for you that you should be allowed to decide (like what to wear or eat)
- Humiliates you in front of others
- Destroys your property or things that you care about
- Threatens to hurt you, the children, or pets
- Hurts you (by hitting, beating, pushing, shoving, punching, slapping, kicking, or biting)
- Uses (or threatens to use) a weapon against you
- Forces you to have sex against your will
- Controls your birth control or insists that you get pregnant
- Blames you for his or her violent outbursts
- Threatens to harm himself or herself when upset with you
- Says things like, "If I can't have you then no one can."

If you think someone is abusing you, get help. Abuse can have serious physical and emotional effects. No one has the right to hurt you.

Healthy vs. Unhealthy Relationships

Sometimes a relationship might not be abusive, but it might have some serious problems that make it unhealthy. If you think you might be in an unhealthy relationship, you should be able to talk to your partner about your concerns. If you feel like you can't

talk to your partner, try talking to a trusted friend, family member, or counselor. Consider calling a confidential hotline to get the support you need and to explore next steps. If you're afraid to end the relationship, call a hotline for help.

Signs of an unhealthy relationship include:

- Focusing all your energy on your partner
- Dropping friends and family or activities you enjoy
- Feeling pressured or controlled a lot
- Having more bad times in the relationship than good
- Feeling sad or scared when with your partner

Signs of a healthy relationship include:

- Having more good times in the relationship than bad
- Having a life outside the relationship, with your own friends and activities
- Making decisions together, with each partner compromising at times
- Dealing with conflicts by talking honestly
- Feeling comfortable and able to be yourself
- Feeling able to take care of yourself
- Feeling like your partner supports you

If you feel confused about your relationship, a mental health professional can help. Remember, you deserve to be treated with respect.

Learning Activity: Unhealthy Relationships

It can be hard to know what to do when someone you care about is in a controlling or violent relationship.
If this topic is unfamiliar to you and seems overwhelming, visit Help Someone in an Unhealthy Relationship: Quick tips.

Learning Activity: Take Action

Visit this website then click on The Basics and Take Action Take Steps to Protect Yourself from Relationship Violence

What specific ways are you willing and able to help someone who is in an unhealthy relationship?

Sources

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Understanding Violence: Veto Violence, www.vetoviolence.org/basics-violence.html.

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2.5.7: HUMAN SEXUALITY, CONTRACEPTION, AND REPRODUCTION

2.5.7.1: Behavioral Presentation of Human Sexuality

2.5.7.2: Sexual Bias and Misconceptions

2.5.7.3: Contraception

2.5.7.4: Reproduction

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2.5.7.1: Behavioral Presentation of Human Sexuality

Sexual Health

Sexual health is a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination, and violence.

Sexuality

Sexuality is a big part of being human. Love, affection and sexual intimacy all play a role in healthy relationships. They also contribute to your sense of well-being. A number of disorders can affect the ability to have or enjoy sex in both men and women. Concerns about infertility or fear of unplanned pregnancy can also come into play. In addition, a number of diseases and disorders affect sexual health. These include sexually transmitted diseases and cancer. In men, treatment of prostate cancer can cause erectile dysfunction. In women, cervical, uterine, vaginal, vulvar, or ovarian cancer may have sexual effects.

Public Health Approach to Sexual Health

Sexuality affects individuals and society across a broad spectrum of activities: through health, but also through factors at multiple levels, such as gender relations, reproduction, and economics. Physiologic, behavioral, and affective measurement of sexuality and sexual behavior is complicated by cultural values and norms, but is essential to individual health (including happiness) as well as public health.

Stigma

Cultural or structural norms that stigmatize aspects of sexuality, such as sexual orientation, have adverse effects on individuals across their lifespan, with homophobia being a prominent example of such. In addition, survey data reveal several individual and relationship factors that are important to sexual health at all levels, with overall health noted as the greatest predictor of sexual satisfaction.

Infidelity

Sexuality is important to society not only because of health implications; it also affects gender and property relations, reproduction potential, and economics. Physical, mental, social, and cultural factors affect health, especially sexual health. For instance, infidelity between couples often leads to hurt and divorce, and in Western countries, between 25% and 50% of divorcees cite a spouse's infidelity as the primary cause of divorce.

Sexual Dysfunction

Sexual dysfunction can pose public health problems, as it is related to public health issues and affects people's happiness and general well-being.

According to the National Health and Social Life Survey,

- The prevalence of sexual dysfunction was found to be higher among women than men.
- Lack of sexual desire is the most common problem among women
- For men, the most common sexual problem is premature ejaculation, not erectile dysfunction.
- Sexual problems increase with age, but sex-related personal distress decreases.

Sexual Frequency

Sexual frequency is important for sexual relationship satisfaction. Sexual intercourse frequency is noted as being the most important factor when predicting sexual satisfaction. Satisfaction declines with age but not as steeply as sexual frequency declines. However, although satisfaction is lower in women, satisfaction levels do not change over time among women, compared with men.

Sex and Health

Duration and age matter, but health matters most of all. Health proves to be a critical predictor of sexual satisfaction. Among those indicating their health is at least “very good,” more than half say they are satisfied with their sex lives. The majority of older Americans do not practice safe sex, even if they have multiple partners. It was reported that only 1 in 5 sexually active, dating singles use condoms regularly. Many older Americans report dating more than one person at a time and being sexually active with more than one sex partner (6% of men and 1% of women).

There are cultural differences that affect sexual and romantic happiness. Despite having a lower overall reported health rating, Hispanics report being happier with their sex lives compared with the general population. Sexuality was found to be a higher priority for older Hispanics, who report higher levels of sexual activity and satisfaction. Having a partner matters.

Sexual Happiness

The most important indicator of the sexual happiness of older Americans is having a steady sex partner. That indicator is less important than the frequency of sexual intercourse, good health, low levels of stress, and the absence of financial worries. There are still behavioral differences between older men and women, and older men and women continue to rank the importance of sex and the enjoyment of sex differently—even as they age. Older men continue to have more sex and think about sex more than older women; they see it as more important to their quality of life. Older men report having more frequent orgasms than women (2 out of 3 men, compared with 1 in 3 women), but their frequency of orgasm drops with age. Older men are twice as likely (21% compared with 11%) to admit sexual activity outside their relationship than women.

Sex Trafficking

Sex trafficking is a modern-day form of slavery in which a commercial sex act is induced by force, fraud, or coercion, or in which the person induced to perform such an act is under the age of 18 years. Enactment of the Trafficking Victims Protection Act of 2000 (TVPA) made sex trafficking a serious violation of Federal law. The TVPA also recognizes labor trafficking, which is discussed in a separate fact sheet.

As defined by the TVPA, the term ‘commercial sex act’ means any sex act on account of which anything of value is given to or received by any person.

The TVPA recognizes that traffickers use psychological and well as physical coercion and bondage, and it defines coercion to include: threats of serious harm to or physical restraint against any person; any scheme, plan, or pattern intended to cause a person to believe that failure to perform an act would result in serious harm to or physical restraint against any person; or the abuse or threatened abuse of the legal process.

Victims of Sex Trafficking and What They Face

Victims of sex trafficking can be women or men, girls or boys, but the majority are women and girls. There are a number of common patterns for luring victims into situations of sex trafficking, including:

- A promise of a good job in another country
- A false marriage proposal turned into a bondage situation
- Being sold into the sex trade by parents, husbands, boyfriends
- Being kidnapped by traffickers

Sex traffickers frequently subject their victims to debt-bondage, an illegal practice in which the traffickers tell their victims that they owe money (often relating to the victims’ living expenses and transport into the country) and that they must pledge their

personal services to repay the debt.

Sex traffickers use a variety of methods to “condition” their victims including starvation, confinement, beatings, physical abuse, rape, gang rape, threats of violence to the victims and the victims’ families, forced drug use and the threat of shaming their victims by revealing their activities to their family and their families’ friends.

Victims face numerous health risks. Physical risks include drug and alcohol addiction; physical injuries (broken bones, concussions, burns, vaginal/anal tearings); traumatic brain injury (TBI) resulting in memory loss, dizziness, headaches, numbness; sexually transmitted diseases (e.g., HIV/AIDS, gonorrhea, syphilis, UTIs, pubic lice); sterility, miscarriages, menstrual problems; other diseases (e.g., TB, hepatitis, malaria, pneumonia); and forced or coerced abortions.

Psychological harms include mind/body separation/disassociated ego states, shame, grief, fear, distrust, hatred of men, self-hatred, suicide, and suicidal thoughts. Victims are at risk for Posttraumatic Stress Disorder (PTSD)—acute anxiety, depression, insomnia, physical hyper-alertness, self-loathing that is long-lasting and resistant to change (complex-PTSD).

Victims may also suffer from traumatic bonding—a form of coercive control in which the perpetrator instills in the victim fear as well as gratitude for being allowed to live.

Types of Sex Trafficking

Victims of trafficking are forced into various forms of commercial sexual exploitation including prostitution, pornography, stripping, live-sex shows, mail-order brides, military prostitution and sex tourism.Victims trafficked into prostitution and pornography are usually involved in the most exploitive forms of commercial sex operations. Sex trafficking operations can be found in highly-visible venues such as street prostitution, as well as more underground systems such as closed-brothels that operate out of residential homes. Sex trafficking also takes place in a variety of public and private locations such as massage parlors, spas, strip clubs and other fronts for prostitution. Victims may start off dancing or stripping in clubs and then be coerced into situations of prostitution and pornography.

Learning Activity: Identifying and Interacting With Victims of Human Trafficking

Find out about how to identify and interact with victims of human trafficking.

- What would you do if you think you identified someone who might be a victim of human trafficking?

Sources

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2.5.7.2: Sexual Bias and Misconceptions

Lesbian, Gay, Bisexual, and Transgender Health

People who are lesbian, gay, bisexual, or transgender (LGBT) are members of every community. They are diverse, come from all walks of life, and include people of all races and ethnicities, all ages, all socioeconomic statuses, and from all parts of the country. The perspectives and needs of LGBT people should be routinely considered in public health efforts to improve the overall health of every person and eliminate health disparities.

In addition to considering the needs of LGBT people in programs designed to improve the health of entire communities, there is also a need for culturally competent medical care and prevention services that are specific to this population. Social inequality is often associated with poorer health status, and sexual orientation has been associated with multiple health threats. Members of the LGBT community are at increased risk for a number of health threats when compared to their heterosexual peers. Differences in sexual behavior account for some of these disparities, but others are associated with social and structural inequities, such as the stigma and discrimination that LGBT populations experience.

Learning Activity: Embrace Diversity in School

Watch this 4-minute video, Embrace diversity in school: say no to HIV-related stigma and other forms of discrimination:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

What are the challenges an HIV positive student, gay or lesbian student faces at school?

Public Health Approach for Advancing Sexual Health

Lesbian, Gay, Bisexual, and Transgender (LGBT) sexual health and well-being is affected by numerous social and cultural challenges across the life course, contributing to negative health outcomes and posing barriers to attain such protective health indicators as marriage and family formation, community support, and inclusion in faith communities.

Key Takeaways

It is critical to ask the right questions. The fundamental issue we face in this field is not “What is wrong with LGBT people,” but rather “What is right with them?” Homophobia has proven to be a structural norm in the United States.

The incidence of hate crimes, continued discrimination promulgated though denial of marriage rights, and policies such as, “don’t ask, don’t tell,” in the armed forces contribute to the continuation of homophobia as a structural norm. Psychological, interpersonal, and cultural scripts perpetuate attitudes that homophobia is normal, that discrimination is okay, and that high levels of society approve of homophobia. As a result of cultural and societal discriminations, LGBT people suffer an added burden of stress and experience health disparities.

U.S. culture has historically disapproved of LGBT people as evidenced by “sodomy” laws and institutional recognition that homosexuality was a psychiatric disorder. In addition, the LGBT population experiences health disparities and minority-related stress based on their marginalized social status. Sexual attraction is established early, and LGBT youth are susceptible to the added burden of emotional and physical trauma.Some research suggests that sexual attraction is established by the ages of 9–10

years in humans. Around the ages of 13–14 years, young LGBT persons typically have their first sexual experience (13.5 for males, 15.5 for females). However, some studies have indicated that many young LGBT persons aspire to save themselves for love or more committed relationships when they are older. Societal values and norms may preclude sexual expression, as LGBT youth are stigmatized early. Young gay men experience disproportionate rates of sexual victimization and pre-pubertal LGBT youth are often marginalized or victimized in schools. Violence and harassment against LGBT students is widespread.

Knowledge of young adult sexual behavior and related negative health outcomes proves to be critical when implementing interventions to ensure the health of this population. The majority of new HIV diagnoses are made in young MSM, with the bulk occurring in black and Latino MSM. The Internet is used as a source of sexual health information, pornography, and as a main source for “hooking up” in the MSM population. Also, recent research indicates that women are more sexually fluid, changing lesbian identification and indicating a higher degree of bisexuality. LGBT seniors face many barriers to successful aging. Unlike heterosexuals, LGBT seniors can’t count on legal and biological families, which poses a tremendous challenge when assessing basic needs as they age. Further, along with incurring past and present stigmas, elderly LGBT are more likely to be more single and to have less good health care, and thus, must come to rely upon their friends or “families of choice” as a primary source of social support.

Gay and Bisexual Men’s Health

Gay and bisexual men and other men who have sex with men (MSM) represent an incredibly diverse community. Gay and bisexual men have both shared and unique experiences and circumstances that affect their physical health and mental health needs as well as their ability to receive high-quality health services.

Stigma and Discrimination

Homophobia, stigma, and discrimination persist in the United States and negatively affect the health and well-being of gay, bisexual, other men who have sex with men (MSM), and other members of the LGBT community. Homophobia, stigma, and discrimination are social determinants of health that can affect physical and mental health, whether MSM seek and are able to obtain health services, and the quality of the services they receive. Such barriers to health need to be addressed at different levels of society, such as health care settings, work places, and schools in order to increase opportunities for improving the health of MSM.

Homophobia and stigma persist in the United States even though acceptance of same-sex relationships has been steadily increasing. For example, a Gallup poll conducted in May 2010 found that more than half (52%) of Americans believed that gay and lesbian relationships were acceptable. Forty-three percent of Americans believed that gay and lesbian relationships are not morally acceptable.

The Effects of Negative Attitudes About Homosexuality

Negative attitudes about homosexuality can lead to rejection by friends and family, discriminatory acts and violence that harm specific individuals, and laws and policies that adversely affect the lives of many people; this can have damaging effects on the health of MSM and other sexual minorities. Homophobia, stigma and discrimination can:

- Limit MSM’s ability to access high quality health care that is responsive to health issues of MSM
- Affect income, employment status, and the ability to get and keep health insurance
- Contribute to poor mental health and unhealthy behaviors, such as substance abuse, risky sexual behaviors, and suicide attempts
- Affect MSM’s ability to establish and maintain long-term same-sex relationships that reduce HIV & STD risk
- Make it difficult for some MSM to be open about same-sex behaviors with others, which can increase stress, limit social support, and negatively affect health

The effects of homophobia, stigma and discrimination can be especially hard on adolescents and young adults. Young MSM and other sexual minorities are at increased risk of being bullied in school. They are also at risk of being rejected by their families and, as a result, are at increased risk of homelessness. A study published in 2009 compared gay, lesbian, and bisexual young adults who experienced strong rejection from their families with their peers who had more supportive families. The researchers found that those who experienced stronger rejection were:

- 8.4 times more likely to have tried to commit suicide
- 5.9 times more likely to report high levels of depression
- 3.4 times more likely to use illegal drugs
- 3.4 times more likely to have risky sex

Reducing the Effects of Stigma and Discrimination

MSM and their family and friends can take steps to reduce the effects of homophobia, stigma and discrimination and protect their physical and mental health. One way to cope with the stress from stigma and discrimination is social support. Some studies show that gay men who have good social support—from family, friends, and the wider gay community—have:

- higher self-esteem
- a more positive group identity

Learning Activity: Bullying of Gay and Lesbian Youth

Find out about the It Gets Better Project.

- Do you think that this campaign is effective in showing gay and lesbian youth that they are not alone and that they can get past bullying?
- Will this campaign help reduce suicide and attempted suicide among gay and lesbian youth caused by harassment?

Lesbian and Bisexual Women's Health

What challenges do lesbian and bisexual women face in the health care system?

Lesbians and bisexual women face unique problems within the health care system that an hurt their health. Many health care professionals have not had enough training to know the specific health issues that lesbians and bisexuals face. They may not ask about sexual orientation when taking personal health histories. Health care professionals may not think that a lesbian or bisexual woman, like any woman, can be a healthy, normal female.

Things that can stop lesbians and bisexual women from getting good health care include:

- Being scared to tell your doctor about your sexuality or your sexual history
- Having a doctor who does not know your disease risks or the issues that affect lesbians and bisexual women
- Not having health insurance. Many lesbians and bisexuals don't have domestic partner benefits. This means that one person does not qualify to get health insurance through the plan that the partner has (a benefit usually available to married couples).
- Not knowing that lesbians are at risk for STIs and cancer

For these reasons, lesbian and bisexual women often avoid routine health exams. They sometimes even delay seeking health care when feeling sick. It is important to be proactive about your health, even if you have to try different doctors before you find the right one. Early detection—such as finding cancer early before it spreads—gives you the best chance to do something about it. That's one example of why it's important to find a doctor who will work with you to identify your health concerns and make a plan to address them.

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2.5.7.3: Contraception

> In 2008, there were 6.4 million pregnancies to the 62 million women of reproductive age (15–44) in the United States. Sixty-six percent of these pregnancies resulted in live births and 19% in induced abortions. And, nearly half of pregnancies among American women—more than three million each year—are unintended.
>
> —Guttmacher Institute

Unintended Pregnancy

An unintended pregnancy is a pregnancy that is either mistimed or unwanted at the time of conception. It is a core concept in understanding the fertility of populations and the unmet need for contraception. Unintended pregnancy is associated with an increased risk of morbidity for women, and with health behaviors during pregnancy that are associated with adverse effects. For example, women with an unintended pregnancy may delay prenatal care, which may affect the health of the infant. Women of all ages may have unintended pregnancies, but some groups, such as teens, are at a higher risk.

Efforts to decrease unintended pregnancy include finding better forms of contraception, and increasing contraceptive use and adherence.

What is contraception?

Contraception, also known as birth control, is designed to prevent pregnancy. Some types of birth control include (but are not limited to):

- Barrier methods, such as condoms, the diaphragm, and the cervical cap, are designed to prevent the sperm from reaching the egg for fertilization.Intrauterine device, or IUD, is a small device that is inserted into the uterus by a health care provider. The IUD prevents a fertilized egg from implanting in the uterus. An IUD can stay in the uterus for up to 10 years until it is removed by a health care provider.
- Hormonal birth control, such as birth control pills, injections, skin patches, and vaginal rings, release hormones into a woman's body that interfere with fertility by preventing ovulation, fertilization, or implantation.
- Sterilization is a method that permanently prevents a woman from getting pregnant or a man from being able to get a woman pregnant. Sterilization involves surgical procedures that must be done by a health care provider and usually cannot be reversed.

The choice of birth control depends on factors such as a person's overall health, age, frequency of sexual activity, number of sexual partners, desire to have children in the future, and family history of certain diseases. A woman should talk to her health care provider about her choice of birth control method.

It is important to remember that even though birth control methods can prevent pregnancy, they do not all protect against sexually transmitted diseases or HIV.

Contraception Methods

There is no "best" method of birth control. Each method has its pros and cons.

All women and men can have control over when, and if, they become parents. Making choices about birth control, or contraception, isn't easy. There are many things to think about. To get started, learn about birth control methods you or your partner can use to prevent pregnancy. You can also talk with your doctor about the choices.

Before choosing a birth control method, think about:

- Your overall health
- How often you have sex
- The number of sex partners you have

- If you want to have children someday
- How well each method works to prevent pregnancy
- Possible side effects
- Your comfort level with using the method

What are the different types of birth control?

You can choose from many methods of birth control. They are grouped by how they work:

Continuous abstinence

This means not having sex (vaginal, anal, or oral) *at any time*. It is the only sure way to prevent pregnancy and protect against sexually transmitted infections (STIs), including HIV.

Natural family planning/rhythm method

This method is when you do not have sex or use a barrier method on the days you are most fertile (most likely to become pregnant). You can read about barrier methods in the following chart.

A woman who has a regular menstrual cycle has about 9 or more days each month when she is able to get pregnant. These fertile days are about 5 days before and 3 days after ovulation, as well as the day of ovulation.

To have success with this method, you need to learn about your menstrual cycle. Then you can learn to predict which days you are fertile or "unsafe." To learn about your cycle, keep a written record of:

- When you get your period
- What it is like (heavy or light blood flow)
- How you feel (sore breasts, cramps)

This method also involves checking your cervical mucus and recording your body temperature each day. Cervical mucus is the discharge from your vagina. You are most fertile when it is clear and slippery like raw egg whites. Use a basal thermometer to take your temperature and record it in a chart. Your temperature will rise 0.4 to 0.8° F on the first day of ovulation. You can talk with your doctor or a natural family planning instructor to learn how to record and understand this information.

Barrier methods—put up a block, or barrier, to keep sperm from reaching the egg

Contraceptive Sponge

Before having sex, you wet the sponge and place it, loop side down, inside your vagina to cover the cervix. The sponge is effective for more than one act of intercourse for up to 24 hours. It needs to be left in for at least 6 hours after having sex to prevent pregnancy. It must then be taken out within 30 hours after it is inserted.

Only one kind of contraceptive sponge is sold in the United States. It is called the Today Sponge. Women who are sensitive to the spermicide nonoxynol-9 should not use the sponge.

Diaphragm, cervical cap, and cervical shield

These barrier methods block the sperm from entering the cervix (the opening to your womb) and reaching the egg.

- The diaphragm is a shallow latex cup.
- The cervical cap is a thimble-shaped latex cup. It often is called by its brand name, FemCap.
- The cervical shield is a silicone cup that has a one-way valve that creates suction and helps it fit against the cervix. It often is called by its brand name, Lea's Shield.

The diaphragm and cervical cap come in different sizes, and you need a doctor to "fit" you for one. The cervical shield comes in

one size, and you will not need a fitting.

Before having sex, add spermicide (to block or kill sperm) to the devices. Then place them inside your vagina to cover your cervix. You can buy spermicide gel or foam at a drug store.

All three of these barrier methods must be left in place for 6 to 8 hours after having sex to prevent pregnancy. The diaphragm should be taken out within 24 hours. The cap and shield should be taken out within 48 hours.

Female condom

This condom is worn by the woman inside her vagina. It keeps sperm from getting into her body. It is made of thin, flexible, manmade rubber and is packaged with a lubricant. It can be inserted up to 8 hours before having sex. Use a new condom each time you have intercourse. And don't use it and a male condom at the same time.

Male condom

Male condoms are a thin sheath placed over an erect penis to keep sperm from entering a woman's body. Condoms can be made of latex, polyurethane, or "natural/lambskin". The natural kind do not protect against STIs. Condoms work best when used with a vaginal spermicide, which kills the sperm. And you need to use a new condom with each sex act.

Condoms are either:

- Lubricated, which can make sexual intercourse more comfortable
- Non-lubricated, which can also be used for oral sex. It is best to add lubrication to non-lubricated condoms if you use them for vaginal or anal sex. You can use a water-based lubricant, such as K-Y jelly. You can buy them at the drug store. Oil-based lubricants like massage oils, baby oil, lotions, or petroleum jelly will weaken the condom, causing it to tear or break.

Keep condoms in a cool, dry place. If you keep them in a hot place (like a wallet or glove compartment), the latex breaks down. Then the condom can tear or break.

Hormonal methods

These methods prevent pregnancy by interfering with ovulation, fertilization, and/or implantation of the fertilized egg.

Oral contraceptives—combined pill ("The pill")

The pill contains the hormones estrogen and progestin. It is taken daily to keep the ovaries from releasing an egg. The pill also causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining the egg.

Some women prefer the "extended cycle" pills. These have 12 weeks of pills that contain hormones (active) and 1 week of pills that don't contain hormones (inactive). While taking extended cycle pills, women only have their period three to four times a year.

Many types of oral contraceptives are available. Talk with your doctor about which is best for you.
Your doctor may advise you not to take the pill if you:

- Are older than 35 and smoke
- Have a history of blood clots
- Have a history of breast, liver, or endometrial cancer

Antibiotics may reduce how well the pill works in some women. Talk to your doctor about a backup method of birth control if you need to take antibiotics.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

The patch

Also called by its brand name, Ortho Evra, this skin patch is worn on the lower abdomen, buttocks, outer arm, or upper body. It releases the hormones progestin and estrogen into the bloodstream to stop the ovaries from releasing eggs in most women. It also thickens the cervical mucus, which keeps the sperm from joining with the egg. You put on a new patch once a week for 3 weeks. You don't use a patch the fourth week in order to have a period.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Shot/injection

The birth control shot often is called by its brand name Depo-Provera. With this method you get injections, or shots, of the hormone progestin in the buttocks or arm every 3 months. A new type is injected under the skin. The birth control shot stops the ovaries from releasing an egg in most women. It also causes changes in the cervix that keep the sperm from joining with the egg.

Vaginal ring

This is a thin, flexible ring that releases the hormones progestin and estrogen. It works by stopping the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining the egg.

It is commonly called NuvaRing, its brand name. You squeeze the ring between your thumb and index finger and insert it into your vagina. You wear the ring for 3 weeks, take it out for the week that you have your period, and then put in a new ring.

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Implantable devices

These devices are inserted into the body and left in place for a few years.

Implantable rod

This is a matchstick-size, flexible rod that is put under the skin of the upper arm. It is often called by its brand name, Implanon. The rod releases a progestin, which causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining an egg. Less often, it stops the ovaries from releasing eggs. It is effective for up to 3 years.

Intrauterine devices or IUDs

An IUD is a small device shaped like a "T" that goes in your uterus. There are two types:

- **Copper IUD** The copper IUD goes by the brand name ParaGard. It releases a small amount of copper into the uterus, which prevents the sperm from reaching and fertilizing the egg. It fertilization does occur, the IUD keeps the fertilized egg from implanting in the lining of the uterus. A doctor needs to put in your copper IUD. It can stay in your uterus for 5 to 10 years.
- **Hormonal IUD** The hormonal IUD goes by the brand name Mirena. It is sometimes called an intrauterine system, or IUS. It releases progestin into the uterus, which keeps the ovaries from releasing an egg and causes the cervical mucus to thicken so sperm can't reach the egg. It also affects the ability of a fertilized egg to successfully implant in the uterus. A doctor needs to put in a hormonal IUD. It can stay in your uterus for up to 5 years.

Sterilization implant (essure)

Essure is the first non-surgical method of sterilizing women. A thin tube is used to thread a tiny spring-like device through the vagina and uterus into each fallopian tube. The device works by causing scar tissue to form around the coil. This blocks the

fallopian tubes and stops the egg and sperm from joining.

It can take about 3 months for the scar tissue to grow, so it's important to use another form of birth control during this time. Then you will have to return to your doctor for a test to see if scar tissue has fully blocked your tubes.

Surgical sterilization

For women, surgical sterilization closes the fallopian tubes by being cut, tied, or sealed. This stops the eggs from going down to the uterus where they can be fertilized. The surgery can be done a number of ways. Sometimes, a woman having cesarean birth has the procedure done at the same time, so as to avoid having additional surgery later.

For men, having a vasectomy keeps sperm from going to his penis, so his ejaculate never has any sperm in it. Sperm stays in the system after surgery for about 3 months. During that time, use a backup form of birth control to prevent pregnancy. A simple test can be done to check if all the sperm is gone; it is called a semen analysis.

Emergency contraception

Used if a woman's primary method of birth control fails. It should *not* be used as a regular method of birth control. Emergency contraception (Plan B One-Step or Next Step. It is also called the "morning after pill.")

Emergency contraception keeps a woman from getting pregnant when she has had unprotected vaginal intercourse. "Unprotected" can mean that no method of birth control was used. It can also mean that a birth control method was used but it was used incorrectly, or did not work (like a condom breaking). Or, a woman may have forgotten to take her birth control pills. She also may have been abused or forced to have sex. These are just some of the reasons women may need emergency contraception.

Emergency contraception can be taken as a single pill treatment or in two doses. A single dose treatment works as well as two doses and does not have more side effects. It works by stopping the ovaries from releasing an egg or keeping the sperm from joining with the egg. For the best chances for it to work, take the pill as soon as possible after unprotected sex. It should be taken within 72 hours after having unprotected sex.

A single-pill dose or two-pill dose of emergency contraception is available over-the-counter (OTC) for women ages 17 and older.

Can all types of birth control prevent sexually transmitted infections (STIs)?

No. The male latex condom is the *only* birth control method proven to help protect you from STIs, including HIV. Research is being done to find out how effective the female condom is at preventing STIs and HIV. For more information, see Will birth control pills protect me from sexually transmitted infections (STIs), including HIV/AIDS?

How well do different kinds of birth control work? Do they have side effects?

All birth control methods work the best if used correctly and every time you have sex. Be sure you know the right way to use them. Sometimes doctors don't explain how to use a method because they assume you already know. Talk with your doctor if you have questions. They are used to talking about birth control. So don't feel embarrassed about talking to him or her.

Some birth control methods can take time and practice to learn. For example, some people don't know you can put on a male condom "inside out." Also, not everyone knows you need to leave a little space at the tip of the condom for the sperm and fluid when a man ejaculates, or has an orgasm.

Where to Get Birth Control

Where you get birth control depends on what method you choose.

You can buy these forms over the counter:

- Male condoms
- Female condoms

- Sponges
- Spermicides
- Emergency contraception pills (girls younger than 17 need a prescription)

You need a prescription for these forms:

- Oral contraceptives: the pill, the mini-pill
- Skin patch
- Vaginal ring
- Diaphragm (your doctor needs to fit one to your shape)
- Cervical cap
- Cervical shield
- Shot/injection (you get the shot at your doctor's office)
- IUD (inserted by a doctor)
- Implantable rod (inserted by a doctor)

You will need surgery or a medical procedure for:

- Sterilization, female and male

Spermacides

You can buy spermicides over the counter. They work by killing sperm. They come in many forms:

- Foam
- Gel
- Cream
- Film
- Suppository
- Tablet

Spermicides are put in the vagina no more than 1 hour before having sex. If you use a film, suppository, or tablet, wait at least 15 minutes before having sex so the spermicide can dissolve. Do not douche or rinse out your vagina for at least 6 to 8 hours after having sex. You will need to use more spermicide each time you have sex.

Spermicides work best if used along with a barrier method, such as a condom, diaphragm, or cervical cap. Some spermicides are made just for use with the diaphragm and cervical cap. Check the package to make sure you are buying what you need.

All spermicides contain sperm-killing chemicals. Some contain nonoxynol-9, which may raise your risk of HIV if you use it a lot. It irritates the tissue in the vagina and anus, so it can cause the HIV virus to enter the body more freely. Some women are sensitive to nonoxynol-9 and need to use spermicides without it. Medications for vaginal yeast infections may lower the effectiveness of spermicides. Also, spermicides do not protect against sexually transmitted infections.

Withdrawal

Withdrawal is when a man takes his penis out of a woman's vagina (or "pulls out") before he ejaculates, or has an orgasm. This stops the sperm from going to the egg. "Pulling out" can be hard for a man to do. It takes a lot of self-control.

Even if you use withdrawal, sperm can be released *before* the man pulls out. When a man's penis first becomes erect, pre-ejaculate fluid may be on the tip of the penis. This fluid has sperm in it. So you could still get pregnant.

Withdrawal does not protect you from STIs or HIV.

Dental Dams

The dental dam is a square piece of rubber that is used by dentists during oral surgery and other procedures. It is not a method of birth control. But it can be used to help protect people from STIs, including HIV, during oral-vaginal or oral-anal sex. It is placed

over the opening to the vagina or the anus before having oral sex. You can buy dental dams at surgical supply stores.

Learning Activity

For a handy summary of birth control information, see this Frequently Asked Questions Fact Sheet.

Learning Activity

Find out the Real Cost of Contraceptives: *"Choosing the most money-smart method isn't as easy as crunching numbers because costs depend on a variety of factors, including how long you want the birth control to last, how often you need it, and how generous your insurance policy is."*

- Which birth control methods are the most affordable? Why?

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2.5.7.4: Reproduction

Reproductive Health

Both the male and female reproductive systems play a role in pregnancy. Problems with these systems can affect fertility and the ability to have children. There are many such problems in men and women.

Reproductive health problems can also be harmful to overall health and impair a person's ability to enjoy a sexual relationship.

Your reproductive health is influenced by many factors. These include your age, lifestyle, habits, genetics, use of medicines and exposure to chemicals in the environment. Many problems of the reproductive system can be corrected.

What is reproductive health?

Reproductive health includes a variety of topics, such as:

- Menstruation and menopause
- Pregnancy and preconception care
- Fertility/Infertility
- Contraception

More information on some of these issues is provided below.

Menstrual Cycle

The menstrual cycle is the process by which a woman's body gets ready for the chance of a pregnancy each month. The average menstrual cycle is 28 days from the start of one to the start of the next, but it can range from 21 days to 35 days.

Most menstrual periods last from three to five days. In the United States, most girls start menstruating at age 12, but girls can start menstruating between the ages of 8 and 16.

Menstruation and the menstrual cycle fact sheet

Menstruation is a woman's monthly bleeding. When you menstruate, your body sheds the lining of the uterus (womb). Menstrual blood flows from the uterus through the small opening in the cervix and passes out of the body through the vagina (see how the menstrual cycle works below). Most menstrual periods last from 3 to 5 days.

What is the menstrual cycle?

When periods (menstruations) come regularly, this is called the menstrual cycle. Having regular menstrual cycles is a sign that important parts of your body are working normally. The menstrual cycle provides important body chemicals, called hormones, to keep you healthy. It also prepares your body for pregnancy each month. A cycle is counted from the first day of 1 period to the first day of the next period. The average menstrual cycle is 28 days long. Cycles can range anywhere from 21 to 35 days in adults and from 21 to 45 days in young teens.

What happens during the menstrual cycle?

In the first half of the cycle, levels of estrogen (the female hormone) start to rise. Estrogen plays an important role in keeping you healthy, especially by helping you to build strong bones and to help keep them strong as you get older. Estrogen also makes the lining of the uterus (womb) grow and thicken. This lining of the womb is a place that will nourish the embryo if a pregnancy occurs. At the same time the lining of the womb is growing, an egg, or ovum, in one of the ovaries starts to mature. At about day 14 of an average 28-day cycle, the egg leaves the ovary. This is called ovulation.

After the egg has left the ovary, it travels through the fallopian tube to the uterus. Hormone levels rise and help prepare the uterine lining for pregnancy. A woman is most likely to get pregnant during the 3 days before or on the day of ovulation. Keep in mind, women with cycles that are shorter or longer than average may ovulate before or after day 14.

A woman becomes pregnant if the egg is fertilized by a man's sperm cell and attaches to the uterine wall. If the egg is not fertilized, it will break apart. Then, hormone levels drop, and the thickened lining of the uterus is shed during the menstrual period.

The Menstrual Cycle

- **Day 1** starts with the first day of your period. This occurs after hormone levels drop at the end of the previous cycle, signaling blood and tissues lining the uterus (womb) to break down and shed from the body. Bleeding lasts about 5 days.
- Usually by **Day 7**, bleeding has stopped. Leading up to this time, hormones cause fluid-filled pockets called follicles to develop on the ovaries. Each follicle contains an egg.
- Between **Day 7 and 14**, one follicle will continue to develop and reach maturity. The lining of the uterus starts to thicken, waiting for a fertilized egg to implant there. The lining is rich in blood and nutrients.
- Around **Day 14** (in a 28-day cycle), hormones cause the mature follicle to burst and release an egg from the ovary, a process called ovulation.
- Over the next few days, the egg travels down the fallopian tube towards the uterus. If a sperm unites with the egg here, the fertilized egg will continue down the fallopian tube and attach to the lining of the uterus.
- If the egg is not fertilized, hormone levels will drop around **Day 25**. This signals the next menstrual cycle to begin. The egg will break apart and be shed with the next period.

What is a typical menstrual period like?

During your period, you shed the thickened uterine lining and extra blood through the vagina. Your period may not be the same every month. It may also be different than other women's periods. Periods can be light, moderate, or heavy in terms of how much blood comes out of the vagina. This is called menstrual flow. The length of the period also varies. Most periods last from 3 to 5 days. But, anywhere from 2 to 7 days is normal.

For the first few years after menstruation begins, longer cycles are common. A woman's cycle tends to shorten and become more regular with age. Most of the time, periods will be in the range of 21 to 35 days apart.

What kinds of problems do women have with their periods?

Women can have a range of problems with their periods, including pain, heavy bleeding, and skipped periods.
Amenorrhea—the lack of a menstrual period. This term is used to describe the absence of a period in:

- Young women who haven't started menstruating by age 15
- Women and girls who haven't had a period for 90 days, even if they haven't been menstruating for long

Causes can include:

- Pregnancy
- Breastfeeding
- Extreme weight loss
- Eating disorders
- Excessive exercising
- Stress
- Serious medical conditions in need of treatment

As above, when your menstrual cycles come regularly, this means that important parts of your body are working normally. In some cases, not having menstrual periods can mean that your ovaries have stopped producing normal amounts of estrogen. Missing these hormones can have important effects on your overall health. Hormonal problems, such as those caused by polycystic ovary syndrome (PCOS) or serious problems with the reproductive organs, may be involved. It's important to talk to a doctor if you have this problem.

Dysmenorrhea (dis-men-uh-REE-uh)—painful periods, including severe cramps. Menstrual cramps in teens are caused by too much of a chemical called prostaglandin (pros-tuh-GLAN-duhn). Most teens with dysmenorrhea do not have a serious disease, even though the cramps can be severe. In older women, the pain is sometimes caused by a disease or condition such as uterine fibroids or endometriosis.

For some women, using a heating pad or taking a warm bath helps ease their cramps. Some over-the-counter pain medicines can also help with these symptoms. They include:

- Ibuprofen (for instance, Advil, Motrin, Midol Cramp>
- Ketoprofen (for instance, Orudis KT)
- Naproxen (for instance, Aleve)

If these medicines don't relieve your pain or the pain interferes with work or school, you should see a doctor. Treatment depends on what's causing the problem and how severe it is. Report vaginal bleeding that's different from normal menstrual periods. It includes:

- Bleeding between periods
- Bleeding after sex
- Spotting anytime in the menstrual cycle
- Bleeding heavier or for more days than normal
- Bleeding after menopause

Abnormal bleeding can have many causes. Your doctor may start by checking for problems that are most common in your age group. Some of them are not serious and are easy to treat. Others can be more serious. Treatment for abnormal bleeding depends on the cause.

In both teens and women nearing menopause, hormonal changes can cause long periods along with irregular cycles. Even if the cause is hormonal changes, you may be able to get treatment. You should keep in mind that these changes can occur with other serious health problems, such as uterine fibroids, polyps, or even cancer. See your doctor if you have any abnormal bleeding.

When does a girl usually get her first period?

In the United States, the average age for a girl to get her first period is 12. This does not mean that all girls start at the same age. A girl can start her period anytime between the ages of 8 and 15. Most of the time, the first period starts about 2 years after breasts first start to develop. If a girl has not had her first period by age 15, or if it has been more than 2 to 3 years since breast growth started, she should see a doctor.

Menopause

Women usually have periods until menopause. Menopause occurs between the ages of 45 and 55, usually around age 50. Menopause means that a woman is no longer ovulating (producing eggs) or having periods and can no longer get pregnant. Like menstruation, menopause can vary from woman to woman and these changes may occur over several years.

The time when your body begins its move into menopause is called the menopausal transition. This can last anywhere from 2 to 8 years. Some women have early menopause because of surgery or other treatment, illness, or other reasons. If you don't have a period for 90 days, you should see your doctor. He or she will check for pregnancy, early menopause, or other health problems that can cause periods to stop or become irregular.

When to Consult a Doctor about Your Period

See your doctor about your period if:

- You have not started menstruating by the age of 15.
- You have not started menstruating within 3 years after breast growth began, or if breasts haven't started to grow by age 13.
- Your period suddenly stops for more than 90 days.
- Your periods become very irregular after having had regular, monthly cycles.
- Your period occurs more often than every 21 days or less often than every 35 days.

- You are bleeding for more than 7 days.
- You are bleeding more heavily than usual or using more than 1 pad or tampon every 1 to 2 hours.
- You bleed between periods.
- You have severe pain during your period.
- You suddenly get a fever and feel sick after using tampons.

You should change a pad before it becomes soaked with blood. Each woman decides for herself what works best. You should change a tampon at least every 4 to 8 hours. Make sure to use the lowest absorbency tampon needed for your flow. For example, use junior or regular tampons on the lightest day of your period. Using a super absorbency tampon on your lightest days increases your risk for toxic shock syndrome (TSS). TSS is a rare but sometimes deadly disease. TSS is caused by bacteria that can produce toxins. If your body can't fight the toxins, your immune (body defense) system reacts and causes the symptoms of TSS (see below).

Young women may be more likely to get TSS. Using any kind of tampon puts you at greater risk for TSS than using pads. The Food and Drug Administration (FDA) recommends the following tips to help avoid tampon problems:

- Follow package directions for insertion.
- Choose the lowest absorbency for your flow.
- Change your tampon at least every 4 to 8 hours.
- Consider switching between pads and tampons.
- Know the warning signs of TSS (see below).
- Don't use tampons between periods.

If you have any of these symptoms of TSS while using tampons, take the tampon out, and contact your doctor right away:

- Sudden high fever (over 102 degrees)
- Muscle aches
- Diarrhea
- Vomiting
- Dizziness and/or fainting
- Sunburn-like rash
- Sore throat
- Bloodshot eyes

Preconception Care

Why preconception health matters

Preconception health is a woman's health before she becomes pregnant. It means knowing how health conditions and risk factors could affect a woman or her unborn baby if she becomes pregnant. For example, some foods, habits, and medicines can harm your baby—even before he or she is conceived. Some health problems, such as diabetes, also can affect pregnancy.

Every woman should be thinking about her health whether or not she is planning pregnancy. One reason is that about half of all pregnancies are not planned. Unplanned pregnancies are at greater risk of preterm birth and low birth weight babies. Another reason is that, despite important advances in medicine and prenatal care, about 1 in 8 babies is born too early. Researchers are trying to find out why and how to prevent preterm birth. But experts agree that women need to be healthier before becoming pregnant. By taking action on health issues and risks before pregnancy, you can prevent problems that might affect you or your baby later.

Five most important things to boost your preconception health

Women and men should prepare for pregnancy before becoming sexually active—or at least three months before getting pregnant. Some actions, such as quitting smoking, reaching a healthy weight, or adjusting medicines you are using, should start even earlier.

The five most important things a woman can do for preconception health are:

1. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) of folic acid every day if you are planning or capable of pregnancy to lower your risk of some birth defects of the brain and spine, including spina bifida. All women need folic

acid every day. Talk to your doctor about your folic acid needs. Some doctors prescribe prenatal vitamins that contain higher amounts of folic acid.
2. Stop smoking and drinking alcohol.
3. If you have a medical condition, be sure it is under control. Some conditions that can affect pregnancy or be affected by it include asthma, diabetes, oral health, obesity, or epilepsy.
4. Talk to your doctor about any over-the-counter and prescription medicines you are using. These include dietary or herbal supplements. Be sure your vaccinations are up to date.
5. Avoid contact with toxic substances or materials that could cause infection at work and at home. Stay away from chemicals and cat or rodent feces.

Talk to your doctor before you become pregnant

Did you know?

It's best to be at a healthy weight when you become pregnant. Being overweight or underweight puts you at increased risk for problems during pregnancy. Learn how healthy food choices and physical fitness, together, can help you reach or maintain a healthy weight.

Preconception care can improve your chances of getting pregnant, having a healthy pregnancy, and having a healthy baby. If you are sexually active, talk to your doctor about your preconception health now.

Preconception care should begin at least three months before you get pregnant. But some women need more time to get their bodies ready for pregnancy. Be sure to discuss your partner's health too. Ask your doctor about:

- Family planning and birth control.
- Taking folic acid.
- Vaccines and screenings you may need, such as a Pap test and screenings for sexually transmitted infections (STIs), including HIV.
- Managing health problems, such as diabetes, high blood pressure, thyroid disease, obesity, depression, eating disorders, and asthma. Find out how pregnancy may affect, or be affected by, health problems you have.
- Medicines you use, including over-the-counter, herbal, and prescription drugs and supplements.
- Ways to improve your overall health, such as reaching a healthy weight, making healthy food choices, being physically active, caring for your teeth and gums, reducing stress, quitting smoking, and avoiding alcohol.
- How to avoid illness.
- Hazards in your workplace or home that could harm you or your baby.
- Health problems that run in your or your partner's family.
- Problems you have had with prior pregnancies, including preterm birth.
- Family concerns that could affect your health, such as domestic violence or lack of support.

Bring a list of talking points to be sure you don't forget anything. If you run out of time at your visit, schedule a follow-up visit to make sure everything is covered.

Your partner's role in preparing for pregnancy

Your partner can do a lot to support and encourage you in every aspect of preparing for pregnancy. Here are some ways:

- Make the decision about pregnancy together. When both partners intend for pregnancy, a woman is more likely to get early prenatal care and avoid risky behaviors such as smoking and drinking alcohol.
- Screening for and treating sexually transmitted infections (STIs) can help make sure infections are not passed to female partners.
- Male partners can improve their own reproductive health and overall health by limiting alcohol, quitting smoking or illegal drug use, making healthy food choices, and reducing stress. Studies show that men who drink a lot, smoke, or use drugs can have problems with their sperm. These might cause you to have problems getting pregnant. If your partner won't quit smoking, ask that he not smoke around you, to avoid harmful effects of secondhand smoke.
- Your partner should also talk to his doctor about his own health, his family health history, and any medicines he uses.
- People who work with chemicals or other toxins can be careful not to expose women to them. For example, people who work with fertilizers or pesticides should change out of dirty clothes before coming near women. They should handle and wash soiled clothes separately.

Genetic counseling

Did you know?

Some companies offer genetic tests that you can do yourself through the mail. These tests may not provide true or meaningful information. These tests might provide harmful information. Talk to your doctor before using this type of test.

The genes your baby is born with can affect your baby's health in these ways:

- Single gene disorders are caused by a problem in a single gene. Genes contain the information your body's cells need to function. Single gene disorders run in families. Examples of single gene disorders are cystic fibrosis and sickle cell anemia.
- Chromosome disorders occur when all or part of a chromosome is missing or extra, or if the structure of one or more chromosomes is not normal. Chromosomes are structures where genes are located. Most chromosome disorders that involve whole chromosomes do not run in families.

Talk to your doctor about your and your partner's family health histories before becoming pregnant. This information can help your doctor find out any genetic risks you might have.

Depending on your genetic risk factors, your doctor might suggest you meet with a genetic professional. Some reasons a person or couple might seek genetic counseling are:

- A family history of a genetic condition, birth defect, chromosomal disorder, or cancer
- Two or more pregnancy losses, a stillbirth, or a baby who died
- A child with a known inherited disorder, birth defect, or intellectual disability
- A woman who is pregnant or plans to become pregnant at 35 years or older
- Test results that suggest a genetic condition is present
- Increased risk of getting or passing on a genetic disorder because of one's ethnic background
- People related by blood who want to have children together

During a consultation, the genetics professional meets with a person or couple to discuss genetic risks or to diagnose, confirm, or rule out a genetic condition. Sometimes, a couple chooses to have genetic testing. Some tests can help couples to know the chances that a person will get or pass on a genetic disorder. The genetics professional can help couples decide if genetic testing is the right choice for them.

Learning Activity

Find out about direct-to-consumer genetic testing kits.

- Would you use a genetic test that you can do yourself through the mail? Why or why not?

What is pregnancy?

Pregnancy is the term used to describe when a woman has a growing fetus inside of her. In most cases, the fetus grows in the uterus.

Human pregnancy lasts about 40 weeks, or just more than 9 months, from the start of the last menstrual period to childbirth.

What are prenatal and preconception care and why are they important?

Prenatal care is the care woman gets during a pregnancy. Getting early and regular prenatal care is important for the health of both mother and the developing baby.

In addition, health care providers are now recommending a woman see a health care provider for preconception care, even before she considers becoming pregnant or in between pregnancies.

Knowing if you are pregnant

A missed period is often the first clue that a woman might be pregnant. Sometimes, a woman might suspect she is pregnant even sooner. Symptoms such as headache, fatigue, and breast tenderness, can occur even before a missed period. The wait to know can be emotional. These days, many women first use home pregnancy tests (HPT) to find out. Your doctor also can test you.

All pregnancy tests work by detecting a special hormone in the urine or blood that is only there when a woman is pregnant. It is called human chorionic gonadotropin (kohr-ee-ON-ihk goh-NAD-uh-TROH-puhn), or hCG. hCG is made when a fertilized egg implants in the uterus. hCG rapidly builds up in your body with each passing day you are pregnant. Read on to learn when and how to test for pregnancy.

Home pregnancy tests

Reading a home pregnancy test

HPTs are inexpensive, private, and easy to use. Most drugstores sell HPTs over the counter. The cost depends on the brand and how many tests come in the box. They work by detecting hCG in your urine. HPTs are highly accurate. But their accuracy depends on many things. These include:

- **When you use them—**The amount of hCG in your urine increases with time. So, the earlier after a missed period you take the test the harder it is to spot the hCG. Some HPTs claim that they can tell if you are pregnant one day after a missed period or even earlier. But a recent study shows that most HPTs don't give accurate results this early in pregnancy. Positive results are more likely to be true than negative results. Waiting one week after a missed period will usually give a more accurate result. You can take the test sooner. But just know that a lot of pregnant women will get negative test results during the first few days after the missed period. It's a good idea to repeat the test again after a week has passed. If you get two negative results but still think you're pregnant, call your doctor.
- **How you use them—**Be sure to check the expiration date and follow the directions. Many involve holding a test stick in the urine stream. For some, you collect urine in a cup and then dip the test stick into it. Then, depending on the brand, you will wait a few minutes to get the results. Research suggests waiting 10 minutes will give the most accurate result. Also, testing your urine first thing in the morning may boost the accuracy. You will be looking for a plus sign, a change in color, or a line. A change, whether bold or faint, means the result is positive. New digital tests show the words "pregnant" or "not pregnant." Most tests also have a "control indicator" in the results window. This line or symbol shows whether or not the test is working. If the control indicator does not appear, the test is not working properly. You should not rely on any results from a HPT that may be faulty.
- **Who uses them—**The amount of hCG in the urine is different for every pregnant woman. So, some women will have accurate results on the day of the missed period while others will need to wait longer. Also, some medicines affect HPTs. Discuss the medicines you use with your doctor before trying to become pregnant.
- **The brand of test—**Some HPT tests are better than others at spotting hCG early on.

The most important part of using any HPT is to follow the directions exactly as written. Most tests also have toll-free phone numbers to call in case of questions about use or results.

If a HPT says you are pregnant, you should call your doctor right away. Your doctor can use a more sensitive test along with a pelvic exam to tell for sure if you're pregnant. Seeing your doctor early on in your pregnancy can help you and your baby stay healthy.

Unplanned Pregnancy

Unplanned pregnancy is common. About 1 in 2 pregnancies in America are unplanned. Ideally, a woman who is surprised by an unplanned pregnancy is in good preconception health and is ready and able to care for a new child. But this sometimes isn't the case.

If you have an unplanned pregnancy, you might not know what to do next. You might worry that the father won't welcome the news. You might not be sure you can afford to care for a baby. You might worry if past choices you have made, such as drinking or drug use, will affect your unborn baby's health. You might be concerned that having a baby will keep you from finishing school or pursuing a career.

If you are pregnant after being raped, you might feel ashamed, numb, or afraid. Unplanned pregnancy is common among abused women. Research has found that some abusers force their partners to have sex without birth control and/or sabotage the birth control their partners are using, leading to unplanned pregnancy.

You might wonder what options you have. Here are some next steps to help you move forward:

- Start taking care of yourself right away. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) folic acid every. Stop alcohol, tobacco, and drug use.
- Make a doctor's visit to confirm your pregnancy. Discuss your health and issues that could affect your pregnancy. Ask for help quitting smoking. Find out what you can do to take care of yourself and your unborn baby.
- Ask your doctor to recommend a counselor who you can talk to about your situation.
- Seek support in someone you trust and respect.

Trying to Get Pregnant

How do you figure out when you're fertile and when you're not? Wondering if you or your partner is infertile? Read on to boost your chances of conception and get help for fertility problems.

Fertility awareness

The menstrual cycle

Being aware of your menstrual cycle and the changes in your body that happen during this time can help you know when you are most likely to get pregnant.

The average menstrual cycle lasts 28 days. But normal cycles can vary from 21 to 35 days. The amount of time before ovulation occurs is different in every woman and even can be different from month to month in the same woman, varying from 13 to 20 days long. Learning about this part of the cycle is important because it is when ovulation and pregnancy can occur. After ovulation, every woman (unless she has a health problem that affects her periods or becomes pregnant) will have a period within 14 to 16 days.

Charting your fertility pattern

Knowing when you're most fertile will help you plan pregnancy. There are three ways you can keep track of your fertile times. They are:

1. **Basal body temperature method**—Basal body temperature is your temperature at rest as soon as you awake in the morning. A woman's basal body temperature rises slightly with ovulation. So by recording this temperature daily for several months, you'll be able to predict your most fertile days.

Basal body temperature differs slightly from woman to woman. Anywhere from 96 to 98 degrees Fahrenheit orally is average before ovulation. After ovulation most women have an oral temperature between 97 and 99 degrees Fahrenheit. The rise in temperature can be a sudden jump or a gradual climb over a few days.

Usually a woman's basal body temperature rises by only 0.4 to 0.8 degrees Fahrenheit. To detect this tiny change, women must use a basal body thermometer. These thermometers are very sensitive. Most pharmacies sell them for about $10. You can then record your temperature on our special Basal Body Temperature Chart.

The rise in temperature doesn't show exactly when the egg is released. But almost all women have ovulated within three days after their temperatures spike. Body temperature stays at the higher level until the woman's period starts.

A woman is most fertile and most likely to get pregnant:

- Two to three days before your temperature hits the highest point (ovulation)
- 12 to 24 hours after ovulation

A man's sperm can live for up to three days in a woman's body. The sperm can fertilize an egg at any point during that time. So if you have unprotected sex a few days before ovulation, you could get pregnant.

Many things can affect basal body temperature. For your chart to be useful, make sure to take your temperature every morning at about the same time. Things that can alter your temperature include:

- Drinking alcohol the night before
- Smoking cigarettes the night before
- Getting a poor night's sleep
- Having a fever
- Doing anything in the morning before you take your temperature—including going to the bathroom and talking on the phone

2. **Calendar method**—This involves recording your menstrual cycle on a calendar for eight to 12 months. The first day of your period is Day 1. Circle Day 1 on the calendar. The length of your cycle may vary from month to month. So write down the total number of days it lasts each time. Using this record, you can find the days you are most fertile in the months ahead:
    - To find out the first day when you are most fertile, subtract 18 from the total number of days in your shortest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The X marks the first day you're likely to be fertile.
    - To find out the last day when you are most fertile, subtract 11 from the total number of days in your longest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The time between the two Xs is your most fertile window.

    This method always should be used along with other fertility awareness methods, especially if your cycles are not always the same length.

Optional Learning Activity

Use this Ovulation and due date calculator to find out when you (or a woman you know) are most likely to become pregnant and to estimate your due date should conception occur.

Did you know?

The cervical mucus method is less reliable for some women. Women who are breastfeeding, taking hormonal birth control (like the pill), using feminine hygiene products, have vaginitis or sexually transmitted infections (STIs), or have had surgery on the cervix should not rely on this method.

3. **Cervical mucus method** (also known as the ovulation method)—This involves being aware of the changes in your cervical mucus throughout the month. The hormones that control the menstrual cycle also change the kind and amount of mucus you have before and during ovulation. Right after your period, there are usually a few days when there is no mucus present or "dry days." As the egg starts to mature, mucus increases in the vagina, appears at the vaginal opening, and is white or yellow and cloudy and sticky. The greatest amount of mucus appears just before ovulation. During these "wet days" it becomes clear and slippery, like raw egg whites. Sometimes it can be stretched apart. This is when you are most fertile. About four days after the wet days begin the mucus changes again. There will be much less and it becomes sticky and cloudy. You might have a few more dry days before your period returns. Describe changes in your mucus on a calendar. Label the days, "Sticky," "Dry," or "Wet." You are most fertile at the first sign of wetness after your period or a day or two before wetness begins.To most accurately track your fertility, use a combination of all three methods. This is called the symptothermal method. You can also purchase over-the-counter ovulation kits or fertility monitors to help find the best time to conceive. These kits work by detecting surges in a specific hormone called luteinizing hormone, which triggers ovulation.

Infertility

Some women want children but either cannot conceive or keep miscarrying. This is called *infertility*. Lots of couples have infertility problems. About one-third of the time, it is a female problem. In another one-third of cases, it is the man with the fertility problem. For the remaining one-third, both partners have fertility challenges or no cause is found.

Causes of infertility

Some common reasons for infertility in women include:

Age—Women generally have some decrease in fertility starting in their early 30s. And while many women in their 30s and 40s have no problems getting pregnant, fertility especially declines after age 35. As a woman ages, normal changes that occur in her ovaries and eggs make it harder to become pregnant. Even though menstrual cycles continue to be regular in a woman's 30s and 40s, the eggs that ovulate each month are of poorer quality than those from her 20s. It is harder to get pregnant when the eggs are poorer in quality. As a woman nears menopause, the ovaries may not release an egg each month, which also can make it harder to get pregnant. Also, as a woman and her eggs age, she is more likely to miscarry, as well as have a baby with genetic problems, such as Down syndrome.

Health problems—Some women have diseases or conditions that affect their hormone levels, which can cause infertility. Women with polycystic ovary syndrome (PCOS) rarely or never ovulate. Failure to ovulate is the most common cause of infertility in women.

- With primary ovarian insufficiency (POI), a woman's ovaries stop working normally before she is 40. It is not the same as early menopause. Some women with POI get a period now and then. But getting pregnant is hard for women with POI.
- A condition called luteal phase defect (LPD) is a failure of the uterine lining to be fully prepared for pregnancy. This can keep a fertilized egg from implanting or result in miscarriage.

Common problems with a woman's reproductive organs, like uterine fibroids, endometriosis, and pelvic inflammatory disease can worsen with age and also affect fertility. These conditions might cause the fallopian tubes to be blocked, so the egg can't travel through the tubes into the uterus.

Lifestyle factors—Certain lifestyle factors also can have a negative effect on a woman's fertility. Examples include smoking, alcohol use, weighing much more or much less than an ideal body weight, a lot of strenuous exercise, and having an eating disorder. Stress also can affect fertility.

Unlike women, some men remain fertile into their 60s and 70s. But as men age, they might begin to have problems with the shape and movement of their sperm. They also have a slightly higher risk of sperm gene defects. Or they might produce no sperm, or too few sperm. Lifestyle choices also can affect the number and quality of a man's sperm. Alcohol and drugs can temporarily reduce sperm quality. And researchers are looking at whether environmental toxins, such as pesticides and lead, also may be to blame for some cases of infertility. Men also can have health problems that affect their sexual and reproductive function. These can include sexually transmitted infections (STIs), diabetes, surgery on the prostate gland, or a severe testicle injury or problem.

When to see your doctor

You should talk to your doctor about your fertility if:

- You are younger than 35 and have not been able to conceive after one year of frequent sex without birth control.
- You are age 35 or older and have not been able to conceive after six months of frequent sex without birth control.
- You believe you or your partner might have fertility problems in the future (even before you begin trying to get pregnant).
- You or your partner has a problem with sexual function or libido.

Happily, doctors are able to help many infertile couples go on to have babies.

If you are having fertility issues, your doctor can refer you to a fertility specialist, a doctor who treats infertility. The doctor will need to test both you and your partner to find out what the problem is. Depending on the problem, your doctor might recommend treatment. About 9 in 10 cases of infertility are treated with drugs or surgery. *Don't delay seeing your doctor as age also affects the success rates of these treatments.* For some couples, adoption or foster care offers a way to share their love with a child and to build a family.

Infertility treatment

Some treatments include:

- **Drugs**—Various fertility drugs may be used for women with ovulation problems. It is important to talk with your doctor about the drug to be used. You should understand the drug's benefits and side effects. Depending on the type of fertility drug and

the dosage of the drug used, multiple births (such as twins) can occur.
- **Surgery**—Surgery is done to repair damage to a woman's ovaries, fallopian tubes, or uterus. Sometimes a man has an infertility problem that can be corrected by surgery.
- **Intrauterine insemination (IUI), also called artificial insemination**—Male sperm is injected into part of the woman's reproductive tract, such as into the uterus or fallopian tube. IUI often is used along with drugs that cause a woman to ovulate.
- **Assisted reproductive technology (ART)**—ART involves stimulating a woman's ovaries; removing eggs from her body; mixing them with sperm in the laboratory; and putting the embryos back into a woman's body. Success rates of ART vary and depend on many factors.
- **Third party assistance**—Options include donor eggs (eggs from another woman are used), donor sperm (sperm from another man are used), or surrogacy (when another woman carries a baby for you).

Finding the cause of infertility is often a long, complex, and emotional process. And treatment can be expensive. Many health insurance companies do not provide coverage for infertility or provide only limited coverage. Check your health insurance contract carefully to learn about what is covered. Some states have laws that mandate health insurance policies to provide infertility coverage.

Birth Control Methods

Birth Control Methods: Reversible and Permanent

In the United States, **almost half of all pregnancies are unintended**. Yet, several safe and highly effective methods of contraception (birth control) are available to prevent unintended pregnancy. Since 2000, several new methods of birth control have become available in the United States, including

- the levonorgestrel-releasing intrauterine system,
- the hormonal contraceptive patch,
- the hormonal contraceptive ring,
- the hormonal implant, a 91-day regimen of oral contraceptives, two new barrier methods, and
- a new form of female sterilization.

Most women of reproductive age in the United States use birth control. Between 2006–2008, 99% of women who had ever had sexual intercourse had used at least one method of birth control; however, 7.3% of women who were currently at risk of unintended pregnancy were not using a contraceptive method. The **most popular method of birth control was the oral contraceptive pill**, used by 10.7 million women in the United States, followed by female sterilization, condoms, male sterilization, and other methods of birth control. Approximately **10% of women had ever used emergency contraception**.

Types of Birth Control

The effectiveness of birth control methods is critically important for reducing the risk of unintended pregnancy. Intrauterine contraception and the contraceptive implant remain effective for years once correctly in place. The effectiveness of hormonal, barrier, and fertility awareness-based methods depends on correct and consistent use. For each of these methods, a range of effectiveness estimates is provided; lower estimates are based on typical use and higher estimates are based on perfect use.

Reversible Methods of Birth Control

Intrauterine Contraception* Copper T intrauterine device (IUD) —An IUD is a small device that is shaped in the form of a "T." Your doctor places it inside the uterus to prevent pregnancy. It can stay in your uterus for up to 10 years. This IUD is more than 99% effective at preventing pregnancy.

- **Levonorgestrel intrauterine system (IUS)**—The IUS is a small T-shaped device like the IUD. It is placed inside the uterus by a doctor. It releases a small amount of progestin each day to keep you from getting pregnant. The IUS stays in your uterus for up to 5 years. The IUS is more than 99% effective at preventing pregnancy.

Hormonal Methods

- **Implant**—The implant is a single, thin rod that is inserted under the skin of a women's upper arm. The rod contains a progestin that is released into the body over 3 years. It is 99% effective at preventing pregnancy.
- **Injection or "shot"**—Women get shots of the hormone progestin in the buttocks or arm every three months from their doctor. It is 94–99% effective at preventing pregnancy.**Combined oral contraceptives**—Also called "the pill,"combined oral contraceptives contain the hormones estrogen and progestin. It is prescribed by a doctor. A pill is taken at the same time each day. If you are older than 35 years and smoke, have a history of blood clots or breast cancer, your doctor may advise you not to take the pill. The pill is 91–99% effective at preventing pregnancy.
- **Progestin only pill**—Unlike the combined pill, the progestin-only pill (sometimes called the mini-pill) only has one hormone, progestin, instead of both estrogen and progestin. It is prescribed by a doctor. It is taken at the same time each day. It is a good option for women who can't take estrogen. They are 91–99% effective at preventing pregnancy.**Patch**—This skin patch is worn on the lower abdomen, buttocks, or upper body (but not on the breasts). This method is prescribed by a doctor. It releases hormones progestin and estrogen into the bloodstream. You put on a new patch once a week for three weeks. During the fourth week, you do not wear a patch, so you can have a menstrual period. The patch is 91–99% effective at preventing pregnancy, but it appears to be less effective in women who weigh more than 198 pounds.
- **Hormonal vaginal contraceptive ring**—The ring releases the hormones progestin and estrogen. You place the ring inside your vagina. You wear the ring for three weeks, take it out for the week you have your period, and then put in a new ring. It is 91–99% effective at preventing pregnancy.
- **Emergency contraception**—Emergency contraception is NOT a regular method of birth control. Emergency contraception can be used after no birth control was used during sex, or if the birth control method failed, such as if a condom broke.
    - Women can take emergency contraceptive pills up to 5 days after unprotected sex, but the sooner the pills are taken, the better they will work. There are three different types of emergency contraceptive pills available in the United States. Some emergency contraceptive pills are available over the counter for women 17 years of age or older. If younger than 17 years, emergency contraceptive pills are available by prescription.
    - Another type of emergency contraception is having your doctor insert the Copper T IUD into your uterus within seven days of unprotected sex. This method is 99% effective at preventing pregnancy.

Barrier Methods

- **Male condom**—Worn by the man, a male condom keeps sperm from getting into a woman's body. Latex condoms, the most common type, help prevent pregnancy and HIV and other STDs as do the newer synthetic condoms. "Natural" or "lambskin" condoms also help prevent pregnancy, but may not provide protection against STDs, including HIV. Male condoms are 82–98% effective at preventing pregnancy. Condoms can only be used once. You can buy condoms, KY jelly, or water-based lubricants at a drug store. Do not use oil-based lubricants such as massage oils, baby oil, lotions, or petroleum jelly with latex condoms. They will weaken the condom, causing it to tear or break.
- **Female condom**—Worn by the woman, the female condom helps keeps sperm from getting into her body. It is packaged with a lubricant and is available at drug stores. It can be inserted up to eight hours before sexual intercourse. Female condoms are 79–95% effective at preventing pregnancy, and also may help prevent STDs.
- **Diaphragm or cervical cap**—Each of these barrier methods are placed inside the vagina to cover the cervix to block sperm. The diaphragm is shaped like a shallow cup. The cervical cap is a thimble-shaped cup.Before sexual intercourse, you insert them with spermicide to block or kill sperm. The diaphragm is 84–94% effective at preventing pregnancy. Visit your doctor for a proper fitting because diaphragms and cervical caps come in different sizes
- **Spermicides**—These products work by killing sperm and come in several forms—foam, gel, cream, film, suppository, or tablet. They are placed in the vagina no more than one hour before intercourse. You leave them in place at least six to eight hours after intercourse. You can use a spermicide in addition to a male condom, diaphragm, or cervical cap. Spermicides alone are about 72–82% effective at preventing pregnancy. They can be purchased at drug stores.

Fertility Awareness-Based Methods

- **Natural family planning or fertility awareness**—Understanding your monthly fertility pattern can help you plan to get pregnant or avoid getting pregnant. Your fertility pattern is the number of days in the month when you are fertile (able to get pregnant), days when you are infertile, and days when fertility is unlikely, but possible. If you have a regular menstrual cycle, you have about nine or more fertile days each month. If you do not want to get pregnant, you do not have sex on the days you are fertile, or you use a barrier method of birth control on those days. These fertility awareness-based methods are 75–96% effective at preventing pregnancy.

Permanent Methods of Birth Control

Contraceptive sterilization is a permanent, safe, and highly effective approach for birth control. These methods are meant for people who are sure that they do not desire a pregnancy in the future.

The following methods are more than 99% effective at preventing pregnancy.

- **Female Sterilization—Tubal ligation or "tying tubes"**—A woman can have her fallopian tubes tied (or closed) so that sperm and eggs cannot meet for fertilization. The procedure can be done in a hospital or in an outpatient surgical center. You can go home the same day of the surgery and resume your normal activities within a few days. This method is effective immediately.
- **Transcervical Sterilization**— A thin tube is used to thread a tiny device into each fallopian tube. It irritates the fallopian tubes and causes scar tissue to grow and permanently plug the tubes. It can take about three months for the scar tissue to grow, so use another form of birth control during this time. Return to your doctor for a test to see if scar tissue has fully blocked your fallopian tubes.
- **Male Sterilization–Vasectomy**—This operation is done to keep a man's sperm from going to his penis, so his ejaculate never has any sperm in it that can fertilize an egg. The procedure is done at an outpatient surgical center. The man can go home the same day. Recovery time is less than one week. After the operation, a man visits his doctor for tests to count his sperm and to make sure the sperm count has dropped to zero; this takes about 12 weeks. Another form of birth control should be used until the man's sperm count has dropped to zero.

Although most women and men who undergo contraceptive sterilization do not regret having had the procedure, the permanence of the method is an important consideration, as regret has been documented in studies. For example, the U.S. Collaborative Review of Sterilization (CREST) study found that women who were younger at the time of the procedure were more likely to experience regret.

An additional issue addressed by the CREST study was the question of whether women who underwent contraceptive sterilization developed a "post-tubal ligation syndrome" of menstrual abnormalities, something that had been debated for years. Results indicated that menstrual abnormalities were no more common among women who had undergone tubal sterilization than among women who had not.

When considering a vasectomy, it's important to understand that failures can occur. CDC research has estimated there is a probability of 11 failures per 1,000 procedures over 2 years; half of the failures occurred in the first three months after the vasectomy, and no failures occurred after 72 weeks. CDC research also examined regret among women whose partner underwent a vasectomy. In interviews with female partners of men who received vasectomies, CDC found that while most women did not regret their husband's vasectomies, the probability of regret over 5 years was about 6%. This is why it is important to know facts about this and other permanent forms of birth control before making a decision.

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2.5.8: PHYSICAL ACTIVITY

Learning Objectives

- Describe the health benefits of physical activity
- Explain the differences between aerobic and muscle-strengthening physical activity

2.5.8.1: Aerobic, Muscle-Strengthening, and Bone-Strengthening Activity

2.5.8.2: Health Benefits of Physical Activity

2.5.8.3: Dealing with Inactivity

2.5.8.4: Safe and Activity

2.5.8.5: Pregnancy and Disabilities

2.5.8.6: Community Efforts to Increase Physical Activity

2.5.8.7: The Relationship between Physical Activity and Health

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2.5.8.1: Aerobic, Muscle-Strengthening, and Bone-Strengthening Activity

Aerobic, Muscle-strengthening, and Bone-strengthening Activity

Aerobic activities, also called endurance activities, are physical activities in which people move their large muscles in a rhythmic manner for a sustained period. Running, brisk walking, bicycling, playing basketball, dancing, and swimming are all examples of aerobic activities. Aerobic activity makes a person's heart beat more rapidly to meet the demands of the body's movement. Over time, regular aerobic activity makes the heart and cardiovascular system stronger and fitter.

Aerobic physical activity has these components:

- Frequency
- Intensity, or how hard a person works to do the activity. The intensities most often examined are moderate intensity (equivalent in effort to brisk walking) and vigorous intensity (equivalent in effort to running or jogging);
- Duration, or how long a person does an activity in any one session.

Although these components make up a physical activity profile, research has shown that the total amount of physical activity (minutes of moderate-intensity physical activity, for example) is more important for achieving health benefits than is any one component (frequency, intensity, or duration).

Quick Review

Which is the more important for achieving health benefits from aerobic activity:

1. total minutes
2. how vigorous the activity is

Key Guidelines for Adults

All adults should avoid inactivity. Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits.

For substantial health benefits, adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week.

For additional and more extensive health benefits, adults should increase their aerobic physical activity to 300 minutes (5 hours) a week of moderate-intensity, or 150 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity. Additional health benefits are gained by engaging in physical activity beyond this amount.

Adults should also do muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups on 2 or more days a week, as these activities provide additional health benefits.

How Much Total Activity a Week?

When adults do the equivalent of 150 minutes of moderate-intensity aerobic activity each week, the benefits are *substantial*. These benefits include lower risk of premature death, coronary heart disease, stroke, hypertension, type 2 diabetes, and depression.

Not all health benefits of physical activity occur at 150 minutes a week. As a person moves from 150 minutes a week toward 300 minutes (5 hours) a week, he or she gains additional health benefits. Additional benefits include lower risk of colon and breast cancer and prevention of unhealthy weight gain.

Also, as a person moves from 150 minutes a week toward 300 minutes a week, the benefits that occur at 150 minutes a week become *more extensive*. For example, a person who does 300 minutes a week has an even lower risk of heart disease or diabetes than a person who does 150 minutes a week.

The benefits continue to increase when a person does more than the equivalent of 300 minutes a week of moderate-intensity aerobic activity. For example, a person who does 420 minutes (7 hours) a week has an even lower risk of premature death than a person who does 150 to 300 minutes a week. Current science does not allow identifying an upper limit of total activity above which there are no additional health benefits.

How Many Days a Week and for How Long?

Aerobic physical activity should preferably be spread throughout the week. Research studies consistently show that activity performed on at least 3 days a week produces health benefits. Spreading physical activity across at least 3 days a week may help to reduce the risk of injury and avoid excessive fatigue.

Both moderate- and vigorous-intensity aerobic activity should be performed in episodes of at least 10 minutes. Episodes of this duration are known to improve cardiovascular fitness and some risk factors for heart disease and type 2 diabetes.

How Intense?

The *Guidelines* for adults focus on two levels of intensity: moderate-intensity activity and vigorous–intensity activity. To meet the Guidelines, adults can do either moderate-intensity or vigorous-intensity aerobic activities, or a combination of both. It takes less time to get the same benefit from vigorous-intensity activities as from moderate-intensity activities. A general rule of thumb is that 2 minutes of moderate-intensity activity counts the same as 1 minute of vigorous-intensity activity. For example, 30 minutes of moderate-intensity activity a week is roughly the same as 15 minutes of vigorous-intensity activity.

A person doing moderate-intensity aerobic activity can talk, but not sing, during the activity. A person doing vigorous intensity activity cannot say more than a few words without pausing for a breath.

Examples of Different Aerobic Physical Activities and Intensities

Moderate Intensity

- Walking briskly (3 miles per hour or faster, but not race-walking)
- Water aerobics
- Bicycling slower than 10 miles per hour
- Tennis (doubles)
- Ballroom dancing
- General gardening

Vigorous Intensity

- Racewalking, jogging, or running
- Swimming laps
- Tennis (singles)
- Aerobic dancing
- Bicycling 10 miles per hour or faster
- Jumping rope
- Heavy gardening (continuous digging or hoeing, with heart rate increases)
- Hiking uphill or with a heavy backpack

Muscle-Strengthening Activity

This kind of activity, which includes **resistance training** and lifting weights, causes the body's muscles to work or hold against an applied force or weight. These activities often involve relatively heavy objects, such as weights, which are lifted multiple times to train various muscle groups. Muscle-strengthening activity can also be done by using elastic bands or body weight for resistance (climbing a tree or doing push-ups, for example).
Muscle-strengthening activity also has three components:

- **Intensity**, or how much weight or force is used relative to how much a person is able to lift;
- **Frequency**, or how often a person does muscle strengthening activity; and
- **Repetitions**, or how many times a person lifts a weight (analogous to duration for aerobic activity). The effects of muscle-strengthening activity are limited to the muscles doing the work. It's important to work all the major muscle groups of the body: the legs, hips, back, abdomen, chest, shoulders, and arms.

Muscle-strengthening activities provide additional benefits not found with aerobic activity. The benefits of muscle-strengthening activity include increased bone strength and muscular fitness. Muscle-strengthening activities can also help maintain muscle mass during a program of weight loss.

Muscle-strengthening activities make muscles do more work than they are accustomed to doing. That is, they overload the muscles. Resistance training, including weight training, is a familiar example of muscle-strengthening activity. Other examples include working with resistance bands, doing calisthenics that use body weight for resistance (such as push-ups, pull-ups, and sit-ups), carrying heavy loads, and heavy gardening (such as digging or hoeing).

Muscle-strengthening activities count if they involve a moderate to high level of intensity or effort and work the major muscle groups of the body: the legs, hips, back, chest, abdomen, shoulders, and arms. Muscle strengthening activities for all the major muscle groups should be done at least 2 days a week.

No specific amount of time is recommended for muscle strengthening, but muscle-strengthening exercises should be performed to the point at which it would be difficult to do another repetition without help. When resistance training is used to enhance muscle strength, one set of 8 to 12 repetitions of each exercise is effective, although two or three sets may be more effective. Development of muscle strength and endurance is progressive over time. Increases in the amount of weight or the days a week of exercising will result in stronger muscles.

Learning Activity

Watch some of the following videos to view muscle strengthening exercises:

- Introduction
- Toe lift
- Half-squat
- Superman
- Sit-ups
- Push-ups
- Bicep curls

Bone-Strengthening Activity

This kind of activity (sometimes called weight-bearing or weight-loading activity) produces a force on the bones that promotes bone growth and strength. This force is commonly produced by impact with the ground. Examples of bone-strengthening activity include jumping jacks, running, brisk walking, and weight-lifting exercises. As these examples illustrate, bone-strengthening activities can also be aerobic and muscle strengthening.

Quick Review

What physical activity is both muscle-strengthening and bone-strengthening?

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2.5.8.2: Health Benefits of Physical Activity

Studies clearly demonstrate that participating in regular physical activity provides many health benefits. Many conditions affected by physical activity occur with increasing age, such as heart disease and cancer. Reducing risk of these conditions may require years of participation in regular physical activity. However, other benefits, such as increased **cardiorespiratory fitness**, increased muscular strength, and decreased depressive symptoms and blood pressure, require only a few weeks or months of participation in physical activity.

Learning Activity

Watch this video: What is the single best thing we can do for our health?

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Health Benefits of Physical Activity—Major Research Findings

- Regular physical activity reduces the risk of many adverse health outcomes.
- Some physical activity is better than none.
- For most health outcomes, additional benefits occur as the amount of physical activity increases through higher intensity, greater frequency, and/or longer duration.
- Most health benefits occur with at least 150 minutes a week of moderate-intensity physical activity, such as brisk walking. Additional benefits occur with more physical activity.
- Both aerobic (endurance) and muscle-strengthening (resistance) physical activity are beneficial.
- Health benefits occur for children and adolescents, young and middle-aged adults, older adults, and those in every studied racial and ethnic group.
- The benefits of physical activity far outweigh the possibility of adverse outcomes.

Quick Review: How many minutes per week does it take to get the health benefits of physical activity?

The Beneficial Effects of Increasing Physical Activity: It's About Overload, Progression, and Specificity

Overload is the physical stress placed on the body when physical activity is greater in amount or intensity than usual. The body's structures and functions respond and adapt to these stresses. For example, aerobic physical activity places a stress on the cardiorespiratory system and muscles, requiring the lungs to move more air and the heart to pump more blood and deliver it to the working muscles. This increase in demand increases the efficiency and capacity of the lungs, heart, circulatory system, and exercising muscles. In the same way, muscle–strengthening and bone-strengthening activities overload muscles and bones, making them stronger.

Progression is closely tied to overload. Once a person reaches a certain fitness level, he or she progresses to higher levels of physical activity by continued overload and adaptation. Small, progressive changes in overload help the body adapt to the additional stresses while minimizing the risk of injury.

Specificity means that the benefits of physical activity are specific to the body systems that are doing the work. For example, aerobic physical activity largely benefits the body's cardiovascular system.

The health benefits of physical activity are seen in children and adolescents, young and middle-aged adults, older adults, women and men, people of different races and ethnicities, and people with disabilities and chronic conditions. The health benefits of physical activity are generally independent of body weight. Adults of all sizes and shapes gain health and fitness benefits by being habitually physically active. The benefits of physical activity also outweigh the risk of injury and sudden heart attacks, two concerns that prevent many people from becoming physically active.

Quick Review

Who benefits most from being habitually physically active: overweight men, obese women, average weight men and women?

The following sections provide more detail on what is known from research studies about the specific health benefits of physical activity and how much physical activity is needed to get the health benefits.

Premature Death

Strong scientific evidence shows that physical activity reduces the risk of premature death (dying earlier than the average age of death for a specific population group) from the leading causes of death, such as heart disease and some cancers, as well as from other causes of death. This effect is remarkable in two ways:

First, only a few lifestyle choices have as large an effect on mortality as physical activity. It has been estimated that people who are physically active for approximately 7 hours a week have a 40 percent lower risk of dying early than those who are active for less than 30 minutes a week.

Second, it is not necessary to do high amounts of activity or vigorous-intensity activity to reduce the risk of premature death. Studies show substantially lower risk when people do 150 minutes of at least moderate-intensity aerobic physical activity a week.

Research clearly demonstrates the importance of avoiding inactivity. Even low amounts of physical activity reduce the risk of dying prematurely. The most dramatic difference in risk is seen between those who are inactive (30 minutes a week) and those with low levels of activity (90 minutes or 1 hour and 30 minutes a week).

All adults can gain this health benefit of physical activity. Age, race, and ethnicity do not matter. Men and women younger than 65 years as well as older adults have lower rates of early death when they are physically active than when they are inactive. Physically active people of all body weights (normal weight, overweight, obese) also have lower rates of early death than do inactive people.

Cardiorespiratory Health

The benefits of physical activity on cardiorespiratory health are some of the most extensively documented of all the health benefits. Cardiorespiratory health involves the health of the heart, lungs, and blood vessels.

Heart diseases and stroke are two of the leading causes of death in the United States. Risk factors that increase the likelihood of cardiovascular diseases include smoking, high blood pressure (called hypertension), type 2 diabetes, and high levels of certain blood lipids (such as low-density lipoprotein, or LDL, cholesterol). Low cardiorespiratory fitness also is a risk factor for heart disease.

People who do moderate- or vigorous-intensity aerobic physical activity have a significantly lower risk of cardiovascular disease than do inactive people. Regularly active adults have lower rates of heart disease and stroke, and have lower blood pressure, better blood lipid profiles, and fitness. Significant reductions in risk of cardiovascular disease occur at activity levels equivalent to 150 minutes a week of moderate-intensity physical activity. Even greater benefits are seen with 200 minutes (3 hours and 20 minutes) a week. The evidence is strong that greater amounts of physical activity result in even further reductions in the risk of cardiovascular disease.

Moderate-intensity physical activity is safe for generally healthy women during pregnancy. It increases cardiorespiratory fitness without increasing the risk of early pregnancy loss, preterm delivery, or low birth weight. Physical activity during the postpartum period also improves cardiorespiratory fitness.

Metabolic Health

Regular physical activity strongly reduces the risk of developing type 2 diabetes as well as the metabolic syndrome. The metabolic syndrome is defined as a condition in which people have some combination of high blood pressure, a large waistline (abdominal obesity), an adverse blood lipid profile (low levels of high-density lipoprotein [HDL] cholesterol, raised triglycerides), and impaired glucose tolerance.

People who regularly engage in at least moderate intensity aerobic activity have a significantly lower risk of developing type 2 diabetes than do inactive people. Although some experts debate the usefulness of defining the metabolic syndrome, good evidence exists that physical activity reduces the risk of having this condition, as defined in various ways. Lower rates of these conditions are seen with 120 to 150 minutes (2 hours to 2 hours and 30 minutes) a week of at least moderate-intensity aerobic activity. As with cardiovascular health, additional levels of physical activity seem to lower risk even further. In addition, physical activity helps control blood glucose levels in persons who already have type 2 diabetes.

Physical activity also improves metabolic health in youth. Studies find this effect when young people participate in at least 3 days of vigorous aerobic activity a week. More physical activity is associated with improved metabolic health, but research has yet to determine the exact amount of improvement.

Physical Activity in a Weight-Control Plan: Obesity and Energy Balance

Along with appropriate dietary intake, physical activity is an important part of maintaining healthy weight, losing weight, and keeping extra weight off once it has been lost. Physical activity also helps reduce abdominal fat and preserve muscle during weight loss. Adults should aim for a healthy, stable body weight. The amount of physical activity necessary to achieve this weight varies greatly from person to person.

The first step in achieving or maintaining a healthy weight is to meet the minimum level of physical activity in the Guidelines. For some people this will result in a stable and healthy body weight, but for many it may not.
The health benefits of physical activity are generally independent of body weight. The good news for people needing to lose weight is that regular physical activity provides major health benefits, no matter how their weight changes over time.

People who are at a healthy body weight but slowly gaining weight can either gradually increase the level of physical activity (toward the equivalent of 300 minutes a week of moderate-intensity aerobic activity), or reduce caloric intake, or both, until their weight is stable. By regularly checking body weight, people can find the amount of physical activity that works for them.

Many adults will need to do more than the 150 minutes a week of moderate-intensity aerobic physical activity as part of a program to lose weight or keep it off. These adults should do more physical activity and/or further reduce their caloric intake. Some people will need to do the equivalent of 300 or more minutes of moderate-intensity physical activity a week to meet their weight-control goals. Combined with restricting caloric intake, these adults should gradually increase minutes or the intensity of aerobic physical activity per week, to the point at which the physical activity is effective in achieving a healthy weight.

It is important to remember that all activities—both baseline and physical activity—“count” for energy balance. Active choices, such as taking the stairs rather than the elevator or adding short episodes of walking to the day, are examples of activities that can be helpful in weight control.

For weight control, vigorous-intensity activity is far more time-efficient than moderate-intensity activity. For example, an adult who weighs 165 pounds (75 kg) will burn 560 calories from 150 minutes of brisk walking at 4 miles an hour (these calories are in addition to the calories normally burned by a body at rest). That person can burn the same number of additional calories in 50 minutes by running 5 miles at a 10 minutes-per-mile pace.

Quick Review

If you wanted to use physical activity for weight loss and control, which approach would make most the sense for you personally: increased intensity or increased minutes per week? Why?

Over short periods of time, such as a year, research shows that it is possible to achieve weight stability by doing the equivalent of 150 to 300 minutes (5 hours) a week of moderate-intensity walking at about a 4 mile-an-hour pace. Muscle-strengthening

activities may help promote weight maintenance, although not to the same degree as aerobic activity.

People who want to lose a substantial (more than 5 percent of body weight) amount of weight and people who are trying to keep a significant amount of weight off once it has been lost need a high amount of physical activity unless they also reduce their caloric intake. Many people need to do more than 300 minutes of moderate-intensity activity a week to meet weight–control goals.

Musculoskeletal Health

Bones, muscles, and joints support the body and help it move. Healthy bones, joints, and muscles are critical to the ability to do daily activities without physical limitations.

Preserving bone, joint, and muscle health is essential with increasing age. Studies show that the frequent decline in bone density that happens during aging can be slowed with regular physical activity. These effects are seen in people who participate in **aerobic, muscle-strengthening, and bone-strengthening physical activity** programs of moderate or vigorous intensity. The range of total physical activity for these benefits varies widely. Important changes seem to begin at 90 minutes a week and continue up to 300 minutes a week.

Hip fracture is a serious health condition that can have life-changing negative effects for many older people. Physically active people, especially women, appear to have a lower risk of hip fracture than do inactive people. Research studies on physical activity to prevent hip fracture show that participating in 120 to 300 minutes a week of physical activity that is of at least moderate intensity is associated with a reduced risk. It is unclear, however, whether activity also lowers risk of fractures of the spine or other important areas of the skeleton.

Building strong, healthy bones is also important for children and adolescents. Along with having a healthy diet that includes adequate calcium and vitamin D, physical activity is critical for bone development in children and adolescents. **Bone-strengthening physical activity** done 3 or more days a week increases bone-mineral content and bone density in youth.

Regular physical activity also helps people with arthritis or other rheumatic conditions affecting the joints. Participation in 130 to 150 minutes (2 hours and 10 minutes to 2 hours and 30 minutes) a week of moderate-intensity, low-impact physical activity improves pain management, function, and quality of life. Researchers don't yet know whether participation in physical activity, particularly at low to moderate intensity, reduces the risk of osteoarthritis. Very high levels of physical activity, however, may have extra risks. People who participate in very high levels of physical activity, such as elite or professional athletes, have a higher risk of hip and knee osteoarthritis, mostly due to the risk of injury involved in competing in some sports.

Progressive muscle-strengthening activities increase or preserve muscle mass, strength, and power. Higher amounts (through greater frequency or higher weights) improve muscle function to a greater degree. Improvements occur in younger and older adults. Resistance exercises also improve muscular strength in persons with such conditions as stroke, multiple sclerosis, cerebral palsy, spinal cord injury, and cognitive disability. Though it doesn't increase muscle mass in the same way that muscle-strengthening activities do, aerobic activity may also help slow the loss of muscle with aging.

Functional Ability and Fall Prevention

Functional ability is the capacity of a person to perform tasks or behaviors that enable him or her to carry out everyday activities, such as climbing stairs or walking on a sidewalk. Functional ability is key to a person's ability to fulfill basic life roles, such as personal care, grocery shopping, or playing with the grandchildren. Loss of functional ability is referred to as functional limitation.

Middle-aged and older adults who are physically active have lower risk of functional limitations than do inactive adults. It appears that greater physical activity levels can further reduce risk of functional limitations.
Older adults who already have functional limitations also benefit from regular physical activity. Typically, studies of physical activity in adults with functional limitations tested a combination of aerobic and muscle strengthening activities, making it difficult to assess the relative importance of each type of activity. However, both types of activity appear to provide benefit.

In older adults at risk of falls, strong evidence shows that regular physical activity is safe and reduces this risk. Reduction in falls is seen for participants in programs that include balance and moderate-intensity muscle-strengthening activities for 90 minutes a week plus moderate-intensity walking for about an hour a week. It's not known whether different combinations of type, amount, or frequency of activity can reduce falls to a greater degree. Tai chi exercises also may help prevent falls.

Mental Health

Physically active adults have lower risk of depression and cognitive decline (declines with aging in thinking, learning, and judgment skills). Physical activity also may improve the quality of sleep. Whether physical activity reduces distress or anxiety is currently unclear.

Mental health benefits have been found in people who do aerobic or a combination of aerobic and muscle-strengthening activities 3 to 5 days a week for 30 to 60 minutes at a time. Some research has shown that even lower levels of physical activity also may provide some benefits.

Regular physical activity appears to reduce symptoms of anxiety and depression for children and adolescents. Whether physical activity improves self-esteem is not clear.

Adverse Events

Some people hesitate to become active or increase their level of physical activity because they fear getting injured or having a heart attack. Studies of generally healthy people clearly show that moderate-intensity physical activity, such as brisk walking, has a low risk of such adverse events.

The risk of musculoskeletal injury increases with the total amount of physical activity. For example, a person who regularly runs 40 miles a week has a higher risk of injury than a person who runs 10 miles each week. However, people who are physically active may have fewer injuries from other causes, such as motor vehicle collisions or work-related injuries. Depending on the type and amount of activity that physically active people do, their overall injury rate may be lower than the overall injury rate for inactive people.

Participation in contact or collision sports, such as soccer or football, has a higher risk of injury than participation in non-contact physical activity, such as swimming or walking. However, when performing the same activity, people who are less fit are more likely to be injured than people who are fitter.

Cardiac events, such as a heart attack or sudden death during physical activity, are rare. However, the risk of such cardiac events does increase when a person suddenly becomes much more active than usual. The greatest risk occurs when an adult who is usually inactive engages in vigorous-intensity activity (such as shoveling snow). People who are regularly physically active have the lowest risk of cardiac events both while being active and overall.

The bottom line is that the health benefits of physical activity far outweigh the risks of adverse events for almost everyone.

Sources

Source: The Physical Activity Guidelines for Americans Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services.http://www.health.gov/paguidelines/guidelines/

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2.5.8.3: Dealing with Inactivity

Inactive adults or those who don't yet do 150 minutes of physical activity a week should work gradually toward this goal. The initial amount of activity should be at a light or moderate intensity, for short periods of time, with the sessions spread throughout the week. The good news is that "some is better than none."

People gain some health benefits even when they do as little as 60 minutes a week of moderate-intensity aerobic physical activity.

To reduce risk of injury, it is important to increase the amount of physical activity gradually over a period of weeks to months. For example, an inactive person could start with a walking program consisting of 5 minutes of slow walking several times each day, 5 to 6 days a week. The length of time could then gradually be increased to 10 minutes per session, 3 times a day, and the walking speed could be increased slowly.

Muscle-strengthening activities should also be gradually increased over time. Initially, these activities can be done just 1 day a week starting at a light or moderate level of effort. Over time, the number of days a week can be increased to 2, and then possibly to more than 2. Each week, the level of effort (intensity) can be increased slightly until it becomes moderate to high.

Flexibility Activities

Flexibility is an important part of physical fitness. Some types of physical activity, such as dancing, require more flexibility than others. Stretching exercises are effective in increasing flexibility, and thereby can allow people to more easily do activities that require greater flexibility. For this reason, flexibility activities are an appropriate part of a physical activity program, even though they have no known health benefits and it is unclear whether they reduce risk of injury. Time spent doing flexibility activities by themselves does not count toward meeting the aerobic or muscle-strengthening guidelines (Physical Activity Guidelines for Americans).

Warm-up and Cool-down

Warm-up and cool-down activities are an acceptable part of a person's physical activity plan. Commonly, the warm-up and cool-down involve doing an activity at a slower speed or lower intensity. A warm-up before moderate- or vigorous-intensity aerobic activity allows a gradual increase in heart rate and breathing at the start of the episode of activity. A cool-down after activity allows a gradual decrease at the end of the episode. Time spent doing warm-up and cool-down may count toward meeting the aerobic activity Guidelines if the activity is at least moderate intensity (for example, walking briskly as a warm-up before jogging). A warm-up for muscle-strengthening activity commonly involves doing exercises with lighter weight.

Getting and Staying Active: Real-Life Examples

Adults can meet the *Physical Activity Guidelines* in all sorts of ways and with many types of physical activity. The choices of types and amounts of physical activity depend on personal health and fitness goals.

Here are three examples.

Jean: An Inactive Middle-Aged Woman

- **Her goals**: Jean sets a goal of doing 1 hour a day of moderate-intensity aerobic activity on 5 days a week (a total of 300 minutes a week). Weighing 220 pounds, Jean is obese and wants to lose about 1 pound of weight each week.
- **Starting out**: Jean cuts back on her caloric intake and starts walking 5 minutes in the morning and 5 minutes in the evening most days of the week. She walks at a 2.5 mile-an-hour pace. Although physical activity tables show this to be light-intensity activity, for her level of fitness and fatness, it is appropriate moderate–intensity activity.
- **Making good progress**: Two months later, Jean is comfortably walking 30 to 40 minutes at moderate intensity to and from her bus stop every day. She then adds variety to her activity by alternating among walking, riding a stationary cycle, and low-impact aerobics. She also begins muscle-strengthening activities, using elastic bands twice each week.

- **Reaching her goal:** Eventually, Jean works up to 300 minutes a week of moderate-intensity aerobic activity, including her brisk walks to and from the bus stop. She has lost 40 pounds of weight in 1 year, with most of the weight loss occurring the previous 6 months when she mastered her diet and was able to do greater amounts of physical activity.

Douglas: An Active Middle-Aged Man

- **His goal and current activity pattern:** Douglas was a soccer player in his youth. His goal is to get back into shape by becoming a regular recreational runner. In addition to his job operating heavy equipment, he walks 30 to 40 minutes a day on 5 days each week. He also lifts weights 2 days a week.
- **Starting out:** Douglas starts a walk/jog program with a co-worker and plans to gradually replace walking with jogging and then running. The first week he goes out on 5 days, walking for 25 minutes and jogging for 5 minutes.
- **Making good progress:** Each week, Douglas gradually increases the time spent jogging (vigorous-intensity activity) and reduces the time spent walking (moderate–intensity activity). He also continues his weight-lifting program.
- **Reaching his goal:** Eventually, Douglas is running 30 to 45 minutes 4 days a week and lifting weights 2 days a week. He goes for a 1-hour bicycle ride on most weekends.

Anita

- **Her goals and current activity pattern:** Anita plays league basketball (vigorous-intensity activity) 4 days each week for 90 minutes each day. She wants to reduce her risk of injury from doing too much of one kind of activity (this is called an overuse injury).
- **Starting out:** Anita starts out by cutting back her basketball playing to 3 days each week. She begins to bicycle to and from campus (30 minutes each way) instead of driving her car. She also joins a yoga class that meets twice each week.
- **Reaching her goal:** Eventually, Anita is bicycling 3 days each week to and from campus in addition to playing basketball. Her yoga class helps her to build and maintain strength and flexibility.

Achieving Target Levels of Physical Activity: Possibilities Are Endless

These examples show how it's possible to meet the Guidelines by doing moderate-intensity or vigorous-intensity activity or a combination of both. Physical activity at this level provides substantial health benefits.

- Ways to get the equivalent of 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic physical activity a week plus muscle-strengthening activities:
- Thirty minutes of brisk walking (moderate intensity) on 5 days, exercising with resistance bands (muscle strengthening) on 2 days;
- Thirty minutes of brisk walking on 2 days, 60 minutes (1 hour) of social dancing (moderate intensity) on 1 evening, 30 minutes of mowing the lawn (moderate intensity) on 1 afternoon, heavy gardening (muscle strengthening) on 2 days;
- Thirty minutes of an aerobic dance class on 1 morning (vigorous intensity), 30 minutes of running on 1 day (vigorous intensity), 30 minutes of brisk walking on 1 day (moderate intensity), calisthenics (such as sit-ups, push-ups) on 3 days (muscle strengthening);
- Thirty minutes of biking to and from work on 3 days (moderate intensity), playing softball for 60 minutes on 1 day (moderate intensity), using weight machines on 2 days (muscle-strengthening on 2 days); and
- Forty-five minutes of doubles tennis on 2 days (moderate intensity), lifting weights after work on 1 day (muscle strengthening), hiking vigorously for 30 minutes and rock climbing (muscle strengthening) on 1 day.

Learning Activity

Find out what kind of physical activity suits you the best at the BAM website.

Personalize the Benefits of Regular Physical Activity

Adults need to identify benefits of personal value to them. For many people, the health benefits, which are the focus of the *Physical Activity Guidelines for Americans*, are compelling enough. For others, different reasons are key motivators to be active. For example, physical activity:

- Provides opportunities to enjoy recreational activities, often in a social setting;
- Improves personal appearance;
- Provides a chance to help a spouse lose weight;
- Improves the quality of sleep;
- Reduces feelings of low energy; and
- Gives older adults a greater opportunity to live independently in the community.

Set Personal Goals for Physical Activity

The Guidelines alone don't provide enough information for individuals to decide the types and amounts of activity that are appropriate for them. Individuals should set goals for activity that allow them to achieve benefits they value. Simple goals are fine. For example, a brisk walk in the neighborhood with friends for 45 minutes 3 days a week and walking to lunch twice a week may be just the right approach for someone who wants to increase both physical activity and social opportunities.

In setting goals, people can consider doing a variety of activities and try both indoor and outdoor activities. In particular, public parks and recreation areas in the United States offer opportunities to experience nature and be physically active at the same time.

The best physical activity is the one that is enjoyable enough to do regularly.

Learning Activity

Try this interactive online tool if you want help scheduling your own physical activity calendar. More tips about scheduling your physical activity are available at Adult Guidelines.

Sources

Source: The Physical Activity Guidelines for Americans Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services.http://www.health.gov/paguidelines/guidelines/

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2.5.8.4: Safe and Activity

Be Safe and Active

Although physical activity has many health benefits, injuries and other adverse events do sometimes happen. The most common injuries affect the musculoskeletal system (the bones, joints, muscles, ligaments, and tendons). Other adverse events can also occur during activity, such as overheating and dehydration. On rare occasions, people have heart attacks during activity.

The good news is that scientific evidence strongly shows that physical activity is safe for almost everyone. Moreover, the health benefits of physical activity far outweigh the risks.

Still, people may hesitate to become physically active because of concern they'll get hurt. For these people, there is even more good news: They can take steps that are proven to reduce their risk of injury and adverse events.

The guidelines in this module provide advice to help people do physical activity safely. Most advice applies to people of all ages. Specific guidance for particular age groups and people with certain conditions is also provided.

Physical Activity is Safe for Almost Everyone

Most people are not likely to be injured when doing moderate-intensity activities in amounts that meet the *Physical Activity Guidelines*. However, injuries and other adverse events do sometimes happen. The most common problems are musculoskeletal injuries. Even so, studies show that only one such injury occurs for every 1,000 hours of walking for exercise, and fewer than four injuries occur for every 1,000 hours of running.

Both physical fitness and total amount of physical activity affect risk of musculoskeletal injuries. People who are physically fit have a lower risk of injury than people who are not. People who do more activity generally have a higher risk of injury than people who do less activity. So what should people do if they want to be active and safe? The best strategies are to:

- Be regularly physically active to increase physical fitness; and
- Follow the other guidance in this chapter (especially increasing physical activity gradually over time) to minimize the injury risk from doing medium to high amounts of activity.
- Following these strategies may reduce *overall* injury risk. Active people are more likely to have an activity related injury than inactive people. But they appear less likely to have non-activity-related injuries, such as work-related injuries or injuries that occur around the home or from motor vehicle crashes.

Key Guidelines for Safe Physical Activity

To do physical activity safely and reduce risk of injuries and other adverse events, people should:

- Understand the risks and yet be confident that physical activity is safe for almost everyone.
- Choose to do types of physical activity that are appropriate for their current fitness level and health goals, because some activities are safer than others.
- Increase physical activity gradually over time whenever more activity is necessary to meet guidelines or health goals. Inactive people should "start low and go slow" by gradually increasing how often and how long activities are done.
- Protect themselves by using appropriate gear and sports equipment, looking for safe environments, following rules and policies, and making sensible choices about when, where, and how to be active.
- Be under the care of a health-care provider if they have chronic conditions or symptoms. People with chronic conditions and symptoms should consult their health-care provider about the types and amounts of activity appropriate for them.

Choose Appropriate Types and Amounts of Activity

People can reduce their risk of injury by choosing appropriate types of activity. The safest activities are moderate intensity and low impact, and don't involve purposeful collision or contact.

Walking for exercise, gardening or yard work, bicycling or exercise cycling, dancing, swimming, and golf are activities with the lowest injury rates. In the amounts commonly done by adults, walking (a moderate-intensity and low-impact activity) has a third or less of the injury risk of running (a vigorous-intensity and higher impact activity).

The risk of injury for a type of physical activity can also differ according to the purpose of the activity. For example, recreational bicycling or bicycling for transportation leads to fewer injuries than training for and competing in bicycle races.

People who have had a past injury are at risk of injuring that body part again. The risk of injury can be reduced by performing appropriate amounts of activity and setting appropriate personal goals. Performing a variety of different physical activities may also reduce the risk of overuse injury.

The risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity.

Learning Activity

Find out more about specific physical activities that might interest you: Physical Activity Cards.

Increase Physical Activity Gradually Over Time

Scientific studies indicate that the risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity. The size of this gap is called the amount of overload. Creating a small overload and waiting for the body to adapt and recover reduces the risk of injury. When amounts of physical activity need to be increased to meet the Guidelines or personal goals, physical activity should be increased gradually over time, no matter what the person's current level of physical activity.

Scientists have not established a standard for how to gradually increase physical activity over time. The following recommendations give general guidance for inactive people and those with low levels of physical activity on how to increase physical activity:

Use relative intensity (intensity of the activity relative to a person's fitness) to guide the level of effort for aerobic activity.

Generally start with relatively moderate-intensity aerobic activity. Avoid relatively vigorous-intensity activity, such as shoveling snow or running. Adults with a low level of fitness may need to start with light activity, or a mix of light- to moderate-intensity activity.

First, increase the number of minutes per session (duration), and the number of days per week (frequency) of moderate-intensity activity. Later, if desired, increase the intensity.

Pay attention to the relative size of the increase in physical activity each week, as this is related to injury risk. For example, a 20-minute increase each week is safer for a person who does 200 minutes a week of walking (a 10 percent increase), than for a person who does 40 minutes a week (a 50 percent increase).

The available scientific evidence suggests that adding a small and comfortable amount of light- to moderate–intensity activity, such as 5 to 15 minutes of walking per session, 2 to 3 times a week, to one's usual activities has a low risk of musculoskeletal injury and no known risk of severe cardiac events. Because this range is rather wide, people should consider three factors in individualizing their rate of increase: age, level of fitness, and prior experience.

The amount of time required to adapt to a new level of activity probably depends on age. Youth and young adults probably can safely increase activity by small amounts every week or 2. Older adults appear to require more time to adapt to a new level of activity, in the range of 2 to 4 weeks.

Level of Fitness

Less fit adults are at higher risk of injury when doing a given amount of activity, compared to fitter adults. Slower rates of increase over time may reduce injury risk. This guidance applies to overweight and obese adults, as they are commonly less physically fit.

Prior Experience

People can use their experience to learn to increase physical activity over time in ways that minimize the risk of overuse injury. Generally, if an overuse injury occurred in the past with a certain rate of progression, a person should increase activity more slowly the next time.

Take Appropriate Precautions

Taking appropriate precautions means using the right gear and equipment, choosing safe environments in which to be active, following rules and policies, and making sensible choices about how, when, and where to be active.

Use Protective Gear and Appropriate Equipment

Using personal protective gear can reduce the frequency of injury. Personal protective gear is something worn by a person to protect a specific body part. Examples include helmets, eyewear and goggles, shin guards, elbow and knee pads, and mouth guards.

Using appropriate sports equipment can also reduce risk of injury. Sports equipment refers to sport or activity-specific tools, such as balls, bats, sticks, and shoes.

For the most benefit, protective equipment and gear should be:

- The right equipment for the activity
- Appropriately fitted
- Appropriately maintained
- Used consistently and correctly.

Be Active in Safe Environments

People can reduce their injury risks by paying attention to the places they choose to be active. To help themselves stay safe, people can look for:

- Physical separation from motor vehicles, such as sidewalks, walking paths, or bike lanes;
- Neighborhoods with traffic-calming measures that slow down traffic;
- Places to be active that are well-lighted, where other people are present, and that are well-maintained (no litter, broken windows);
- Shock-absorbing surfaces on playgrounds;
- Well-maintained playing fields and courts without holes or obstacles;
- Breakaway bases at baseball and softball fields; and
- Padded and anchored goals and goal posts at soccer and football fields.

Follow Rules and Policies That Promote Safety

Rules, policies, legislation, and laws are potentially the most effective and wide-reaching way to reduce activity-related injuries. To get the benefit, individuals should look for and follow these rules, policies, and laws. For example, policies that promote the use of bicycle helmets reduce the risk of head injury among cyclists. Rules against diving into shallow water at swimming pools prevent head and neck injuries.

Make Sensible Choices about How, When, and Where To Be Active

A person's choices can obviously influence the risk of adverse events. By making sensible choices, injuries and adverse events can be prevented. Consider weather conditions, such as extremes of heat and cold. For example, during very hot and humid weather, people lessen the chances of dehydration and heat stress by:

- Exercising in the cool of early morning as opposed to mid-day heat;

- Switching to indoor activities (playing basketball in the gym rather than on the playground);
- Changing the type of activity (swimming rather than playing soccer);
- Lowering the intensity of activity (walking rather than running); and
- Paying close attention to rest, shade, drinking enough fluids, and other ways to minimize effects of heat.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries.

Exposure to air pollution is associated with several adverse health outcomes, including asthma attacks and abnormal heart rhythms. People who can modify the location or time of exercise may wish to reduce these risks by exercising away from heavy traffic and industrial sites, especially during rush hour or times when pollution is known to be high. However, current evidence indicates that the benefits of being active, even in polluted air, outweigh the risk of being inactive.

Quick Review

What are some ways that you can reduce the risk of injury when engaging in physical activity?

Advice from Health-Care Providers

The protective value of a medical consultation for persons with or without chronic diseases who are interested in increasing their physical activity level is not established. People without diagnosed chronic conditions (such as diabetes, heart disease, or osteoarthritis) and who do not have symptoms (such as chest pain or pressure, dizziness, or joint pain) do not need to consult a health-care provider about physical activity.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries. A person who is habitually active with moderate-intensity activity can gradually increase to vigorous intensity without needing to consult a health-care provider. People who develop new symptoms when increasing their levels of activity should consult a health-care provider.

Health-care providers can provide useful personalized advice on how to reduce risk of injuries. For people who wish to seek the advice of a health-care provider, it is particularly appropriate to do so when contemplating vigorous-intensity activity, because the risks of this activity are higher than the risks of moderate-intensity activity.

The choice of appropriate types and amounts of physical activity can be affected by chronic conditions. People with symptoms or known chronic conditions should be under the regular care of a health-care provider. In consultation with their provider, they can develop a physical activity plan that is appropriate for them. People with chronic conditions typically find that moderate-intensity activity is safe and beneficial. However, they may need to take special precautions. For example, people with diabetes need to pay special attention to blood sugar control and proper footwear during activity.

Gradually Increasing Physical Activity over Time: Real-Life Examples

Here are two examples that show how people at different ages, levels of fitness, and levels of experience can safely become more active over time.

Bill: A Man Who Has Been Inactive for Many Years

Bill wants to work his way up to the equivalent of 180 to 210 minutes (3 hours to 3 hours and 30 minutes) of walking a week. On weekdays he has time for up to 45 minutes of walking, and he plans to do something physically active each weekend. He decides to start with walking because it is moderate intensity and has a low risk of injury.

The first week, Bill starts at a low level. He walks 10 minutes a day 3 days a week. Sometimes he divides the 10 minutes a day into two sessions. He prefers to alternate rest days and active days. (Total = 30 minutes a week.)
Between weeks 3 and 8, Bill increases duration by adding 5 minutes a day and continues walking on 3 non-consecutive days each week. The weekly increase is 15 minutes. (Week 3 total = 45 minutes. Week 8 total = 120 minutes or 2 hours.)

In week 9, Bill adds another day of moderate intensity activity on the weekend, and starts doing a variety of activities, including biking, hiking, and an aerobics class. Gradually increasing the minutes of activity, by week 12 he is doing 60 minutes or more of moderate-intensity activity on the weekend. Reaching his goal: Over 3 months, Bill has increased to a total of 180 moderate-intensity minutes a week.

Kim: An Active Woman

Kim currently does 150 minutes (2 hours and 30 minutes) a week of moderate-intensity activity. She wants to work up to at least the equivalent of 300 minutes (5 hours) of moderate-intensity activity a week. She also wants to shift some of that moderate intensity activity to vigorous-intensity activity. Her current 150 minutes a week includes:

- Thirty minutes of mowing the grass 1 day a week;
- Thirty minutes of brisk walking 4 days a week; and
- Fifteen minutes of muscle-strengthening exercises 2 days a week.
- Increasing frequency and duration:

Over a month, Kim adds walking on another weekday, and she gradually adds 15 minutes of moderate-intensity activity on each of the 5 walking days each week. This provides an additional 105 minutes (1 hour and 45 minutes) of moderate–intensity activity.

- **Increasing intensity:** Over the next month, Kim decides to replace some walking with jogging. Instead of walking 45 minutes, she walks for 30 minutes and jogs for 15 minutes on each weekday, providing the equivalent of 300 minutes a week of moderate-intensity physical activity from her walking and jogging.
- **Reaching her goal:** After these increases, Kim is doing a total of 180 minutes of moderate-intensity activity each week (walking and mowing) and also doing 75 minutes (1 hour and 15 minutes) of vigorous–intensity jogging. One minute of vigorous-intensity activity is about the same as 2 minutes of moderate intensity activity, so she is now doing the equivalent of 330 moderate-intensity minutes (5 hours and 30 minutes) a week. She has more than met her goal.

Which physical activity plan would work best for **you** to increase your physical activity over time: Bill's or Kim's? Why?

Sources

Source: The Physical Activity Guidelines for Americans, Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services. http://www.health.gov/paguidelines/guidelines/

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2.5.8.5: Pregnancy and Disabilities

Keeping Active during Pregnancy and with Disabilities

All Americans should be physically active to improve overall health and fitness and to prevent many adverse health outcomes. However, some people have conditions that raise special issues about recommended types and amounts of physical activity. This chapter provides guidance on physical activity for healthy women who are pregnant and for people with disabilities.

Physical Activity for Women during Pregnancy and the Postpartum Period

Women who are pregnant and those who've recently had a baby should be under the regular care of a health-care provider. Moderate-intensity physical activity is generally safe for women with uncomplicated pregnancies, but women should talk with their provider about how to adjust the amounts and types of activity while they are pregnant and right after the baby's birth.

During pregnancy, women should avoid:

- Doing activities with high risk of falling or abdominal trauma, including contact or collision sports, such as horseback riding, soccer, basketball, and downhill skiing.
- Physical activity during pregnancy benefits a woman's overall health. For example, moderate-intensity physical activity by healthy women during pregnancy maintains or increases cardiorespiratory fitness.

Strong scientific evidence shows that the risks of moderate-intensity activity done by healthy women during pregnancy are very low, and do not increase risk of low birth weight, preterm delivery, or early pregnancy loss. Some evidence suggests that physical activity reduces the risk of pregnancy complications, such as preeclampsia and gestational diabetes, and reduces the length of labor, but this evidence is not conclusive.

During a normal postpartum period, regular physical activity continues to benefit a woman's overall health. Studies show that moderate-intensity physical activity during the period following the birth of a child increases a woman's cardiorespiratory fitness and improves her mood. Such activity does not appear to have adverse effects on breast milk volume, breast milk composition, or infant growth.

Physical activity also helps women achieve and maintain a healthy weight during the postpartum period, and when combined with caloric restriction, helps promote weight loss.

Key Guidelines for Women during Pregnancy and the Postpartum Period

Women who are pregnant should be under the care of a health-care provider with whom they can discuss how to adjust amounts of physical activity during pregnancy and the postpartum period. Unless a woman has medical reasons to avoid physical activity during pregnancy, she can begin or continue moderate-intensity aerobic physical activity during her pregnancy and after the baby is born.

When beginning physical activity during pregnancy, women should increase the amount gradually over time. The effects of vigorous-intensity aerobic activity during pregnancy have not been studied carefully, so there is no basis for recommending that women should begin vigorous-intensity activity during pregnancy.

Women who habitually do vigorous-intensity activity or high amounts of activity or strength training should continue to be physically active during pregnancy and after giving birth. They generally do not need to drastically reduce their activity levels, provided that they remain healthy and discuss with their health-care provider how to adjust activity levels during this time.

During pregnancy, women should avoid doing exercises involving lying on their back after the first trimester of pregnancy. They should also avoid doing activities that increase the risk of falling or abdominal trauma, including contact or collision sports, such as horseback riding, downhill skiing, soccer, and basketball.

Physical Activity for People with Disabilities

The benefits of physical activity for people with disabilities have been studied in diverse groups. These groups include stroke victims, people with spinal cord injury, multiple sclerosis, Parkinson's disease, muscular dystrophy, cerebral palsy, traumatic brain injury, limb amputations, mental illness, intellectual disability, and dementia.

Overall, the evidence shows that regular physical activity provides important health benefits for people with disabilities. The benefits include improved cardiovascular and muscle fitness, improved mental health, and better ability to do tasks of daily life. Sufficient evidence now exists to recommend that adults with disabilities should get regular physical activity.

People with disabilities are encouraged to get advice from professionals with experience in physical activity and disability because matching activity to abilities can require modifying physical activity in many different ways. Some people with disabilities also need help with their exercise program. For example, some people may need supervision when performing muscle-strengthening activities, such as lifting weights.

Sources

Keeping Active during Pregnancy and with Disabilities: The Physical Activity Guidelines for Americans, Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services. http://www.health.gov/paguidelines/guidelines/

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2.5.8.6: Community Efforts to Increase Physical Activity

The low level of physical activity among Americans is a major contributor to the burden of chronic disease. This burden is costly in terms of quality of life and economic resources needed to provide medical care. Like life in other modern societies around the world, life in the United States requires very little daily physical activity. The amount of physical activity we do is largely a matter of personal choice and the environmental conditions under which we live. So far, little progress has been made in meeting our national health objectives for physical activity.

Based on a careful review of the science, the *Physical Activity Guidelines* provides essential guidance to help Americans achieve the health benefits of regular physical activity. However, providing guidance by itself is not enough to produce change. Action is necessary. Regular physical activity needs to be made the easy choice for Americans.

To accomplish this goal, public health research suggests the use of a "socio-ecologic" approach. This comprehensive approach involves action at all levels of society: individual, interpersonal, organizational, community, and public policy.

What Can Communities and Government Do to Help People Be Active?

Actions by communities and government can influence whether regular physical activity is an easy choice. Communities can provide many opportunities for physical activity, such as walking trails, bicycle lanes on roads, sidewalks, and sports fields. Organizations in the community have a role to play as well. Schools, places of worship, worksites, and community centers can provide opportunities and encouragement for physical activity.

Involve Many Sectors in Promoting Physical Activity

Interventions to improve access should also include outreach that increases awareness of the opportunity to be active.

Policies and programs that support street-scale design principles and practices that promote physical activity. For example, these types of policies and programs use crosswalks, sidewalks, traffic calming, and other safety measures to make it easier and safer for people to choose active transportation.

Policies and programs that support community-scale design principles and practices that promote physical activity. Community-scale design includes zoning that facilitates bicycling and walking by allowing schools, housing, and businesses to be built near one another.

The following list identifies relevant sectors and illustrates roles they play in promoting physical activity. The division of functions in the community into the following sectors does not use mutually exclusive categories. These sectors were chosen simply to illustrate how parts of the community have a role to play in promoting physical activity. Some communities may use different names and divisions of functions.

- **Parks and recreation.** This sector plays a lead role in providing access to places for active recreation, such as playgrounds, hiking and biking trails, basketball courts, sports fields, and swimming pools.
- **Concern about crime can deter people from outdoors recreation.** Law enforcement can promote a safe environment that facilitates outdoor activity.
- **Urban planning.***The Guide to Community Preventive Services* recommends both street-scale and community-scale design principles to promote physical activity. Urban planners have a lead role in implementing design principles to promote physical activity.
- **Transportation.** The transportation sector has a lead role in designing and implementing options that provide areas for safe walking and bicycling. Mass transit systems also promote walking, as people typically walk to and from transit stops. Programs that support safe walking and bicycling to school help children be more physically active.
- **Education.** The education sector takes a lead role in providing physical education, after-school sports, and public access to school facilities during after-school hours.
- **Architecture.** Architects and builders can design and construct buildings with active options, such as access to stairs. Campuses should allow pedestrians pleasant and efficient methods of walking within and between buildings.
- **Employers and private organizations.** Employers can encourage workers to be physically active, facilitate active transportation by supplying showers and secure bicycle storage, and provide other incentives to be active. Private and faith-

based organizations can support community physical activity initiatives financially or by providing space for programs. Health and fitness facilities and community programs can provide access to exercise programs and equipment for a broad range of people, including older adults and people with disabilities. Local sports organizations can organize road races and events for the public. Senior centers can provide exercise programs for older adults.

- **Health care.** Health-care providers can assess, counsel, and advise patients on physical activity and how to do it safely. Health-care providers can model healthy behaviors by being physically active themselves.
- **Public health**. Public health departments can monitor community progress in providing places and opportunities to be physically active and can track changes in the proportion of the population meeting the *Physical Activity Guidelines for Americans*. They can also take the lead in setting objectives and coordinating activities among sectors. Public health departments and organizations can disseminate appropriate messages and information to the public about physical activity.

Learning Activity

Find out steps you can take to encourage your employees to take the stairs and increase their physical activity while at work at *StairWELL*.

Use this Walkability audit tool to determine how safe and attractive the walking environment is at your work site.

Optional Learning Activity

Implement a Fitness Promotion program at your workplace (e.g., develop signs to post by elevators encouraging people to take the stairs, get permission to post the signs, observe to see if anyone reads the signs and actually uses the stairs; start a noontime walking club, develop a walking route that is timed and measured for distance, recruit club members; launch a campaign to get people to park in the far end of the parking lot).

Sources

Source: The Physical Activity Guidelines for Americans Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services.http://www.health.gov/paguidelines/guidelines/

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2.5.8.7: The Relationship between Physical Activity and Health

Learning Activity

Find out how much you already know about physical activity by completing this ungraded quiz. Do you know more or less than you thought?

All Americans should be regularly physically active to improve overall health and fitness and to prevent many adverse health outcomes. The benefits of physical activity occur in generally healthy people, in people at risk of developing chronic diseases, and in people with current chronic conditions or disabilities. The Physical Activity Guidelines for Americans (2008) gives guidance on the amount of physical activity that will provide health benefits for all Americans. In addition to presenting the Guidelines, this Chapter gives an overview of research findings on physical activity and health.

Physical activity affects many health conditions, and the specific amounts and types of activity that benefit each condition vary. One consistent finding from research studies is that once the health benefits from physical activity begin to accrue, additional amounts of activity provide additional benefits.

Although some health benefits seem to begin with as little as 60 minutes (1 hour) a week, research shows that a total amount of 150 minutes (2 hours and 30 minutes) a week of moderate-intensity aerobic activity, such as brisk walking, consistently reduces the risk of many chronic diseases and other adverse health outcomes.

Learning Activity

Watch the first three videos in this playlist about The Physical Activity Guidelines for Americans:

https://youtu.be/lEutFrar1dI?list=PL43D95102E29BC901

Examining the Relationship between Physical Activity and Health

In many studies covering a wide range of issues, researchers have focused on **exercise**, as well as on the more broadly defined concept of **physical activity**. Exercise is a form of physical activity that is planned, structured, repetitive, and performed with the goal of improving health or fitness. So, although all exercise is physical activity, not all physical activity is exercise.

Quick Review: What is the difference between physical activity and exercise?

Studies have examined the role of physical activity in many groups—men and women, children, teens, adults, older adults, people with disabilities, and women during pregnancy and the postpartum period. These studies have focused on the role that physical activity plays in many health outcomes, including:

- Premature (early) death;
- Diseases such as coronary heart disease, stroke, some cancers, type 2 diabetes, osteoporosis, and depression;
- Risk factors for disease, such as high blood pressure and high blood cholesterol;
- Physical fitness, such as **aerobic capacity**, and muscle **strength** and endurance
- Functional capacity (the ability to engage in activities needed for daily living);
- Mental health, such as depression and cognitive function; and
- Injuries or sudden heart attacks.

These studies have also prompted questions as to what type and how much physical activity is needed for various health benefits. To answer this question, investigators have studied three main kinds of physical activity: aerobic, muscle-strengthening, and bone-strengthening.

Sources

Examining the Relationship between Physical Activity and Health: The Physical Activity Guidelines for Americans Office of Disease Prevention & Health Promotion, U.S. Department of Health and Human Services.http://www.health.gov/paguidelines/guidelines/

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3: STRESS

3.1: What Is Stress and How Does It Affect Wellness?
3.2: General Adaptation Syndrome
3.3: What Are the Strategies for Managing Stress?
3.4: Assess Your Stress Level
3.5: Test Your Knowledge

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3.1: What Is Stress and How Does It Affect Wellness?

In today's fast-paced society, most people complain about being stressed. However, when they use the term *stress*, they rarely know it's true meaning. The word carries many negative connotations and is associated with an unpleasant or traumatic event. As such, people mistakenly believe that stress is simply the nervousness and tension experienced prior to, during, or after a negative event. In fact, the effects of stress are physiological, emotional, *and* psychological.

Additionally, not all levels of stress are detrimental. The stress athletes experience right before a big game or college students feel right before an exam can enhance focus and increase their ability to concentrate. Stress is either good or bad depending on how long it persists and how it is perceived by the individual.

This chapter will provide a deeper understanding of what stress is and provide effective strategies for managing stress.

Stress is defined as the body's physical, mental, and emotional response to a particular stimulus, called a **stressor**. This adaption/coping-response helps the body prepare for challenging situations. It is the level of a person's response to a stressor that determines whether the experience is positive or negative. As a hardworking college student, you may feel as if you know the meaning of stress all too well. You may dream of a future where the demands on your time are diminished, so you can escape the high levels of stress you are feeling now. Unfortunately, regardless of their situation, everyone experiences stress on a regular basis. The good news is, not all stress is bad! Small levels of stress can enhance cognitive brain function. Stress may provide the motivation and concentration you need to write an essay, practice a speech, or prepare for a job interview. For most people, these types of stressors are manageable and not harmful. Stressors that have the potential for harm include the sudden loss of a loved one, the unexpected ending of a romantic relationship, or the unfair demands of an unreasonable boss.

Defining Stress

Stress, then, is more than simply the tension and apprehension generated by problems, obstacles, or traumatic events. Stress is the body's automatic response (physical, mental, and emotional) to any stressor. It is a natural and unavoidable part of life, and it can be empowering and motivating, or harmful and potentially dangerous.

For more information on stress click on the links below:

What is Stress?

What is stress and what causes it?

Effects of Stress on Wellness

As stated previously, not all stress is bad. In fact, the stress associated with riding a roller coaster, watching a scary movie, or scaling a cliff can enhance these experiences. Regardless of whether the stress experienced is negative or positive, the effects on the body are identical.

When a person senses that a situation demands action, the body responds by releasing chemicals into the blood. The hypothalamus signals the adrenal glands to release a surge of hormones that include adrenaline and cortisol. The physiological effects of those chemicals—enhanced focus, quicker reaction time, and increased heart rate, energy, and strength—are quite beneficial when faced with a potentially dangerous situation that is temporary.

Unfortunately, most of the stressors people face—work, school, finances, relationships—are a part of everyday life, and thus, inescapable. Experiencing ongoing, unavoidable stress can result in some very unpleasant and harmful effects, both mental and physical. Chronic stress can cause upset stomach, headaches, sleep problems, and heart disease. It can also cause depression, anxiety, and even memory loss.

To watch a video that describes the effects of stress in detail, click on the link below:

How Stress Affects Your Body and Mind

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3.2: General Adaptation Syndrome

Even if you know the physical effects of stress, you may be unaware of the different stages of stress, known as the general adaptation syndrome (GAS). The general adaptation syndrome is a universal and predictable response pattern to all stressors, whether good stress (called **eustress**) or bad stress (called **distress**).

Endocrinologist Hans Selye first described GAS in the 1930s and 1940s. He believed that when we are chronically exposed to stress, over time, the stress response causes aging and disease. During experiments with rats, Selye observed a series of physiological changes in the rats after they were exposed to stressful events.

After additional research, Selye concluded that these changes were not an isolated case, but rather the typical response to stress. He subsequently identified these stages as alarm, resistance, and exhaustion. Understanding these different responses and how they relate to each other may help you cope with stress. The sequence of physical responses associated with GAS is the same for eustress and distress and occurs in three stages.

Three Stages of GAS

1. Alarm reaction stage

In this stage, your body experiences the “fight or flight” response. This natural reaction prepares you to either flee or protect yourself in dangerous situations. The **sympathetic branch** of the autonomic nervous system is activated and the adrenal glands secrete two hormones to stimulate your reactions to stress: epinephrine (also known as adrenalin) and norepinephrine (also known as noradrenalin).

Adrenalin mobilizes glucose and fatty acid release from fatty cells. The body is able to use both as energy to respond to stress. Adrenalin and noradrenalin also have powerful effects on the heart. Both the heart rate and stroke volume are increased, thereby increasing the body’s cardiac output. They also help to shunt blood away from the other parts of the body and thereby push more blood to the heart, brain, and muscles as the body prepares to attack or flee. At the same time, the adrenal glands also release cortisol, to help meet the body’s energy needs in times of stress.

2. Resistance stage

After the initial reaction to the stressor during the alarm reaction stage, the **parasympathetic branch** of the autonomic nervous system counteracts the changes that the stressful stimulus has produced, and attempts to restore a state of **homeostasis**, the default state in which the body functions normally.

During the resistance stage, the results of the hormonal changes which occurred in the previous stage are still apparent, including increased glucose levels in the blood and higher blood pressure, but stress hormone levels begin to return to normal, enabling the body’s focus to shift from alertness to repair.

If the resistance stage continues for too long the body will stay in a state of alertness and continue to produce the stress hormones. Signs of the resistance stage include:

- Irritability
- Frustration
- Poor concentration

3. Exhaustion stage

After an extended period of stress, the body enters this final stage of GAS. At this stage, the body has depleted its physical, emotional, and mental resources and is unable to maintain normal function. Once the body is no longer equipped to fight stress and may experience these symptoms:

- Fatigue

- Depression
- Anxiety
- Feeling unable to cope

The Fight or Flight Response

When an individual perceives a potential stressor as dangerous, the body enters into a stress response termed “Fight or Flight”. This is a natural physiological deviation from homeostasis designed to protect an individual from harm. When our ancestors lived among other animals out in the wild, it was important for survival that when faced with danger, an automatic “alarm” response would take over causing them to take immediate action (attack or run). This is still an important response mechanism in today’s world. Imagine a bus speeding toward you, horn blasting, and you experienced no sense of danger or alarm. You would probably be killed. Luckily, your fight-or-flight response automatically steps in and takes over.

During the initial stress response, a person’s brain sends messages to a part the nervous system called the autonomic nervous system. The autonomic nervous system has two branches: the sympathetic nervous system and the parasympathetic nervous system. The sympathetic nervous system is the fight-or-flight system which gets the body aroused and ready for action, and the parasympathetic nervous system returns the body to a normal, non-aroused state.

When activated, the sympathetic nervous system releases a chemical called adrenalin. Adrenalin is used as a messenger to continue sympathetic nervous system activity, so that once activity begins, it often continues and increases for some time. Adrenalin takes time to fully exit the blood stream so even after your sympathetic nervous system has stopped responding, you are likely to continue to feel “stressed”. The parasympathetic nervous system takes over when the perceived danger is over (or the fight or run response took place).

Exercise and Fight or Flight

Physical activity or regular exercise serve to act as simulated “fight or flee” scenarios that trigger the parasympathetic nervous system and return the body to homeostasis.

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3.3: What Are the Strategies for Managing Stress?

Although stress in everyday life is unavoidable, there are ways to cope with it that will minimize or eliminate its harmful effects.

The Anxiety and Depression Association of America (ADAA) provides a list of effective strategies for coping with stress. That document is linked here: Tips: Coping Strategies. For your convenience, it is also reprinted below with the ADAA's permission.

When you are feeling anxious or stressed, these strategies will help you cope:

- **Take a time-out.** Practice yoga, listen to music, meditate, get a massage, or learn relaxation techniques. Stepping back from the problem helps clear your head.
- **Eat well-balanced meals.** Do not skip any meals. Do keep healthful, energy-boosting snacks on hand.
- **Limit alcohol and caffeine**, which can aggravate anxiety and trigger panic attacks.
- **Get enough sleep.** When stressed, your body needs additional sleep and rest.
- **Exercise daily** to help you feel good and maintain your health.
- **Take deep breaths**. Inhale and exhale slowly.
- **Count to 10 slowly**. Repeat, and count to 20 if necessary.
- **Do your best**. Instead of aiming for perfection, which isn't possible, be proud of however close you get.
- **Accept that you cannot control everything**. Put your stress in perspective: Is it really as bad as you think?
- **Welcome humor**. A good laugh goes a long way.
- **Maintain a positive attitude**. Make an effort to replace negative thoughts with positive ones.
- **Get involved.** Volunteer or find another way to be active in your community, which creates a support network and gives you a break from everyday stress.
- **Learn what triggers your anxiety.** Is it work, family, school, or something else you can identify? Write in a journal when you're feeling stressed or anxious and look for a pattern.
- **Talk to someone.** Tell friends and family you're feeling overwhelmed, and let them know how they can help you. Talk to a physician or therapist for professional help.
- **Get help online.** Online programs guided by professional coaches to help you turn healthy anxiety management into a habit.
    - Listen to podcasts on a wide range of topics
    - Watch recorded webinars on topics ranging from how to worry less, coping with panic attacks, treatments for children, and helping suicidal families,and many more.

Fitness Tips: Stay Healthy, Manage Stress

To receive the greatest benefits from exercising, try to include at least 2½ hours of moderate-intensity physical activity (e.g., brisk walking) each week, 1¼ hours of a vigorous-intensity activity (such as jogging or swimming laps), or a combination of the two.

- **5 X 30:** Jog, walk, bike, or dance three to five times a week for 30 minutes.
- **Set small daily goals** and aim for daily consistency rather than perfect workouts. It is better to walk every day for 15–20 minutes than to wait until the weekend for a three-hour fitness marathon. Lots of scientific data suggests that frequency is most important.
- **Find forms of exercise** that are fun or enjoyable. Extroverted people often like classes and group activities. People who are more introverted often prefer solo pursuits.
- **Distract yourself** with an iPod or other portable media player to download audiobooks, podcasts, or music. Many people find it is more fun to exercise while listening to material they enjoy.
- **Recruit** an "exercise buddy." It is often easier to stick to your exercise routine when you have to stay committed to a friend, partner, or colleague.
- **Be patient** when you start a new exercise program. Most sedentary people require about four to eight weeks to feel coordinated and sufficiently in shape so that exercise feels easier.

Additional strategies for coping with stress are linked below:

Stress Management

10 Tips to Manage Stress

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3.4: Assess Your Stress Level

Are you more or less stressed than your peers? The website linked below contains a stress test. On the website, scroll down to the “Quiz: Are You Stressed?”

How Stressed Are You?

Below is a link to the Lab for this chapter on stress. This may or may not be assigned for extra credit. Your instructor will inform you if it is.

Online Stress Test

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3.5: Test Your Knowledge

1. The stage of stress where the stressor can cause death or health problems

    a. Alarm

    b. Resistance

    c. Exhaustion

    d. Relapse

2. Which of the following does not occur when the body first encounters stress

    a. Heart rate increase

    b. Breathing increase

    c. Increased sweating

    d. Faster digestion

3. What hormone is most likely to be released when stress is encountered

    a. Testosterone

    b. Adrenaline

    c. Estrogen

    d. Leptin

4. The immune system becomes stronger when a stress is first encounters

    a. True

    b. False

5. Stress can cause all of the following except

    a. Headaches

    b. Insomnia

    c. Muscle cramps

    d. Upset stomach

6. Stress can lead to some mental concerns

    a. True

    b. False

Answers: 1.C, 2.D, 3.B, 4.A, 5.C, 6.A

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4: NUTRITION

4.1: The Basics

4.2: Carbohydrates

4.3: Proteins

4.4: Fats (Lipids)

4.5: Vitamins

4.6: Minerals

4.7: Calories (Food Energy)

4.8: Test Your Knowledge

4.9: Basic Nutrition and Healthy Eating

4.9.1: Nutrition and Health

4.9.2: Planning a Diet

4.9.3: Popular Diets

4.9.4: Food Supplements and Food Replacements

4.9.5: Food Safety

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4.1: The Basics

Nutrition can be defined as the science of the action of food, beverages, and their components in biological systems. A nutrient is a compound that provides a needed function in the body. Nutrients can be further classified based on the amount needed in the body. **Macronutrients** are the nutrients the body needs in larger amounts. **Micronutrients** are also important nutrients, but ones the body needs in smaller amounts.

[table id=3 /]

Macronutrients

Carbohydrates

The word *carbohydrate* literally means “hydrated carbon,” or carbon with water. Thus, it is no surprise that carbohydrates are made up of carbon, hydrogen, and oxygen. Sucrose (table sugar) is an example of a commonly consumed carbohydrate. Some dietary examples of carbohydrates are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta.

Proteins

Like carbohydrates, proteins are comprised of carbon, hydrogen, and oxygen, but they also contain nitrogen. Several dietary sources of proteins include nuts, beans/legumes, skim milk, egg whites, and meat.

Lipids

Lipids consist of fatty acids, triglycerides, phospholipids, and sterols (cholesterol). Lipids are also composed of carbon, hydrogen, and oxygen. Some dietary sources of lipids include, oils, butter, and egg yolks.

Water

Water is made up of hydrogen and oxygen and is the only macronutrient that provides no energy.

Micronutrients

Vitamins

These compounds are essential for normal physiologic processes in the body.

Minerals

Minerals are the elements (think periodic table) that are essential for normal physiologic processes in the body.

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4.2: Carbohydrates

Carbohydrates have become, surprisingly, quite controversial. However, it is important to understand that carbohydrates are a diverse group of compounds that have a multitude of effects on bodily functions. Thus, trying to make blanket statements about carbohydrates is not a good idea.

Carbohydrates provide energy for the body as well as fiber for digestive health and blood sugar regulation. Many natural carbohydrates such as fruits, vegetables and whole grains provide essential vitamins and minerals. Carbohydrates can be broken into 2 categories:

Simple carbohydrates: found naturally in fruits and milk and are added to candy and sweetened beverages. Simple carbohydrates provide quick energy.

Complex carbohydrates: found in grains and legumes provide sustained energy.

High-Fructose Corn Syrup

Food manufacturers are always searching for cheaper ways to produce their products. One extremely popular method for reducing costs is the use of high-fructose corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose, which is the same as sucrose. Nevertheless, because increased consumption of high-fructose corn syrup has coincided with increased obesity in the United States, a lot of controversy surrounds its use.

The New York Times article linked below discusses the growing popularity of sugar compared to high fructose corn syrup: "Sugar is Back on Food Labels, This Time as a Selling Point"

Fiber

The simplest definition of fiber is indigestible matter. Indigestible means that it survives digestion in the small intestine and reaches the large intestine. There are three major fiber classifications:

1. Dietary fiber

This type of fiber contains both nondigestible carbohydrates and lignin and is always intrinsic and intact in plants.

2. Functional fiber

This type of fiber contains nondigestible carbohydrates only and can be isolated, extracted, or synthesized. Functional fiber can be from plants or animals and produces beneficial physiological effects in humans.

3. Total Fiber

Fiber that contains both dietary fiber and functional fiber.

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4.3: Proteins

Protein is another major macronutrient that, like carbohydrates, consists of small repeating units. But instead of sugars, proteins are made up of amino acids.

Proteins can be classified as either complete or incomplete. Complete proteins provide adequate amounts of all nine essential amino acids. Animal proteins, such as meat, fish, milk, and eggs, are good examples of complete proteins. Incomplete proteins do not contain adequate amounts of one or more of the essential amino acids. For example, if a protein does not provide enough of the essential amino acid leucine it would be considered incomplete. Leucine would be referred to as the limiting amino acid because there is not enough of it for the protein to be complete. Most plant foods are incomplete proteins, with a few exceptions, such as soy. The following link discusses limiting amino acids and protein complementation: https://nutrition.org/protein-complementation/

Self Magazine's Nutrition Data website is a useful resource for determining protein quality and identifying complementary proteins. To use the site, go to www.nutritiondata.com, type the name of the food you want information on in the search bar and hit Enter. When you have selected your food from the list of possibilities, you will be given information about this food. Included in this information is the Protein Quality section. This will give you an amino acid score and a figure that illustrates which amino acid(s) is limiting. If your food is an incomplete protein, you can click "Find foods with a complementary profile." This will take you to a list of dietary choices that will provide complementary proteins for your food.

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4.4: Fats (Lipids)

Fats (lipids) are the most concentrated source of energy at 9 calories per gram. Fats provide long term stored energy, insulation, cushion and help the body absorb fat-soluble vitamins. Depending on the fatty acid structure a lipid may be monounsaturated, polyunsaturated, or saturated.

Linoleic acid (omega 6) and alpha-linoleic acid (omega 3) are examples of polyunsaturated fats and are essential components of a healthy diet. These healthy fats have an interactive roll in cell metabolism as well as overall vascular health which reduces risk of certain types of heart disease.

Trans-Fats

When unsaturated fats go through a process of hydrogenation some fatty acids are changed to trans-fats. This hydrogenation process makes liquid fats (such as oils) solid at room temperature and resistant to spoilage. Many food manufacturers used hydrogenated oils in processed foods to give these foods a longer shelf-life. However, trans-fats have a negative impact on health by raising levels of bad cholesterol (LDL) and lowering good cholesterol (HDL). Trans-fats are associated with increased risk of heart disease, stroke and type-2 diabetes.

Cholesterol

Cholesterol is a fat-like (lipid-like) substance that your body uses as a building block to produce hormones, vitamin D, and digestive juices that help you break down fats in your diet. HDL (high-density lipoprotein, or “good” cholesterol) and LDL (low-density lipoprotein, or “bad” cholesterol) are two types of lipoproteins that carry cholesterol to and from the body’s cells in the blood.The body needs some cholesterol to function, but when levels get too high, fatty deposits can accumulate in blood vessels, which causes them to narrow. This narrowing of the blood passageways by these lipids can lead to heart attacks, coronary artery disease, strokes, or other vascular diseases.

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4.5: Vitamins

Vitamins are organic compounds found in foods and are a necessary part of the biochemical reactions in the body. They are involved in a number of processes, including mineral and bone metabolism, and cell and tissue growth, and they act as cofactors for energy metabolism.

You get most of your vitamins through your diet, although some can be formed from the precursors absorbed during digestion. For example, the body synthesizes vitamin A from the β-carotene in orange vegetables like carrots and sweet potatoes. Vitamins are either fat-soluble or water-soluble. Fat-soluble vitamins A, D, E, and K, are absorbed through the intestinal tract with lipids. Vitamin D is also synthesized in the skin through exposure to sunlight. Because they are carried in lipids, fat-soluble vitamins can accumulate in the lipids stored in the body. If excess vitamins are retained in the lipid stores in the body, hypervitaminosis can result.

Water-solublevitamins, including the eight BvitaminsandvitaminC, are absorbed with water in the gastrointestinal tract. Thesevitaminsmove easily through bodily fluids, which are water based, so they are not stored in the body. Excess water-solublevitaminsare excreted in the urine. Therefore, hypervitaminosis of water-solublevitaminsrarely occurs, except with an excess ofvitaminsupplements.

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4.6: Minerals

Mineralsin food are inorganic compounds that work with other nutrients to ensure the body functions properly. Minerals cannot be made in the body; they come from the diet. The amount of minerals in the body is small—only 4 percent of the total body mass—and most of that consists of the minerals that the body requires in moderate quantities: potassium, sodium, calcium, phosphorus, magnesium, and chloride.

The most common minerals in the body are calcium and phosphorous, both of which are stored in the skeleton and necessary for the hardening of bones. Most minerals are ionized, and their ionic forms are used in physiological processes throughout the body. Sodium and chloride ions are electrolytes in the blood and extracellular tissues, and iron ions are critical to the formation of hemoglobin. There are additional trace minerals that are still important to the body's functions, but their required quantities are much lower.

Like vitamins, minerals can be consumed in toxic quantities (although it is rare). A healthy diet includes most of the minerals your body requires, so supplements and processed foods can add potentially toxic levels of minerals. The Major Minerals tableprovides a summary of minerals and their function in the body.

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4.7: Calories (Food Energy)

Food energy is measured in kilocalories (kcals), commonly referred to as calories. Although technically incorrect, this terminology is so familiar that it will be used throughout this course. A kilocalorie is the amount of energy needed to raise 1 kilogram of water 1 degree Celsius.

The number of kilocalories per gram for each nutrient is shown below:

[table id=4 /]

As the table above illustrates, only carbohydrates, protein, and lipids provide energy. However, there is another dietary energy source that is not a nutrient—alcohol. To emphasize, alcohol is *not* a nutrient, but it does provide 7 kilocalories of energy per gram.

Knowing the number of calories in each nutrient allows a person to calculate/estimate the amount of calories contained in any food consumed.

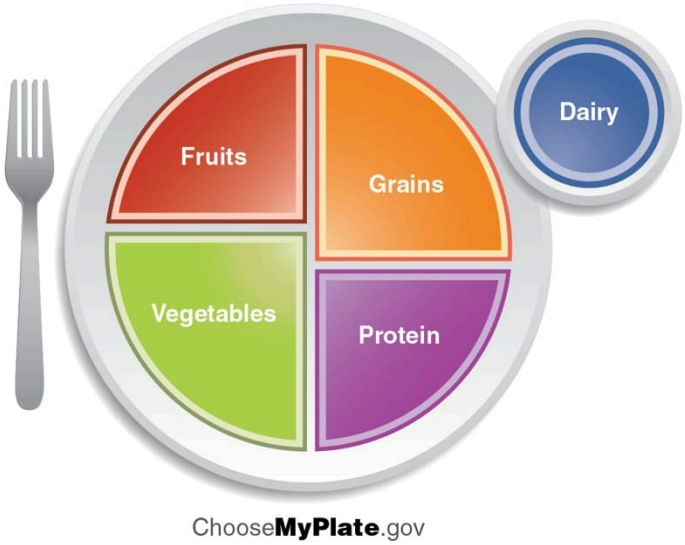
My Plate

On average, a person needs 1500 to 2000 calories per day to sustain (or carry out) daily activities. The total number of calories needed by one person is dependent on their body mass, age, height, gender, activity level, and the amount of exercise per day. If exercise is a regular part of one's day, more calories are required. As a rule, people underestimate the number of calories ingested and overestimate the amount they burn through exercise. This can lead to ingestion of too many calories per day. The accumulation of an extra 3500 calories adds one pound of weight. If an excess of 200 calories per day is ingested, one extra pound of body weight will be gained every 18 days. At that rate, an extra 20 pounds can be gained over the course of a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns almost 100 calories.

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. In fact, the breakdown of carbohydrates requires the least amount of energy, whereas the processing of proteins demands the most energy. In general, the amount of calories ingested and the amount of calories burned determines the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything you ingest, so when considering calorie intake, beverages must also be considered.

To help provide guidelines regarding the types and quantities of food that should be eaten every day, the USDA has updated their food guidelines from MyPyramid to MyPlate. They have put the recommended elements of a healthy meal into the context of a place setting of food. MyPlate categorizes food into the standard six food groups: fruits, vegetables, grains, protein foods, dairy, and oils. The accompanying website gives clear recommendations regarding quantity and type of each food that you should consume each day, as well as identifying which foods belong in each category. The accompanying graphic (Figure) gives a clear visual with general recommendations for a healthy and balanced meal. The guidelines recommend to "Make half your plate fruits and vegetables." The other half is grains and protein, with a slightly higher quantity of grains than protein. Dairy products are represented by a drink, but the quantity can be applied to other dairy products as well.

MyPlate



The U.S. Department of Agriculture developed food guidelines called MyPlate to help demonstrate how to maintain a healthy lifestyle.

Myplate.gov

Summary Video: Healthy Eating 101

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4.8: Test Your Knowledge

1. The type of fiber that is known for lowering cholesterol levels:

    a. Insoluble

    b. Soluble

    c. Dietary

    d. No fiber is known for this

2. What type of protein is typically found from animals?

    a. Insoluble

    b. Soluble

    c. Incomplete

    d. Complete

3. MyPlate tells you to make half your plate have:

    a. Red meat

    b. Fruits and Veggies

    c. Carbohydrates, specifally simple ones

    d. Water

4. Macronutrients are:

    a. Vitamins and Minerals

    b. Water

    c. Vitamins, Minerals and Protein

    d. Carbohydrates, Fats and Proteins

5. The calories that are found in one gram of fat is:

    a. 3

    b. 4

    c. 6

    d. 9

Answers: 1.B, 2.D, 3.B, 4.D, 5.D

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4.9: BASIC NUTRITION AND HEALTHY EATING

The word nutrition first appeared in 1551 and comes from the Latin word *nutrire,* meaning “to nourish.” Today, we define *nutrition* as the sum of all processes involved in how organisms obtain nutrients, metabolize them, and use them to support all of life’s processes. *Nutritional science* is the investigation of how an organism is nourished, and incorporates the study of how nourishment affects personal health, population health, and planetary health. Nutritional science covers a wide spectrum of disciplines. As a result, nutritional scientists can specialize in particular aspects of nutrition such as biology, physiology, immunology, biochemistry, education, psychology, sustainability, and sociology. Without adequate nutrition the human body does not function optimally, and severe nutritional inadequacy can lead to disease and even death. The typical American diet is lacking in many ways, from not containing the proper amounts of essential nutrients, to being too speedily consumed, to being only meagerly satisfying.

4.9.1: Nutrition and Health

4.9.2: Planning a Diet

4.9.3: Popular Diets

4.9.4: Food Supplements and Food Replacements

4.9.5: Food Safety

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- 10.5D: Public Health Measures for Disease Control is licensed CC BY-SA 4.0.

4.9.1: Nutrition and Health

The foods we eat affect all dimensions of health and wellness. For example, a teen with Type 2 diabetes (a disease brought on by poor diet) is first diagnosed by physical signs and symptoms such as increased urination, thirstiness, and unexplained weight loss. But research has also found that teens with Type 2 diabetes have impaired thinking and do not interact well with others in school, thereby affecting psychological and social wellbeing. Type 2 diabetes is just one example of a physiological disease that affects multiple dimensions of health—physical, psychological, and social.

Public Health and Disease Prevention

In 1894, the first congressional funds were appropriated to the US Department of Agriculture (USDA) for the study of the relationship between nutrition and human health. Dr. Wilbur Olin Atwater was appointed as the Chief of Nutrition Investigations and is accoladed as the “Father of Nutrition Science” in America.Combs, G.F. “Celebration of the Past: Nutrition at USDA.” *J Nutr* 124, no. 9 supplement (1994): 1728S–32S.

Under his guidance, the USDA released the first bulletin to the American public that contained information on the amounts of fat, carbohydrates, proteins, and food energy (calories) in various foods. Nutritional science advanced considerably in these early years, but it took until 1980 for the USDA and the US Department of Health and Human Services (HHS) to jointly release the first edition of *Nutrition and Your Health: Dietary Guidelines for Americans*. Although wide distribution of dietary guidelines did not come about until the 1980s, many historical events that demonstrated the importance of diet to health preceded their release. Assessments of the American diet in the 1930s led President Franklin D. Roosevelt to declare in his inaugural address on January 20, 1937, “I see one-third of our nation is ill-housed, ill-clad, and ill-nourished.” From the time of Atwater until the onset of the Great Depression nutritional scientists had discovered many of the vitamins and minerals essential for the functioning of the human body. Their work and the acknowledgement by President FDR of the nutritional inadequacy of the American diet evoked a united response between scientists and government leading to the enrichment of flour, the development of school lunch programs, and advancements of nutritional education in this country.

In the latter part of the twentieth century nutritional scientists, public health organizations, and the American public increasingly recognized that eating too much of certain foods is linked to chronic diseases. We now know that diet-related conditions and diseases include hypertension (high blood pressure), obesity, Type 2 diabetes, cardiovascular disease, some cancers, and osteoporosis. These diet-related conditions and diseases are some of the biggest killers of Americans. The HHS reports that unhealthy diets and inactivity cause between 310,000 and 580,000 deaths every single year.

Calories

As previously stated, many of the health issues associated with poor eating habits are a result of an energy imbalance. Most Americans are obtaining more energy from food than they actually need to function in their daily lives. With a large percentage of Americans engaging in no physical activity, this excess of energy is stored as fat in the body. This food energy is measured in calories, also known as kilocalories (kcals). A kilocalorie is the amount of energy needed to raise 1 kilogram of water 1 degree Celsius, but food labels use the term calorie to describe the amount of energy in the individual foods described. The term calorie is used in this textbook to describe food energy.

Nutrients

Ideally, when we consume and obtain energy from our food, we will primarily eat nutrient dense foods. A nutrient is a compound that provides a needed function in the body. Nutrients can be further classified based on the amount needed in the body. The six Essential Nutrients are the nutrients that our bodies need in order to survive. They can be broken into two categories: macronutrients and micronutrients.

Macronutrients are nutrients needed in larger amounts. There are four macronutrients which include:

- Carbohydrates: 4 calories per gram
- Fats (lipids): 9 calories per gram

- Protein: 4 calories per gram
- Water: contains 0 calories

Note: *As can be seen, carbohydrates, protein, and fats provide energy. However, there is another energy source in the diet that is not a nutrient- alcohol.*

Alcohol is NOT a nutrient! But it does provide energy. Alcohol has 7 calories per gram.

Micronutrients are nutrients needed in smaller amounts, but they are still considered essential. There are two groups of micronutrients which are:

- Vitamins
- Minerals

Carbohydrates

Carbohydrates are a diverse group of compounds that have a multitude of effects in the body and are the primary form of energy for activities of daily living. The name carbohydrate means “hydrated carbon” or carbon with water. Thus, it isn’t a surprise that carbohydrates are made up of carbon, hydrogen, and oxygen. Sucrose (table sugar) is an example of a commonly consumed carbohydrate. Although grains and starchy foods are most often associated with carbohydrates, almost all foods do contain some carbohydrates. Some dietary examples of carbohydrate rich foods are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta. There are many different types of carbohydrates, but the three main types are: simple, complex, and alternative sugar sweeteners.

Simple Carbohydrates

Simple carbohydrates contain one molecule called monosaccharides, and double molecules are called disaccharides.

Monosaccharides

Monosaccharides are: glucose (a major source of energy in our bodies), fructose (commonly found in fruits and used commercially in many beverages), and galactose (not normally found in nature alone but found in the disaccharide called lactose).

Monosaccharides are sweet foods such as honey and cane sugar. Other foods that contain simple sugars are dairy products, beans, and fruit.

Disaccharides

Disaccharides are: sucrose (table sugar), lactose (milk sugar), maltose (malt sugar). Disaccharides are in beverages and baked goods. They are refined for making brown sugar, powdered sugar, and molasses. Lactose is in dairy products such as cheese, yogurt, and ice cream. Maltose is found in beer and some breads and grains.

Food manufacturers are always searching for cheaper ways to produce their food. One method that has been popular is the use of high-fructose corn syrup as an alternative to sucrose (table sugar). High-fructose corn syrup contains 55% fructose which is similar to sucrose. Nevertheless, because an increase in high-fructose corn syrup consumption has coincided with the increase of obesity in the US, there is a lot of controversy surrounding its use. In reading labels, one will usually see high-fructose corn syrup plus other sugars listed which could be adding to the obesity epidemic.

Complex Carbohydrates

Complex Carbohydrates contain many sugar molecules while simple carbohydrates contain only one or two sugars. Complex Carbohydrates are called polysaccharides. Poly means “many,” and thus polysaccharides are made of more than 10 sugar molecules. (Monosaccharides are the simplest forms of sugar meaning one molecule.) There are three classes of polysaccharides: starch, glycogen, and most fibers.

Starch

Starch is the storage form of glucose in plants. Glucose is a single sugar used in both plant and animal tissues for energy. It is the main source of fuel for the cells. After cooking, starch becomes digestible for humans. Raw starch may resist digestion. Examples

of starch foods are corn, potatoes, rice, beans, pasta, and grains.

Glycogen

Glycogen is made up of many glucose units (single sugar). It is made and stored by the liver and muscle tissues of humans. It is not considered a complex carbohydrate in foods.

Fiber

Fiber is indigestible matter that survives digestion in the small intestine and then reaches the large intestine. It is divided into two categories: soluble and insoluble. Soluble means it can be dissolved in water, and insoluble means it does not dissolve in water.

- ***Soluble fibers are fermentable fibers. It is believed that these fibers decrease blood cholesterol and sugar levels thus lowering the risk of heart disease and diabetes II.***
- ***Insoluble fibers are non-fermentable, and it is believed that this type of fiber decreases the risk of constipation and colon cancer because it increases stool bulk and reduces transit time. This reduced transit time means shorter exposure to consumed carcinogens in the intestine which may lower cancer risk.***

The goal for a day's fiber intake is 25-40 grams depending on one's caloric intake. Suggestions would be to buy high fiber foods. Read the Nutrition Facts' label for how much fiber is in the product for one serving. Drink lots of fluids when eating fiber. Try to eat a minimum of five plant foods for fiber each day.

Alternative Sweeteners

Alternative sweeteners are simply alternatives to sucrose (table sugar) and other monosaccharides and disaccharides that provide sweetness. There are basically two categories: sugar alcohol and commonly used alternative sweeteners.

Sugar alcohol

Sugar alcohol can provide some calories but do not contribute to tooth decay. Sugar alcohols are also known as "sugar replacers." Some people get confused by the name sugar alcohol thinking it is a sweet alcoholic beverage. It is not alcohol. Another name for sugar alcohols is a nutritive sweetener. Sugar alcohols are almost as sweet as sucrose (table sugar) but only provide approximately half the calories.

The major advantage of sugar alcohols over sucrose is that sugar alcohols are not fermented by bacteria on the tooth surface which causes less tooth decay. Sugar alcohols are listed on the Nutrition Facts' label.

Other Alternative Sweeteners

Other Alternative Sweeteners have been developed to provide zero-calorie or low-calorie sweetening for foods and drinks. Because many of these provide little to no calories, these sweeteners are also referred to as non-nutritive sweeteners. (The FDA is using high-intensity sweeteners to describe these products.)

Fats (Lipids)

Lipids, commonly referred to as fats, have a poor reputation among most people. "Fat free" labeling on packaging is often perceived as healthy. We do need to consume certain fats, and we should try to incorporate these fats into our diets for their health benefits. However, consumption of certain fats is also associated with a greater risk of developing chronic disease(s). There are different categories of lipids:

- Triglycerides
- Oils
- Cholesterol

These compounds are grouped together because of their structural and physical similarities. All lipids are insoluble in water, are oily to the touch, and together with carbohydrates and proteins constitute the principal structural material of the body.

Triglycerides

Triglycerides (triacylglycerols or TAG's) are molecules made of glycerol and fatty acids. They are the major form of energy storage in animals. Saturated fatty acids have higher melting point than unsaturated fatty acids because they are more dense (they have more hydrogen and fewer double bonds). Animal fats usually contain more saturated fatty acids than do vegetable oils. Therefore the melting points of animal fats are higher than those of vegetable oils.

Triglycerides are the most common lipid in our bodies and in the foods we consume. Fatty acids are not typically found free in nature; instead they are found in triglycerides. Breaking down the name triglyceride tells a lot about its structure. "Tri" refers the three fatty acids; "glyceride" refers to the glycerol backbone that the 3 fatty acids are bonded to. Triglycerides perform the following functions in our bodies:

- Provide energy
- Primary form of energy storage in the body
- Insulate and protect
- Aid in the absorption and transport of fat-soluble vitamins.

Structures of Fatty Acids

Fatty acids are components of triglycerides. They are like the brick in a brick wall. Each individual brick is needed to make the overall wall. There are two basic types of fatty acids:

- saturated fatty acid
- unsaturated fatty acid

These molecules differ in structure and food sources. Saturated fats are typically found in animal products such as poultry, meat and dairy and are solid at room temperature. Unsaturated fats are typically found in plants and vegetable oils and are liquid at room temperature. There are also monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (MUFAs), which appear to have a healthy affect on cholesterol levels.

There are two essential fatty acids, which are:

- linoleic acid (omega-6)
- alpha-linolenic (omega-3)

These fatty acids are essential because the body cannot synthesize them. The essential fatty acids are critical to human health as they play important roles in every system of the body.

Good food sources of omega-6 include whole grains, fresh fruits and veggies, fish, olive oil, and garlic. Good food sources of omega-3 include flax seed, egg yolk, and chia seeds.

Trans-fatty acids

Trans-fatty acids – like Crisco- are hydrogenated vegetable oils. In an artificial chemical process hydrogen is added to natural vegetable oils to make them more solid at room temperature, and more heat resistant for cooking. Hydrogenated oils are more resistant to heat degradation. The body doesn't have an efficient process for using trans-fats, so they get stored for the long term. The U.S. Food and Drug Administration have determined that trans-fatty acids are no longer safe for human consumption and currently being removed from our food supply.

Food Sources of Fatty Acids

The figure below shows the fatty acid composition of certain oils and oil-based foods. As can be seen, most foods contain a mixture of fatty acids. Stick margarine is the only product in the figure that contains an appreciable amount of trans fatty acids. Corn, walnut, and soybean are rich sources of omega-6 polyunsaturated fatty acids while flax seed is fairly unique among plants in that it is a good source of omega-3 polyunsaturated fatty acids. Canola and olive oil are rich sources of monounsaturated fatty acids. Lard, palm oil, butter and coconut oil all contain a significant amount of saturated fatty acids.

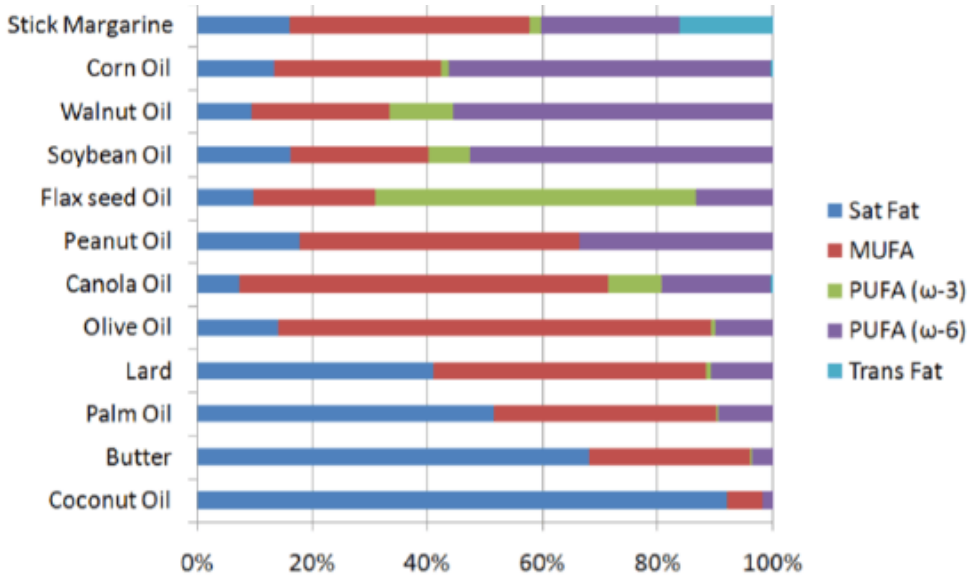


Figure 4.9.1.1. Different Types of Fat

Cholesterol

Cholesterol is a type of lipid found in the blood and in the diet. It has many functions and is a structural part of all body cells. It is an essential component of brain and nerve tissue. Cholesterol is needed to form hormones, bile, and vitamin D. Many foods contain cholesterol, but primarily it is found in foods of animal origin. Some meats are higher in cholesterol than others.

The body needs cholesterol, but it produces all of the cholesterol that it needs. It is almost impossible to avoid consuming outside sources of cholesterol, but it is possible and advisable to limit cholesterol intake by avoiding foods high in cholesterol. Elevated levels of LDL in the blood can increase the risk of artery and heart disease.

The human body produces two types of cholesterol: low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

LDL: The Bad Cholesterol

LDL is cholesterol that usually enters the human body through consuming food that contains cholesterol. LDL is considered the "bad cholesterol" because it bonds with triglycerides, another lipid, and stores it within the tissues. This is the leading cause of plaque in the arteries and can lead to restricted blood flow and possible cardiac arrest. This process takes place over several years with continuous eating of saturated fats, smoking, diabetes, and high blood pressure.



Figure 4.9.1.2. Blood flow restricted by the buildup of LDL cholesterol

Cholesterol plaque in the artery

HDL: The Good Cholesterol

HDL is produced when a person exercises, and it is considered the “good cholesterol.” HDL also bonds with triglycerides, but it is then processed by the body, added to feces, and expelled through the colon. In other words, HDL helps the body to process excess triglycerides thus managing the amount of excess fat in the overall system. The best way to increase HDL in the body is to exercise regularly.

Lipid Panel

A Lipid Panel is series of tests that measures the amount of cholesterol in the blood. A small sample of blood is drawn from the patient for this test. One number is for “total cholesterol.” This number will show the total fats in the blood. The HDL will show the good fats; LDL will show the bad fats; Triglycerides will show good or bad fats depending on the number above or below 150.

Adult Blood Cholesterol and Triglyceride Target Numbers:

- Total Cholesterol < 200 mg/dl
- Total HDL > 35
- Total LDL < 100
- Total Triglycerides < 150

Proteins

Proteins are another major macronutrient. They are similar to carbohydrates in that they are made up of small repeating units, but instead of sugars, proteins are made up of amino acids. Protein makes up approximately 20 percent of the human body and is present in every single cell. The word protein is a Greek word, meaning “of utmost importance.” Proteins are called the workhorses of life as they provide the body with structure and perform a vast array of functions. You can stand, walk, run, skate, swim, and more because of your protein-rich muscles. Protein is necessary for proper immune system function, digestion, and hair and nail growth, and is involved in numerous other body functions. In fact, it is estimated that more than one hundred thousand different proteins exist within the human body.

What Is Protein?

Proteins, simply put, are macromolecules composed of amino acids. **Amino acids** are commonly called protein’s building blocks. Proteins are crucial for the nourishment, renewal, and continuance of life. Proteins contain the elements carbon, hydrogen, and oxygen just as carbohydrates and lipids do, but proteins are the only macronutrient that contains nitrogen. In each amino acid the elements are arranged into a specific conformation around a carbon center. Each amino acid consists of a central carbon atom connected to a side chain, a hydrogen, a nitrogen-containing *amino* group, a carboxylic *acid* group—hence the name “amino acid.” Amino acids differ from each other by which specific side chain is bonded to the carbon center.

The functions of proteins are very diverse because there are 20 distinct amino acids that form long chains. For example, proteins can function as enzymes or hormones. Enzymes, one type of protein, are produced by living cells and are catalysts in biochemical reactions (like digestion). Enzymes can function to break molecular bonds, to rearrange bonds, or to form new bonds. An example of an enzyme is salivary amylase which breaks down amylose, a component of starch.

Amino Acids Function

Amino acids are combined in order to form all of the protein the human body needs. In fact, the body makes proteins itself, but it needs amino acids from food to construct proteins that the body uses. Antibodies, enzymes, muscle proteins, as well as proteins in the skin are all made up of amino acids, some that the body produces and some that must be consumed.

Non-Essential Amino

Acids Amino acids that the body produces are called non-essential amino acids. There are eleven non-essential amino acids: alanine, arginine, asparagine, aspartate, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine.

Essential Amino Acids

In Nutrition the term essential is used to name nutrients that the body doesn't produce itself; essential nutrients including essential amino acids must be consumed. There are nine essential amino acids: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

Complete and Incomplete Proteins

As a way of simplifying protein, sources are described as either complete or incomplete. Complete proteins – such as eggs, tuna fish, peanut butter, almonds – contain most if not all of the essential amino acids. Incomplete proteins – such as spinach, beans, wheat germ – contain just a few of the essential amino acids.

Most plant-based proteins are categorized as incomplete proteins, but vegetarians should not be concerned about protein intake because a person can consume all of the essential amino acids by combining food sources. For example a person can eat beans and quinoa with a spinach salad and consume the essential amino acids.

Water

Water is made up of hydrogen and oxygen (H_2O) and is the only macronutrient that doesn't provide energy. Humans are 65% water! The body needs water to regulate temperature, moisten tissues in the mouth, eyes, and nose, lubricate joints, protect organs, prevent constipation, reduce the burden on kidneys and liver by helping to flush out waste, and to dissolve nutrients as part of the digestive process.

Although a person can survive for several weeks without food, the body cannot survive longer than a few days without fluids. A loss of water equivalent to:

- 1% of body weight is enough to cause thirst and to impact the ability to concentrate
- 4% loss of hydration results in dizziness and reduced muscle power;
- 6% loss of fluids causes the heart to race and sweating ceases;
- 7% loss of hydration results in collapse and subsequent death if fluids are not replaced.

Water Intake

Table 4.9.1.1

Food	Water Content (%)
lettuce	95
carrots	90
boiled potatoes	80
grapes	80
lentil soup	78
grilled oily fish	65
cooked meats	60
potato chips	52
white bread	37
cheddar cheese	36
cake	15
semi-sweet cookies	2.5
cornflakes	3

In a normal diet, fluid is gained via food as well as in drinks. Along with water, most drinks such as tea, coffee, juices, and milk hydrate the body. However, alcoholic drinks may not contribute to body fluids as alcohol is a diuretic, a substance that increases the output of urine by the body. Caffeine, such as found in energy drinks, coffee, tea, and sodas, is also a diuretic. Caffeine has

also been shown to have an impact on overall hydration, but significant amounts (300+ mg) are typically necessary to exhibit negative effects on the body.

The amounts of water in different foods vary.

- Water Content of Specific Foods

Water Loss

Fluid loss occurs in various ways throughout the body with urination being the primary method. While the elimination of the urine is periodic, the formation of urine constantly occurs. Urination not only removes excess water from the body but also rids the body of nitrogen-containing compounds and other wastes. A "typical" urine output is approximately 1.5 liters daily.

Perspiration (sweating) also removes fluid from the body. When body temperature rises, fluids are secreted through sweat glands to the surface of the skin. This fluid then evaporates which has a cooling effect and reduces overall body temperature. A typical loss of water through sweating is about 0.5 liters per day. With hot weather, exercise, or physical activity, water loss can increase to 2 liters per hour.

Because urine output and sweating are conscious and measurable methods of fluid loss, they are called "sensible" losses.

The body can also exhibit fluid losses in what are termed "insensible losses." Insensible water loss is constantly occurring every minute of every day. These losses are neither consciously felt nor measurable. These include events such as breathing (our expelled breath contains moisture) and defecation (feces also contain water).

As can be seen by the above information, water intake and water loss should be balanced in order to prevent dehydration and to maintain a healthy body. The recommended daily **intake** is 10-13 cups of fluid from food and drink for adult males and 7-9 cups of fluid for adult females.

Vitamins

Vitamins are organic compounds that are essential for normal physiologic processes in the body. Before their detailed chemical structures were known, vitamins were named by being given a letter. They are generally still referred to by that letter as well as by their chemical name, for example, vitamin C or ascorbic acid.

Vitamins: Water-Soluble or Fat-Soluble

Vitamins are categorized as either water-soluble or fat-soluble based on how they are dissolved in the body. Water soluble vitamins are dissolved in water and absorbed during digestion. Excess water-soluble vitamins are excreted through urine. Fat-soluble vitamins are absorbed through the digestive process with the help of fats (lipids). Excess fat-soluble vitamins can build up in the body and become toxic. Vitamin supplements can be dangerous particularly with fat-soluble vitamins because people can overdose. A balanced diet includes all of the vitamins and minerals a person needs daily.

Water-Soluble Vitamins

There are nine water-soluble vitamins: Vitamin C, and eight Vitamin B's.

Fat-Soluble Vitamins

There are four fat-soluble vitamins: Vitamins A, D, E, and K.

Minerals

Minerals are essential, non-caloric nutrients that are in all of our food and are essential for normal physiologic processes in the body. Minerals are micronutrients, which means humans only need to eat them in small quantities. Minerals assist body functions that range from bone strength to regulating your heartbeat.

When plants take up the water through their roots, dissolved minerals from within the soil are absorbed by the plant. When people eat plants, they are likely ingesting minerals found in the plant. Animals are able to concentrate minerals in their tissues, so meats

and other foods derived from animals often contain a higher concentration of minerals.

There are two categories of minerals: major minerals and trace minerals. The classification of a mineral as major or trace depends on how much of the mineral the body needs.

Major minerals include:

- Calcium
- Phosphorus
- Sodium
- Potassium
- Magnesium

Trace minerals include:

- Iron
- Fluoride
- Zinc
- Copper
- Iodine
- Manganese
- Chloride
- Selenium

Vitamin and Mineral Supplements

Vitamin and mineral supplements exist, but are not as effective as getting minerals from whole foods. There are two types of supplement: whole food supplements and synthetic supplements.

Whole food supplements are produced by taking vitamins and minerals straight from natural sources: soil, rocks, or plant/food sources; whereas, synthetic minerals are made in a lab. While synthetic mineral supplements mimic the chemical structure of vitamins and minerals, they are probably not exact copies. That means the body may not recognize the synthetic mineral structure and does not absorb the mineral efficiently. No supplements, including vitamins and minerals, are approved by the FDA. Only prescription drugs are approved by the FDA. A healthy balanced diet can provide all the vitamins and minerals needed.

Food and Metabolism

The amount of energy that is needed or ingested per day is measured in calories. A calorie is the amount of heat it takes to raise 1 g of water by 1 °C. On average, a person needs 1500 to 2000 calories per day to sustain (or carry out) daily activities. The total number of calories needed by one person is dependent on his/her body mass, age, height, gender, activity level, and the amount of exercise per day. If exercise is a regular part of one's day, more calories are required. As a rule, people underestimate the number of calories ingested and overestimate the amount they burn through exercise. This can lead to ingestion of too many calories per day. The accumulation of an extra 3500 calories adds one pound of weight. If an excess of 200 calories per day is ingested, one extra pound of body weight will be gained every 18 days. At that rate, an extra 20 pounds can be gained over the course of a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns almost 100 calories.

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. In fact, the breakdown of carbohydrates requires the least amount of energy; whereas, the processing of proteins demands the most energy. In general, the amount of calories ingested and the amount of calories burned determines the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything one ingests, so when considering calorie intake, beverages must also be considered. Metabolic rates and calorie requirements will be discussed in further detail in the weight management chapter.

MyPlate

To help provide guidelines regarding the types and quantities of food that should be eaten every day, the U.S. Department of

Agriculture (USDA) has updated its food guidelines from MyPyramid to MyPlate. It has put the recommended elements of a healthy meal into the context of a place setting of food. MyPlate categorizes food into the standard six food groups: fruits, vegetables, grains, protein foods, dairy, and oils. The accompanying website gives clear recommendations regarding quantity and type of each food that one should consume each day as well as identifying which foods belong in each category. The accompanying graphic gives a clear visual with general recommendations for a healthy and balanced meal. The guidelines recommend to “Make half your plate fruits and vegetables.” The other half is grains and protein with a slightly higher quantity of grains than protein. Dairy products are represented by a drink, but the quantity can be applied to other dairy products as well.



Figure 4.9.1.3. MyPlate

ChooseMyPlate.gov provides extensive online resources for planning a healthy diet and lifestyle including offering weight management tips and recommendations for physical activity. It also includes the SuperTracker, a web-based application to help analyze one’s diet and physical activity.

FYI: Obesity in the United States is an epidemic. IN 2010, the U.S. Centers for Disease Control and Prevention reported that nearly 36 percent of adults over 20 years old were obese and an additional 33 percent were overweight leaving only about 30 percent of the population at a healthy weight. Research has shown that losing weight can help reduce or reverse the complications associated with obesity. The data and health issues associated with being overweight and obese will be discussed further in the weight management chapter.

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4.9.2: Planning a Diet

The definition of diet is anything that is consumed by a particular person or people on a regular basis. That means if someone routinely drinks coffee in the morning, that is part of his/her diet. If a person consistently eats a Big Mac from McDonald's, that is part of his/her diet. However, it is clear that food choices influence short-term and long-term health. That is why it is so important to make wise choices in what one eats on a regular basis. If a person chooses to have a diet high in calories without balancing energy use, that person can expect to put on unhealthy weight. A diet that is high in fiber, with the appropriate amount of calories and proper amounts of the macronutrients, will contribute to a healthy body.

When people discuss "going on a diet," they are actually talking about changing their existing dietary habits in order to change their body shape. All people are "on a diet" because everyone eats! Many times, the term diet is thought of as a method to lose weight or to change body shape. However, it is important to focus on the nutritional concepts listed below, so long-term health can be achieved.

Decisions about nutrition can be difficult. Knowing and using scientific research can lead to better health. Over time public health organizations have developed tools based on nutritional science to help people design healthy diets. These tools should be used as guidelines for each individual with the awareness that everyone is different and therefore has different needs. Everyone, regardless of age, size, shape, physique, can benefit from learning and utilizing the following tools:

Acceptable Macronutrient Distribution Range (AMDR)

The AMDR describes the proportions of daily caloric intake that should be carbohydrates, lipids, and proteins. Basically the AMDR provides guidelines on how many macronutrient calories one should consume a day.

According to the AMDR, the range of caloric intake in a daily diet should be:

- Carbohydrates: 45-65%
- Lipids: 20-35%
- Proteins: 10-35%

Dietary Reference Intakes (DRI)

The DRI's are reference values of nutrient intake that help with nutrition planning and assessment of healthy individuals. There are four measures that together comprise the DRI:

- Recommended Dietary Allowance (RDA): the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (about 97%) healthy individuals in a group. This is the basic quantity of a nutrient recommended.
- Adequate Intake (AI): a value based on observed or experimentally determined approximations of nutrient intake by a group (or groups) of healthy people—used when an RDA cannot be determined. This is the minimum amount of a nutrient needed for maintaining health.
- Tolerable Upper Intake Level (UL): the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects increases. This is the maximum that would be consumed prior to developing negative effects of eating too much. This is not a level that is met, but rather one that is avoided to prevent a decrease in health.
- Estimated Average Requirement (EAR): a nutrient intake value that is estimated to meet the requirement of half the healthy individuals in a group. These nutrient values should be used as goals for dietary intake for health.

4 Key Concepts for Personalizing a Healthy Diet

Personalizing meal plans can be extremely beneficial psychologically as well as physically. Knowing that one is eating healthy reduces some of the subconscious doubts about doing what needs to be done to be well. However, as with every healthy practice, there can be pitfalls. To help avoid these, there are 4 approaches that can be taken:

1. Assessing and changing your diet

2. Staying committed to a healthy diet
3. Try additions and substitutions to bring your current diet closer to your goals
4. Plan ahead for challenging situations

Planning Healthy Meals

Individual requirements for nutrients vary considerably depending on factors such as age and gender. Other relevant factors are size, metabolic rate, and occupation. A farmer would have a different dietary need than someone in a sedentary occupation. The body also has stores of certain nutrients (fat-soluble vitamins, for example) so that variations in daily intake of such nutrients can be accommodated. Thus it could be misleading to recommend a particular daily intake level.

When considering dietary needs, various techniques have been established by health officials to assist people in choosing foods and food amounts wisely. Choose My Plate is a graphic representation of what a healthy plate of food might look like. Other tools, such as meal planning guides have also been established.

Nutrition Labels

Perhaps one of the most effective tools provided to consumers is the nutrition label that is by law on all food packaging. This information can be useful for evaluating the nutrient content of food and planning healthy meals.

Understanding Food Labels

In the United States, the Food and Drug Administration (FDA) requires packaged foods to have a label that helps consumers make educated decisions about the foods they purchase. The label provides caloric, macronutrient, and some micronutrient content of the food. Labels also indicate ingredients and manufacturer information.

Understanding the information on food labels can lead to healthy choices about food. This page will outline how to interpret food labels.

FYI: Food labels do not provide all nutritional information; they just include the basics to help consumers make healthy food decisions.

Information On Food Labels

- **Name of product:** Sometimes the name of the product includes important information. For example some brands are vegetarian, kosher, gluten-free, etc. It is also important to compare/contrast ingredients in generic and brand name foods
- **Serving Size:** It's important to pay attention to how many servings a package contains. Many packages contain multiple servings.

Figure 4.9.2.1. Using your hand to determine serving size

- **Calories:** Pay attention to whether the caloric content of the food is per serving or per package. Also, some food labels indicate calories before or after preparation.
- **Fats:** The food label includes all fats. Note that the label indicates different types of fats. A later chapter will address different fats and how they are important in human nutrition.
- **Cholesterol:** Dietary cholesterol is a major factor in cardiovascular health. Limiting the intake of cholesterol can prevent heart disease.
- **Sodium:** Another major factor in promoting good health is limiting the amount of sodium intake.
- **Carbohydrates:** The food label includes simple and complex carbohydrates. Note that the label indicates different types of carbohydrates; a later chapter will address these and how they are important in human nutrition.
- **Proteins:** Protein intake needs to be carefully monitored because over or under consumption of protein can cause severe issues.
- **Vitamins and Minerals:** There are four vitamins and minerals (Vitamin D, Calcium, Iron, and Potassium) that are required on food labels; however, the label might include more than these four.
- **Ingredients:** The ingredients are listed in order of their content per volume. If sugar is listed as the first ingredient, there is more sugar in the food than any other ingredient. The last ingredient has the least amount in the food.
- **Name of manufacturer:** In addition to the Nutrition Facts, the food label includes the name and contact information for the

manufacturer as required by law.
- **Allergens:** Food manufacturers are required to draw specific attention to common allergens such as nuts, milk products, soy, etc. There is no specific location for allergen information, but it should be someplace on the packaging.

Figure 4.9.2.2. *Nutrition Facts*

To learn additional details about all of the information contained within the Nutrition Facts panel, see the following website:www.fda.gov/Food/ResourcesFor.../ucm274593.htm

Finding Quality Nutrition Research

"New study shows that margarine contributes to arterial plaque." "Asian study reveals that two cups of coffee per day can have detrimental effects on the nervous system." How do you react when you read news of this nature? Do you boycott margarine and coffee? When reading nutrition-related claims, articles, websites, or advertisements always remember that one study does not substantiate a fact. One study neither proves nor disproves anything. Readers who may be looking for complex answers to nutritional dilemmas can quickly misconstrue such statements and be led down a path of misinformation. Listed below are ways that you can develop discerning eyes when reading nutritional news.

- The scientific study under discussion should be published in a peer-reviewed journal, such as the *Journal of the International Society of Sports Nutrition*. Question studies that come from less trustworthy sources (such as non peer-reviewed journals or websites) or that are not published.
- The report should disclose the methods used by the researcher(s). Did the study last for three or thirty weeks? Were there ten or one hundred participants? What did the participants actually do? Did the researcher(s) observe the results themselves or did they rely on self -reports from program participants?
- Who were the subjects of this study? Humans or animals? If human, are any traits/characteristics noted? You may realize you have more in common with certain program participants and can use that as a basis to gauge if the study applies to you.
- Credible reports often disseminate new findings in the context of previous research. A single study on its own gives you very limited information, but if a body of literature supports a finding, it gives you more confidence in it.
- Peer-reviewed articles deliver a broad perspective and are inclusive of findings of many studies on the exact same subject.
- When reading such news, ask yourself, "Is this making sense?" Even if coffee does adversely affect the nervous system, do you drink enough of it to see any negative effects? Remember, if a headline professes a new remedy for a nutrition-related topic, it may well be a research-supported piece of news, but more often than not it is a sensational story designed to catch the attention of an unsuspecting consumer. Track down the original journal article to see if it really supports the conclusions being drawn in the news report.

When reading information on websites, remember the following criteria for discerning if the site is valid:

- Who sponsors the website?
- Are names and credentials disclosed?
- Is an editorial board identified?
- Does the site contain links to other credible informational websites? Even better, does it reference peer-reviewed journal articles? If so, do those journal articles actually back up the claims being made on the website?
- How often is the website updated?
- Are you being sold something at this website?
- Does the website charge a fee?

Trustworthy Sources

Now let's consider some reputable organizations and websites from which you can obtain valid nutrition information.

Organizations Active in Nutrition Policy and Research

1. **US Department of Agriculture Food and Nutrition Information Center.** The USDA site fnic.nal.usda.gov has more than twenty-five hundred links to dietary, nutrition, diet and disease, weight and obesity, food-safety and food-labeling, packaging, dietary supplement and consumer questions sites. Using this interactive site, you can find tips and resources on how to eat a healthy diet, my Foodapedia, and a food planner, among other sections.
2. **The Academy of Nutrition and Dietetics (AND).** The AND promotes scientific evidenced-based, research-supported food

and nutrition related information on its website, http://www.eatright.org. It is focused on informing the public about recent scientific discoveries and studies, weightloss concerns, food safety topics, nutrition issues, and disease prevention.

3. **Department of Health and Human Services.** The HHS website, HealthFinder.gov, provides credible information about healthful lifestyles and the latest in health news. A variety of online tools are available to assist with food-planning, weight maintenance, physical activity, and dietary goals. You can also find healthful tips for all age groups, tips for preventing disease, and on daily health issues in general.
4. **Centers for Disease Control and Prevention.** The Centers for Disease Control and Prevention (http://www.cdc.gov) distributes an online newsletter called CDC Vital Signs. This newsletter is a valid and credible source for up-to-date public health information and data regarding food, nutrition, cholesterol, high blood pressure, obesity, teenage drinking, and tobacco usage.
5. **Dietitians of Canada.** Dietitians of Canada, http://www.dietitians.ca/, is the national professional association for dietitians. It provides trusted nutrition information to Canadians and health professionals.

Genetically Modified Foods

Genetically modified foods (also known as GM or GMO foods), are plants or animals that have undergone some form of genetic engineering. In the United States, much of the soybean, corn, and canola crop is genetically modified. The process involves the alteration of an organism's DNA, which allows farmers to cultivate plants with desirable characteristics.

For example, scientists could extract a gene that produces a chemical with antifreeze properties from a fish that lives in an arctic region (such as a flounder). They could then splice that gene into a completely different species, such as a tomato, to make it resistant to frost, which would enable farms to grow that crop year-round.

Certain modifications can be beneficial in resisting pests or pesticides, improving the ripening process, increasing the nutritional content of food, or providing resistance to common viruses. Although genetic engineering has improved productivity for farmers, it has also stirred up debate about consumer safety and environmental protection. Possible side effects related to the consumption of GM foods include an increase in allergenicity, or tendencies to provoke allergic reactions. There is also some concern related to the possible transfer of the genes used to create genetically engineered foods from plants to people. This could influence human health if antibiotic-resistant genes are transferred to the consumer. Therefore, the World Health Organization (WHO) and other groups have encouraged the use of genetic engineering without antibiotic-resistance genes. Genetically modified plants may adversely affect the environment as well and could lead to the contamination of non-genetically engineered organisms.

Genetically modified foods fall under the purview of the EPA, the USDA, and the FDA. Each agency has different responsibilities and concerns in the regulation of GM crops. The EPA ensures that pesticides used for GM plants are safe for the environment. The USDA makes sure genetically engineered seeds are safe for cultivation prior to planting. The FDA determines if foods made from GM plants are safe to eat. Although these agencies act independently, they work closely together and many products are reviewed by all three.

Organic food products

Organically produced foods have been cultivated or raised without synthetic pesticides, antibiotics, or genetic engineering. Certified organic foods can be identified by the USDA's stamp and is usually more expensive than conventionally produced foods. There have been a lot of questions about the nutritional superiority of organic foods over those traditionally produced. These questions do not have simple answers. Most studies differ substantially in their methodology and involve many different aspects of the food being studied. The USDA makes no claims that organic food is safer or more nutritious than conventionally produced food, and indeed many organic foods - e.g., milk, butter, ice cream, meat - are likely to match their conventional counterparts for fat and calories.

There are, however, specific health reasons that motivate shoppers to buy natural or organic, foods. For instance, people with food allergies, chemical allergies or intolerance to preservatives can substitute organic foods, personal care products and clothing. To reduce fat and cholesterol in their diets, consumers can replace meat with products made from organic soy, wheat or vegetables.

Some organic foods also have significantly higher levels of cancer- fighting antioxidants, according to a study of corn, strawberries and marionberries, which was published in Feb.26, 2003, in the Journal of Agriculture and Food Chemistry, a peer-reviewed publication of the American Chemical Society ("Bitter or Harsh Phenalics Guard the Plant Against These Pests").

Some officials say, however, that organic foods may at times 'be less safe than conventional foods. In October 2002, USDA's undersecretary for food safety warned that organic foods' lack of preservatives makes them vulnerable to bacteria and parasites.

The following month., the Institute of Food Technologies issued a release stating that organics "have the potential for greater pathogen contamination." Also in 2002, records from the U.S. Food and Drug Administration and Health Canada revealed that organic and all-natural products are eight times more likely to be recalled for safety problems, including bacterial contamination. Organic products are as safe as conventional ones, according to the ` Organic Trade Association. "Certified organic growers follow strict guidelines for safe and hygienic food production. As with all food producers, they must comply with local, state and federal health standards.

Dietary Food Trends

Hundreds of years ago, when food was less accessible and daily life required much more physical activity, people worried less about obesity and more about simply getting enough to eat. In today's industrialized nations, conveniences have solved some problems and introduced new ones, including the hand-in-hand obesity and diabetes epidemics. Fad diets gained popularity as more North Americans struggled with excess pounds. However, new evidence-based approaches that emphasize more holistic measures are on the rise. These new dietary trends encourage those seeking to lose weight to eat healthy, whole foods first, while adopting a more active lifestyle. These sound practices put dietary choices in the context of wellness and a healthier approach to life.

Functional Foods

Many people seek out foods that provide the greatest health benefits. This trend is giving rise to the idea of **functional foods**, which not only help meet basic nutritional needs but also are reported to fight illness and aging. According to the Academy of Nutrition and Dietetics (AND), formerly known as the The Academy of Nutrition and Dietetics, functional foods may reduce the risk of disease or promote optimal health. The AND recognizes four types of functional foods. They are: conventional foods, modified foods, medical foods, and special dietary use foods.

The first group, **conventional foods**, represents the simplest form of functional foods. They are whole foods that have not been modified. Examples include whole fruits and vegetables (which are abundant in phytochemicals and antioxidants), yogurt and kefir (which contain natural probiotic bacteria that can help maintain digestive system health), and dark chocolate (which contains antioxidants).

- **Modified foods** have been fortified, enriched, or enhanced with additional nutrients or bioactive compounds. Foods are modified using biotechnology to improve their nutritional value and health attributes. Examples of modified foods include calcium-fortified orange juice, breads enriched with B vitamins, iodized salt, cereals fortified with vitamins and minerals, margarine enhanced with plant sterols, and energy drinks that have been enriched with herbs (ginseng or guarana) or amino acids (taurine). It is important to consider that the health claims of some modified foods may be debatable, or entirely fraudulent. Check with a health professional regarding the effects of modified foods on your health.
- **Medical foods** are designed for enteric administration under the guidance of a medical professional. (During enteric administration, food is treated so that it goes through the stomach undigested. Instead, the food is broken down in the intestines only.) Medical foods are created to meet very specific nutritional requirements. Examples of medical foods include liquid formulas for people with kidney disease, liver disease, diabetes, or other health issues. Medical food is also given to comatose patients through a gastronomy tube because they cannot eat by mouth.
- **Special dietary use foods** do not have to be administered under a doctor's care and can be found in a variety of stores. Similar to medical foods, they address special dietary needs and meet the nutritional requirements of certain health conditions. For example, a bottled oral supplement administered under medical supervision is a medical food, but it becomes a special dietary use food when it is sold to retail customers. Examples of special dietary use foods include gluten-free foods, lactose-free dairy products, and formulas and shakes that promote weight loss.

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4.9.3: Popular Diets

The concept of functional foods represents initiatives aimed at addressing health problems. Certain diet plans take this concept one step further, by striving to prevent or treat specific conditions. For example, it is widely understood that people with diabetes need to follow a particular diet. Although some of these diet plans may be nutritionally sound, use caution because some diets may be fads or be so extreme that they actually *cause* health problems. Before experimenting with a diet, discuss your plans with your doctor or a registered dietitian. Throughout this section, we will discuss some of the more popular diets. Some fall under the category of fad diets, while others are backed by scientific evidence. Those that fall into the latter category provide a good foundation to build a solid regimen for optimal health.

The DASH Diet

The Dietary Approaches to Stop Hypertension, or DASH diet, focuses on reducing sodium intake to either 2,300 milligrams per day (as recommended by the *Dietary Guidelines for Americans*) or 1,500 milligrams per day. The DASH diet is an evidence-based eating plan that can help reduce high blood pressure. This plan may also decrease the risk of heart attack, stroke, diabetes, osteoporosis, and certain cancers. DASH tips to lower sodium include:

- Using spices instead of salt to add flavor
- Reading sodium content on processed or canned food labels, and choosing low-sodium options
- Removing some sodium from canned foods (such as beans) by rinsing the product before consumption
- Avoiding salt when cooking

DASH dieters eat lots of whole grains and high-fiber fruits and vegetables, and moderate amounts of low-fat dairy products, lean meats, and heart-healthy fish. In addition, DASH limits the use of saturated fats to less than 7 percent of total calories, and restricts the consumption of sweets and alcohol. The DASH diet also calls for consuming less added sugar and drinking fewer sugar-sweetened drinks. It replaces red meat with fish and legumes and calls for increased calcium, magnesium, potassium, and fiber. Also, even though some people on the DASH diet may find it lowers their HDL (good) cholesterol along with their LDL (bad) cholesterol, it still has a positive cumulative effect on heart health.

The Gluten-Free Diet

The gluten-free diet helps people whose bodies cannot tolerate **gluten**, a protein found in wheat, barley, and rye. One of the most important ways to treat this condition is to avoid the problematic foods, which is not easy. Although following a gluten-free diet is challenging, it is prescribed for patients with gluten intolerance and celiac disease, an autoimmune disorder with a genetic link. People who have celiac disease cannot consume gluten products without damaging their intestinal lining. Eating a gluten-free diet means finding replacements for bread, cereal, pasta, and more. It also means emphasizing fresh fruits, vegetables, and other foods without gluten. However, it is important to note that the gluten-free trend has become something of a fad even for those without a gluten intolerance. Celiac disease is a relatively rare condition found in only 1 percent of the population. Therefore, a gluten-free diet should be followed only with a physician's recommendation.

Low-Carb Diets

Low-carb diets, which include the Atkins Diet and the South Beach Diet, focus on limiting carbohydrates—such as grains, fruit, and starchy vegetables—to promote weight loss. The theory behind the low-carb diet is that insulin prevents the breakdown of fat by allowing sugar in the form of blood glucose to be used for energy. Proponents of this approach believe that because limiting carbs generally lowers insulin levels, it would then cause the body to burn stored fat instead. They believe this method not only brings about weight loss, but also reduces the risk factors for a number of conditions. However, some studies have shown that people who followed certain low-carb diet plans for two years lost an average of nearly 9 pounds, which is similar to the amount of weight lost on higher carbohydrate diets.

The benefits of this kind of diet include an emphasis on whole, unprocessed foods and a deemphasis of refined carbohydrates, such as white flour, white bread, and white sugar. However, there are a number of downsides. Typically, the first two weeks allow for only 20 grams of carbs per day, which can be dangerously low. In addition, dieters using the low-carb approach tend to consume

twice as many saturated fats as people on a diet high in healthy carbohydrates. Low-carb diets are also associated with a higher energy intake, and the notion that “calories don’t count,” which is prevalent in this kind of diet, is not supported by scientific evidence.

The Mediterranean Diet

The traditional Mediterranean diet incorporates many elements of the dietary choices of people living in Greece and southern Italy. The Mediterranean diet focuses on small portions of nutritionally-sound food. This diet features food from plant sources, including vegetables, fruits, whole grains, beans, nuts, seeds, breads and potatoes, and olive oil. It also restricts the consumption of processed foods and recommends eating locally grown foods rich in micronutrients and antioxidants. Other aspects of this eating plan include consuming fish and poultry at least twice per week, eating red meat only a few times per month, having up to seven eggs per week, and drinking red wine in moderation and with meals. Unlike most diets, the Mediterranean diet does not cut fat consumption across the board. Instead, it incorporates low-fat cheese and dairy products, and it substitutes olive oil, canola oil, and other healthy oils for butter and margarine.

More than fifty years of nutritional and epidemiological research has shown that people who follow the Mediterranean diet have some of the lowest rates of chronic disease and the highest rates of longevity among the populations of the world. Studies have shown that the Mediterranean diet also helps to decrease excess body weight, blood pressure, blood fats, and blood sugar and insulin levels significantly.

The Raw Food Diet

The raw food diet is followed by those who avoid cooking as much as possible in order to take advantage of the full nutrient content of foods. The principle behind **raw foodism** is that plant foods in their natural state are the most wholesome for the body. The raw food diet is not a weight-loss plan, it is a lifestyle choice. People who practice raw foodism eat only uncooked and non-processed foods, emphasizing whole fruits and vegetables. Staples of the raw food diet include whole grains, beans, dried fruits, seeds and nuts, seaweed, sprouts, and unprocessed produce. As a result, food preparation mostly involves peeling, chopping, blending, straining, and dehydrating fruits and vegetables.

The positive aspects of this eating method include consuming foods that are high in fiber and nutrients, and low in calories and saturated fat. However, the raw food diet offers little in the way of protein, dairy, or fats, which can cause deficiencies of the vitamins A, D, E, and K. In addition, not all foods are healthier uncooked, such as spinach and tomatoes. Also, cooking eliminates potentially harmful microorganisms that can cause foodborne illnesses.

Therefore, people who primarily eat raw foods should thoroughly clean all fruit and vegetables before eating them. Poultry and other meats should *always* be cooked before eating.

Vegetarian and Vegan Diets

Vegetarian and vegan diets have been followed for thousands of years for different reasons, including as part of a spiritual practice, to show respect for living things, for health reasons, or because of environmental concerns. For many people, being a vegetarian is a logical outgrowth of “thinking green.” When a food system is heavily focused on meat production there are deforestation issues, overgrazing of land and pasturage, and animal abuses. By avoiding animal flesh, vegetarians hope to look after their own health and that of the planet at the same time. Broadly speaking, vegetarians eat beans, grains, and fruits and vegetables, and do not eat red meat, poultry, seafood, or any other animal flesh. Some vegetarians, known as lactovegetarians, will eat dairy products. Others, known as lacto-ovo vegetarians, will eat dairy products and eggs. A vegan diet is the most restrictive vegetarian diet— vegans do not eat dairy, eggs, or other animal products, and some do not eat honey.

Vegetarian diets have a number of benefits. Well-balanced eating plans can lower the risk of a number of chronic conditions, including heart disease, diabetes, and obesity. They also help to promote sustainable agriculture. However, if a vegetarian does not vary his or her food choices, the diet may be insufficient in calcium, iron, omega-3 fatty acids, zinc, and vitamin B_{12}. Also, if people who follow these diets do not plan out their meals, they may gravitate toward foods high in fats.

Table 4.9.3.1 The Pros and Cons of Seven Popular Diets

Diet	Pros	Cons

DASH Diet	• Recommended by the National Heart, Lung, and Blood Institute, the American Heart Association, and many physicians • Helps to lower blood pressure and cholesterol • Reduces risk of heart disease and stroke • Reduces risk of certain cancers • Reduces diabetes risk	• There are very few negative factors associated with the DASH diet
Gluten-Free Diet	• Reduces the symptoms of gluten intolerance, such as chronic diarrhea, cramping, constipation, and bloating • Promotes healing of the small intestines for people with celiac disease, preventing malnutrition • May support weight loss • May be beneficial for other autoimmune diseases, such as Parkinson's disease, rheumatoid arthritis, and multiple sclerosis • May be helpful for Types 1 and 2 diabetes and anemia	• Risk of folate and iron deficiencies • Special gluten-free products can be hard to find and expensive • Requires constant vigilance and careful food label reading, since gluten is found in many products
Low-Carb Diet	• Restricts refined carbohydrates, such as white flour and white sugar • May temporarily improve blood sugar or blood cholesterol levels	• Not entirely evidence based • Results in higher fat and protein consumption
Mediterranean Diet	• A reduced risk of cardiovascular disease and mortality • A lower risk of cancer • De-emphasizes processed foods and emphasizes whole foods and healthy fats • Lower sodium intake, due to fewer processed foods • Emphasis on monosaturated fats leads to lower cholesterol • Highlighting fruits and vegetables raises consumption of antioxidants	• Does not specify daily serving amounts • Potential for high fat and high calorie intake as nuts and oils are calorie-dense foods • Drinking one to two glasses of wine per day may not be healthy for those with certain conditions
Raw Food Diet	• Emphasizes whole foods • Focuses on nutritionally-rich foods • High in fiber	• Not entirely evidence-based • Very restrictive and limits protein and healthy fat intake • Could encourage the development of foodborne illness • Extremely difficult to follow • Can cause deficiencies in essential vitamins
Vegetarianism and Veganism	• May reduce cancer risk • May reduce heart disease risk • May reduce obesity risk • May help prevent Type 2 diabetes • Helps with weight reduction and weight maintenance	• Guidelines regarding fat and nutrient consumption must be followed • Requires vigilance to watch out for hidden animal products • Requires negotiating meals and holidays with meat-eating friends and family

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4.9.4: Food Supplements and Food Replacements

Current trends also include the use of supplementation to promote health and wellness. Vitamins, minerals, herbal remedies, and **supplements** of all kinds constitute big business and many of their advertising claims suggest that optimal health and eternal youth are just a pill away. The main types of dietary supplements are macronutrients (amino acids, proteins, essential fatty acids), micronutrients (vitamins and minerals that promote healthy body functions), probiotics (beneficial bacteria such as the kind found in the intestines), and herbal supplements, which often target a specific body part, such as bones.

Some public health officials recommend a daily multivitamin due to the poor diet of most North Americans. The US Preventive Task Force also recommends a level of folate intake which can be easier to achieve with a supplement. In addition, the following people may benefit from taking daily vitamin and mineral supplements:

- women who are pregnant or breast-feeding
- premenopausal women who may need extra calcium and iron
- older adults
- people with health issues that affect their ability to eat
- vegetarians, vegans, and others avoiding certain food groups

However, before you begin using dietary supplementation, consider that the word *supplement* denotes something added. Vitamins, minerals, and other assorted remedies should be considered as extras. They are add-ons—not replacements—for a healthy diet. As food naturally contains nutrients in its proper package, remember that food should always be your primary source of nutrients. When considering taking supplements, it is important to recognize possible drawbacks that are specific to each kind:

Micronutrient Supplements.

Some vitamins and minerals are toxic at high doses. Therefore, it is vital to adhere to the Tolerable Upper Intake Levels (UL) so as not to consume too much of any vitamin. For example, too much vitamin A is toxic to the liver. Symptoms of vitamin A toxicity can include tinnitus (ringing in the ears), blurred vision, hair loss, and skin rash. Too much niacin can cause a peptic ulcer, hyperglycemia, dizziness, and gout.

Herbal Supplements

Some herbs cause side effects, such as heart palpitations and high blood pressure, and must be taken very carefully. Also, some herbs have contraindications with certain medicines. For example, Valerian and St. John's Wort negatively interact with certain prescription medications, most notably antidepressants. Additionally, there is a real risk of overdosing on herbs because they do not come with warning labels or package inserts.

Amino Acid Supplements

Certain amino acid supplements, which are taken by bodybuilders among others, can increase the risk of consuming too much protein. An occasional amino acid drink in the place of a meal is not a problem. However, problems may arise if you add the supplement to your existing diet. Most Americans receive two to three times the amount of protein required on a daily basis from their existing diets—taking amino acid supplements just adds to the excess.

Supplement Claims and Restrictions

The Food and Drug Administration (FDA) regulates supplements, but it treats them like food rather than pharmaceuticals. Dietary supplements must meet the FDA's Good Manufacturing Standards, but are not required to meet the standards for drugs, although some companies do so voluntarily. Also, although supplement manufacturers are allowed to say a particular ingredient may reduce the risk of a disease or disorder, or that it might specifically target certain body systems, these claims are not approved by the FDA. This is why labels that make structural and functional claims are required to carry a disclaimer saying the product is not intended "to diagnose, treat, cure, or prevent any disease." In addition, in the United States, supplements are taken off the market only after the FDA has proven that they are hazardous.

Before Taking Supplements

The phrase *caveat emptor* means “buyer beware,” and it is important to keep the term in mind when considering supplementation. Just because a product is “natural” that does not mean it can’t be harmful or dangerous, particularly if used inappropriately. The following are helpful questions to explore before deciding to take a supplement:

- Does the scientific community understand how this supplement works and are all its effects well known?
- Is there proof that the supplement actually performs in the manner that it claims?
- Does this supplement interact with food or medication?
- Is taking this supplement necessary for my health?
- Is the supplement affordable?
- Is the supplement safe and free from contaminants?

Lastly, please remember that a supplement is only as good as the diet that accompanies it. We cannot overstate the importance of eating a healthy, well-balanced diet designed to provide all of the necessary nutrients. Food contains many more beneficial substances, such as phytochemicals and fiber, that promote good health and cannot be duplicated with a pill or a regimen of supplements. Therefore, vitamins and other dietary supplements should never be a substitute for food. Nutrients should always be derived from food first.

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4.9.5: Food Safety

To minimize the risk of serious adverse health consequences or death from consumption of contaminated produce, the Food and Drug Administration (FDA) is establishing science-based minimum standards for the safe growing, harvesting, packing, and holding of produce, meaning fruits and vegetables grown for human consumption.

FDA is establishing these standards as part of implementation of the FDA Food Safety and Modernization Act. These standards do not apply to produce that is rarely consumed raw, produce for personal or on-farm consumption, or produce that is not a raw agricultural commodity. In addition, produce that receives commercial processing that adequately reduces the presence of microorganisms of public health significance is eligible for exemption from the requirements of this rule. The rule sets forth procedures, processes, and practices that minimize the risk of serious adverse health consequences or death, including those reasonably necessary to prevent the introduction of known or reasonably foreseeable biological hazards into or onto produce and to provide reasonable assurances that the produce is not adulterated on account of such hazards. The FDA expects the rule to reduce foodborne illness associated with the consumption of contaminated produce.

Foodborne Illnesses

While the American food supply is among the safest in the world, the Federal government estimates that there are about **48 million cases of foodborne illness annually**—the equivalent of sickening 1 in 6 Americans each year. Each year these illnesses result in an estimated 128,000 hospitalizations and 3,000 deaths. These cases have driven authorities to seriously consider methods and regulations that help prevent the spread of foodborne illness.

Food Handling

Most foodborne illnesses can be avoided if you take the following precautionary steps:

CLEAN: Always wash your food, hands, counters, and cooking tools.

- Wash hands in warm soapy water for at least 20 seconds (sing Happy Birthday while washing and the 20 seconds will be over). Do this before and after touching food.
- Wash cutting boards, dishes, forks, spoons, knives and counter tops with hot soapy water. Do this after working with each food item.
- Rinse fruits and veggies well
- Clean the lids on canned goods before opening.

SEPARATE (Keep Apart): Keep raw foods apart from other raw foods. Germs can spread from one food to another.

- Keep raw meat, poultry, seafood, and eggs away from other foods in the shopping cart, bags, and the refrigerator.
- Do not reuse marinades used on raw foods unless first brought to a boil first.
- Use a separate cutting board and utensils for raw meats, and a designated plate and clean utensils for raw foods. This prevents cross-contamination.

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5: SLEEP

5.1: Importance of Sleep
5.2: Sleep Stages

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5.1: Importance of Sleep

Sleep is an important part of your daily routine—you spend about one-third of your time doing it. It is estimated that about 1 in 3 adults, and even more adolescents, don't get enough sleep, which can affect their health and well-being. People who don't get enough sleep are more likely to have health problems like obesity, diabetes, heart disease, stroke, dementia, and cancer. They're also more likely to have trouble at work or school. In addition, about 100,000 motor vehicle crashes every year in the United States are related to drowsy driving. It is recognized that improving sleep habits and sleep environments can help people stay healthy and safe. Thus, is is not surprising that one of the goals of Healthy People 2030 is to improve health, productivity, well-being, quality of life, and safety by helping people get enough sleep.

Getting good sleep is not just about the quantity of sleep, but also the quality of sleep. Healthy sleep requires adequate duration, good quality, appropriate timing and regularity, and the absence of sleep disturbances or disorders.

Recommended Sleep Quantity

The American Academy of Sleep Medicine recommends that adults should sleep 7 hours or more per night on a regular basis to promote optimal health.

Table : How much sleep do I need?[7]

Age Group	Recommended Hours of Sleep Per Day
0–3 months	14–17 hours (National Sleep Foundation) No recommendation (American Academy of Sleep Medicine)
4–12 months	12–16 hours per 24 hours (including naps)
1–2 years	11–14 hours per 24 hours (including naps)
3–5 years	10–13 hours per 24 hours (including naps)
6–12 years	9–12 hours per 24 hours
13–18 years	8–10 hours per 24 hours
18–60 years	7 or more hours per night
61–64 years	7–9 hours
65 years and older	7–8 hours

Healthy Sleep Habits

Tips for healthy sleep habits[8] include:

- Keep a consistent sleep schedule. Get up at the same time every day, even on weekends or during vacations.
- Set a bedtime that is early enough for you to get at least 7-8 hours of sleep.
- Don't go to bed unless you are sleepy.
- If you don't fall asleep after 20 minutes, get out of bed. Go do a quiet activity without a lot of light exposure. It is especially important to not get on electronics.
- Establish a relaxing bedtime routine.
- Use your bed only for sleep and sex.
- Have a warm shower/bath or a cup of herbal tea
- Make your bedroom quiet and relaxing. Keep the room at a comfortable, cool temperature.
- Do your best to avoid having disruptive pets, children, partners sleep with you
- Make sure your room is pitch black or use a sleep mask over your eyes
- Limit exposure to bright light in the evenings.
- Turn off electronic devices at least 30 minutes before bedtime.

- Don't eat a large meal before bedtime. If you are hungry at night, eat a light, healthy snack.
- Exercise regularly and maintain a healthy diet.
  - The time we spend doing moderate to vigorous activity throughout or day will benefit our sleep. Strong evidence demonstrates that moderate-to-vigorous physical activity improves the quality of sleep in adults. It does so by reducing the length of time it takes to go to sleep and reducing the time one is awake after going to sleep and before rising in the morning. It also can increase the time in deep sleep and reduce daytime sleepiness. The improvements in sleep with regular physical activity are also reported by people with insomnia and obstructive sleep apnea. In children, the more they are sedentary the lower their sleep duration.
- Avoid consuming caffeine in the afternoon or evening.
- Avoid consuming alcohol before bedtime.
- Reduce your fluid intake before bedtime.

Understanding Sleep

The National Sleep Foundation provides helpful information about the basics of sleep including understanding circadian rhythms and the sleep cycle[9].

Major advances in sleep science have occurred over the past half-century since the discovery of rapid eye movement (REM) sleep in 1953[10].

Circadian Rhythm

Have you heard the term circadian rhythm? Circadian means "recurring naturally on a twenty-four-hour cycle, even in the absence of light fluctuations," it is sometimes called the "body clock." When we talk about circadian rhythms, it's mostly in relation to sleep.

Circadian rhythms are physical, mental, and behavioral changes that follow a 24-hour cycle. Your circadian rhythm is regulated by your bodies biological clock, which is an organisms' natural timing device. The master clock in the brain is a group of about 20,000 nerve cells (neurons) and coordinates all the biological clocks in a living thing, keeping the clocks in sync. Without the right signals from your body's internal master clock, you might not fall asleep, have fragmented or sleep poorly, or wake up too early and not be able to fall back to sleep.

Your body's biological clock produces circadian rhythms and regulates the timing of things in your body, like when you want to sleep or eat. Your circadian rhythm can influence important functions in your body such as releasing hormones, your eating habits, and your body temperature. For example, your digestive system produces proteins to make sure you eat on schedule, and the endocrine system regulates hormones to match your energy expenditures during the day.

Although natural factors in your body produce circadian rhythms, the environment, such as daylight, exercise, and temperature, also affect them. For example if you experience jet lag or change to working a night shift it could impact your light-dark cycle. The light from electronic devices at night can also confuse your biological clock and impact your circadian rhythm.

Sleep Stages (Sleep Cycle)

In 1953 there was a breakthrough in sleep science, this is when our understanding of what happens during sleep drastically changed. Prior to the 1950's it was thought that our brains just shutdown when we slept, however in the 19050's scientist learned that our brains do not shutdown, rather they cycle through several different stages of sleep. Dr. Nathaniel Kleitman was an American physiologist known as the Father of American sleep research, he and his students discovered what we now call REM sleep, or rapid eye movement sleep. Prior to the incredible work produced by Kleitman, it was thought that the brain and body were in a completely inactive state during sleep. It was discovered that over the course of one night, your body goes through the sleep stages every 90 minutes or so. Sleep stages last for different periods of time depending on the age of the sleeper, but generally speaking non-REM cycles are longer in the beginning of the night while REM cycles are longer later in the night.

There are two types of sleep: Non-REM and REM sleep. Non-REM sleep is furthered divided into three stages (stage 1, stage 2, stage 3) where distinct brain activity occurs. REM sleep involves more brain activity than Non-REM and is considered a more "wakeful" state, as your heart rate and blood pressure increase to levels close to what you experience when you are awake. While all sleep stages are important, Stage 3 and REM sleep have unique benefits. One to two hours of Stage 3 deep sleep per night

will keep the average adult feeling restored and healthy. If you're regularly waking up tired, it could be that you're not spending enough time in that deep sleep phase. Meanwhile, REM sleep helps your brain consolidate new information and maintain your mood – both critical for daily life. Talk to your health care provider if you feel you are not getting the restful sleep that you need.

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5.2: Sleep Stages

The Four Sleep Stages (cycles)

Stage 1 (Non-REM)
Stage 1 of the sleep cycle is the lightest phase of sleep and generally lasts about seven minutes. The sleeper is somewhat alert and can be woken up easily. During this stage, the heartbeat and breathing slow down while muscles begin to relax. The brain produces alpha and theta waves.

Stage 2 (Non-REM)
In Stage 2, the brain creates brief bursts of electrical activity known as “sleep spindles” that create a distinct sawtooth pattern on recordings of brain activity. Eventually, the waves continue to slow down. Stage 2 is still considered a light phase of sleep, but the sleeper is less likely to be awakened. Heart rate and breathing slow down even more, and the body temperature drops. This stage lasts around 25 minutes.

Stage 3 (Non-REM)
This stage represents the body falling into a deep sleep, where slow wave sleep occurs. The brain produces slower delta waves, and there’s no eye movement or muscle activity from the sleeper. As the brain produces even more delta waves, the sleeper enters an important restorative sleep stage from which it’s difficult to be awakened. This phase of deep sleep is what helps you feel refreshed in the morning. It’s also the phase in which your body repairs muscle and tissue, encourages growth and development, and improves immune function.

Stage 4 – REM Sleep
About 90 minutes after falling asleep, your body enters REM sleep, which stands for Rapid Eye Movement sleep and is named so for the way your eyes quickly move back and forth behind your eyelids. REM sleep is thought to play a role in central nervous system development in infants, which might explain why infants need more REM sleep than adults. This sleep pattern is characterized by dreaming, since your brain is very active during this stage. Physically, your body experiences faster and irregular breathing, increased heart rate, and increased blood pressure; however, your arm and leg muscles become temporarily paralyzed, stopping you from acting out your dreams. REM sleep increases with each new sleep cycle, starting at about ten minutes during the first cycle and lasting up to an hour in the final cycle. Stage 4 is the last stage before the cycle repeats. REM sleep is critical for learning, memory, daytime concentration, and your mood. REM sleep plays a significant role in helping your brain consolidate and process new information and then retain the information in your long-term memory. Without REM sleep, your immune system could be weakened, you may experience pain more deeply, poor memory, mood dysfunction, less ability to focus, and the growth of new healthy cells and tissue in the body might be blocked. Poor REM sleep may be due to sleep disorders such as insomnia or obstructive sleep apnea, which causes you to wake during the night.

Sleep Disorders

Quality of sleep is impacted by several types of sleep disorders[11] including insomnia, hypersomnias (or excessive sleep), circadian rhythm sleep-wake disorders, parasomnias (or sleep events), sleep-related breathing disorders, or sleep-related movement disorders. Sleep disorders, like sleep apnea, negatively affect people’s health and safety, and many adults who have a sleep disorder don’t get the treatment they need.

Raising awareness about sleep disorders can help people recognize symptoms and get the help they need. The American Academy of Sleep Medicine (AASM) provides extensive information and resources about sleep disorders to help inform you about the different types, symptoms, and treatments.

Challenge: Understand Your Sleep

A sleep diary is a useful way to track your sleep at home by recording when you went to bed, woke during the night, and woke in the morning. It is helpful to also track the time of day when you exercise, nap, or take a medication, and when you have caffeine or alcohol.

A sleep diary will help you understand your sleep pattern and how much sleep you're getting. It also will show how often you have disrupted sleep. It may also will help you note certain activities that can affect your sleep.

Keeping a sleep diary is very helpful for communicating with your doctor about your sleep.

Use the AASM Sleep Diary

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6: INTIMATE RELATIONSHIPS AND COMMUNICATIONS

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6.1: Intro to Relationships and Communication

Love and intimacy go hand in hand. Love is the physical, emotional, sexual, intellectual, or social affection one person holds for another. Concepts related to love include: adoration, desire, prefer, possess, care for, serve, and even worship. Intimacy, on the other hand, is a close relationship where mutual acceptance, nurturance, and trust are shared at some level. In order to understand love in human relationships, you must first understand how the socialized self either enhances or inhibits your capacity to love.

Your socialized self develops under the supervision of your caregiver or parent(s). When you were a newborn, you were totally dependent upon the adults in your life to take care of your needs and raise you in a safe environment. You had to be fed and clothed, bathed and held, and loved and appreciated. Your caregivers provided these basic needs in your early development, and during this time, attachments were formed. An attachment is an emotional and social bond that forms between one person and another. Humans are considered highly motivated to form attachments throughout their lives.

Attachments are crucial to human existence and are essentially the emotional context of those relationships we form in life. As an infant you learned to trust those who cared for you; you learned that they returned once they were out of view and were dependable. Eventually, as your cognitive development matures, your brain allows you to love the person you are attached to and to care for them—whether or not they are caring for you. You learn then that your attachments begin to facilitate your needs and wants being met. How you attached as an infant and young child shape (at least in theory) how you will likely attach as an adult. For example, if you had strong attachments in childhood, then forming adult relationships should be easier for you; if you had weak or interrupted attachments in childhood, then forming adult relationships would be more difficult.

As adults, one of the very first symptoms that you are falling in love is that you begin to feel better about yourself when you are with the other person. It can be argued that you can only be in love as much as your self will allow you to be. Why? Because intimacy develops along with love, and intimacy requires that you have the ability to be your true self with the other person.

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6.2: Theories of Love

Love is a multidimensional concept and psychologists and sociologists have defined it in a variety of ways over the years. John Lee is perhaps the most quoted researcher on love with his six love types. Lee assumed that we all shared six core components of love and that our current loving relationship can be assessed and measured. Lee also claimed that there are qualities of love types—some more long-lasting and supportive of relationships and some pathological and defective which inhibit relationships. Lee's love types are widely used to help people understand their love styles. Lee claimed that six types of love comprised our loving experiences.

Eros

Eros is the love of sensuality: sex, taste, touch, sight, hearing, and smell. Eros love is often what we feel when turned on. Eros love is neither good nor bad; it is simply part of the overall love composite we experience with another person.

Storgé

Storgé is the love of your best friend in a normal casual context of life. Storgé is calm and peaceful, surprising to some who might have simply hung out together at one point but suddenly discovered that their friendship deepened and became more important than other friendships. "We started needing to be together, talking on the phone for hours, and missing each other when apart," are common descriptions of Storgé love.

Pragma

Pragma is the love of details and qualities in the other person. Pragma lovers are satisfied and attracted by the other because of their characteristics (e.g., athleticism, intelligence, wealth). Pragma lovers feel love at a rational level—thinking to a certain degree about the good deal.

Agapé

Agapé is the love that is selfless, other-focused, and seeks to serve others rather than receive from others. In Christian theology it's the love of God for mankind.

Ludis

Ludis is an immature love that is more of a tease than a legitimate loving relationship. Ludic lovers trick their mates into believing that they are sincerely in love, while grooming 1, 2, or even 3 other lovers at the same time. Ludic lovers typically artificially stroke their sense of self-worth by playing a cruel game on their lovers who end up feeling used and betrayed.

Mania

Mania is an insecure love that is a mixture of conflict and artificially romantic Eros expressions. Manic lovers fear abandonment and are simultaneously terrified by the vulnerabilities they feel when intimate with their lover. Thus, their daily routines typically involve extreme highs and lows including arguing, making love, sweet-talking, and fighting with their lovers.

Abraham Maslow, addressed love in terms of how our needs are met by the other person. His basic premise is that we pair-off with those whose love styles fill an unmet childhood need. In other words, Maslow said that if our childhood needs were not met in the basics of survival, safety, food, shelter, love, belonging, and even self-esteem, then we look for an adult companion that can fill those needs for us. It's like an empty cup from our childhood that our adult partner fills for us. Maslow also said that when all those basic needs are met in childhood, we are attracted to an adult partner who compliments our full development into our psychological potential.2 If in your childhood, your survival, safety, food, shelter, love, belonging, and even self-esteem needs were unmet then you will be attracted to a deficiency lover. Deficiency lovers are lovers who provide the basic level of needs for their partner while having their needs reciprocally met in a similar way. Being lovers meet their partner's aesthetic, intellectual, and physical needs while reciprocally having their needs met.

Sternberg's Triangular Theory of Love

Robert Sternberg was the "Geometry of Love" psychologist who triangulated love using intimacy, passion, and commitment by measuring the intensity of each and how intense the triangulation was for the couple. To Sternberg it was important to consider how each partner's triangle matched the other partner's. He said that a couple with all three types of love balanced, and in sufficient magnitude, would have a rare yet rewarding type of love that encompassed much of what couples seek in a loving relationship. Sternberg's consummate love is a love type that had equal measures of passion, intimacy, and commitment that is satisfactory to both lovers.

In modern day applications of love, various components have been found as the ingredients of love: commitment, passion, friendship, trust, loyalty, affections, intimacy, acceptance, caring, concern, care, selflessness, infatuation, and romance. There is a love type identified that many people are aware of called unconditional love. Unconditional love is the sincere love that does not vary regardless of the actions of the person who is loved. You often hear it expressed in greater measure among parents of children whose misbehaviors embarrass or disappoint them. The love types and patterns discussed below are taken from many sources, but fit neatly into the Lee, Maslow, Sternberg, or Chapman paradigms.

Romance

Romantic love is based on continual courtship and physical intimacy. Romantic lovers continue to date long after they marry or move in together. They often express the strong sexual attraction to each other that was there from the beginning. Romantic lovers are idealistic about their relationship and often feel that it was destined to be. They often define mundane activities such as grocery shopping or commuting to work as escapades of two lovers.

Infatuation

What happens when very young people feel love for the first time? What is puppy love or infatuation? Infatuation is a temporary state of love where the other person is overly idolized and seen in narrow and extremely positive terms. An infatuated person might think obsessively about the other, may feel a strong emotional response when they are together, may see their entire world as revolving around the other, may see them being together for the rest of their lives, may find one or two qualities of the other as being near perfect, or may be seen by others as having a crush on the other person. Regardless of the details infatuations rarely last very long. This love develops quickly much like a firework launches quickly into the night sky, puts on an emotional light show, then burns out quickly. Many define puppy love or infatuation as an immature love experienced by those who are younger and perhaps a bit credulous.

Commitment

Committed love is a love that is loyal and devoted. Two lovers may share committed love with or without: physical affection, romance, friendship, trust, loyalty, acceptance, caring, concern, care, selflessness, and or infatuation. Committed lovers have a long-term history with one another and typically combine care-giving, concern for one another's well-being, and spending much time thinking of the other. Committed lovers are there when needed by the other person.

Altruism

Altruism is a selfless type of love that serves others while not serving the one who is altruistic. True altruism is hard to find according to some. Mothers who tend their sick child throughout the night; fathers who work 3-4 decades in a job they don't love to provide for their family; and even fire fighters who sacrifice their safety to save the lives of others are all considered to be altruistic in their actions. Because so much of what we do in our relationships is considered in the larger overall equation of the fairness in a relationship, selfless acts can be seen as acts which either build a reservoir of goodwill which will later be repaid or creating a debt of sorts in which the other person owes you some selfless service in return.

Passion

Sexual or passionate lovers are focused on the intensely sensual pleasures that are found with the senses of taste, smell, touch, feel, hear, and sight. Sexual lovers lust one another and feel closest when together and being physical. Sexual lovers can be together for five minutes, five days, five weeks, or five years, but sexual love, by itself is typically short- lived. There is closeness during sex and activities leading up to sex, but not much thereafter. Sexual love when combined with other love types can be very beneficial to the couple. Sexual love is almost always the love type experienced by those having an extra- marital affair.

Friendship

Friendship love includes intimacy and trust among close friends. Today, most long-burning or enduring love types form among people who were first close friends. Friendship lovers tend to enjoy each other's company, conversation, and daily interactions. They consider one another to be "go-to" friends when advice is needed or when problems need to be talked about together. Not all friendship lovers become a couple. Many are just close or best friends. Yet many who spend the rest of their lives together will start out their relationship as friends.

Realistic Love

Criteria or realistic love is the love feelings you have when your list of a potential mate's personal traits is met in the other person. For example, women often desire their male love companions to be taller. Men and women often desire to find a partner with homogamous traits (e.g., same religion, political leanings, hobbies, etc.).

Obsession

Obsessive love is an unhealthy love type where conflict and dramatic extremes in the relationship are both the goal and the theme of the couple's love. Obsessive lovers live for storms and find peace while they rage. They are often violent or overly aggressive at different levels. Sometimes couples bring complimentary traits to the relationship which light the other's fire of madness. In other words, she may be angry and violent with him, but not with some other males. He may feel simultaneously drawn to her and repulsed, but not with other females. Their personality-chemistry contributes to the insanity and lack of peace. These couples most likely need professional counseling and would probably be better off if they broke up. At the same time, why would they seek help or leave the person whose entanglements bring them such an occupation with drama and conflict that they are freed from their boredom and entertained at the same time?

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6.3: Theories of Mate Selection

The Social Exchange Theory and its rational choice formula clarify the selection process even further. We strive to maximize rewards and minimize costs in our choices of a mate.

Rewards – Costs = Choice

When we interact with potential dates and mates, we run a mental balance sheet in our heads. She might think, “He’s tall, confident, funny, and friends with my friends.” As she talks a bit more she might say, “But, he chews tobacco, only wants to party, and just flirted with another woman while we were talking.” The entire time we interact with potential dates and mates we evaluate them on their appearance, disposition, goals and aspirations, and other traits. This while simultaneously remembering how we rate and evaluate ourselves. Rarely do we seek out the best looking person at the party unless we define ourselves as an even match for him or her. More often we rank and rate ourselves compared to others and as we size up and evaluate potentials we define the overall exchange rationally or in an economic context where we try to maximize our rewards while minimizing our losses.

The overall evaluation of the deal also depends to a great extent on how well we feel matched on racial and ethnic traits, religious background, social economic class, and age similarities. The complexity of the date and mate selection process includes many obvious and some more subtle processes that you can understand for yourself. If you are single you can apply them to the date and mate selection processes you currently pursue.

How do strangers transition from not even knowing one another to eventually cohabiting or marrying together? From the very first encounter, two strangers begin a process that either excludes one another as potential dates or mates or includes them and begins the process of establishing intimacy. Intimacy is the mutual feeling of acceptance, trust, and connection to another person, even with the understanding of personal faults of the individual. In other words, intimacy is the ability to become close to one another, to accept one another as is, and eventually to feel accepted by the other. Intimacy is not sexual intercourse, although sexual intercourse may be one of many expressions of intimacy. When two strangers meet they have a stimulus that alerts one or both to take notice of the other.

Effective Communication

Effective communication is critical to successful relationships. Researchers and therapists have found at least nine skills that can help couples learn to talk effectively about important issues (Gottman 1994; Markman, Stanley, and Blumberg 2010; Schramm and Harris 2011). How we interact about issues such as time spent together/apart, money, health, gender differences, children, family, friends, commitment, trust, and intimacy affects our ability to develop and maintain lasting marital friendships. If learned well, these nine skills can help put our relationships on a positive trajectory for success. (Note: The word "marriage" is interchangeable with "relationship," if you are not married.)

What Do Couples Talk About?

- Time Together/Apart. Both the quantity and quality of time we spend together influence the wellbeing of our marital friendships. Spending time apart participating in other activities also influences the well-being of our relationships.
- Money. How we think and talk about money, our spending habits, and our ability to budget, invest, and plan for the future impact couple financial management processes and practices.
- Health. Couples must talk about many health-related issues, including nutrition, exercise, illness, disease, accidents, health care, mortality, and death.
- Men/Women. Because men tend to be more task-oriented in their communication styles and women tend to be more process-oriented, men tend to want to solve issues immediately, while women tend to want to talk about them more and come to a consensus about what should be done.
- Children. How children develop physically, socially, emotionally, intellectually, and spiritually are often topics of discussion. Focusing on the best ways to consistently meet children's needs is considered being child-centered.
- Family/In-Laws/Friends. Couples often talk about situations and circumstances surrounding the interactions they have with their closest relationships.

What do couples communicate when they are communicating?

- Commitment. How we "hang in there" and contribute to our marital friendship, even when things aren't going particularly well, is a sign of how committed we are to our relationship. Loyalty and fidelity are aspects of commitment and trust.
- Trust. Trusting relationships are relationships in which both partners are dependable, available to support each other, and responsive to each other's needs. An ability to negotiate conflict and a positive outlook about the future of the relationship are also components of trust.
- Intimacy. The social, intellectual, emotional, spiritual, and physical connections we make with each other determine the levels of intimacy we experience in our relationships.

What do couples argue about?

Because the items listed above are some of the major topics couples talk about, it follows that they are also the same topics that can spur disagreements. For instance, it is a familiar joke that people can have difficulties in their relationships with in-laws. Take for example, “What is the difference between in-laws and outlaws? Answer: One is 'Wanted!'” Sayings such as these underscore the importance of knowing how your relationships with others can affect your marriage and could potentially become the topic of a marital conflict.

Learning and Practicing New Habits

Effective communication isn't easy. Teaching and learning new communication skills take patience, patience, patience, as well as practice, practice, practice. Taking the time to talk is important. Your relationship provides a safe place to share feelings, thoughts, fears, dreams, and hopes. Make a special effort to find time to talk to your partner more frequently. In tough times, people feel overwhelmed with worries and responsibilities.

Time together as a couple is often the last thing on our minds as we deal with the hassles of daily life. Although you may be busy, stressed, and worried, take the time to focus on your partners' needs and spend quality time together without interruption. Even a few minutes a day talking about what has occurred can be a relief from stress. Be thoughtful by considering whether those difficult or problem-solving discussions could be reserved for other times when you and your partner are not tired or distracted.

You may need to be the one who starts conversations. It is worth it to be the one who initiates conversations. You can find many ways to open the door for communication if you are sensitive to changes in your partner's feelings and needs. Taking the time to listen keeps the lines of communication open and improves your relationship.

Finding Time to Talk

- Spend time talking with limited interruptions.
- Make a date to talk to your partner.
- Plan at least one routine family time each week.
- Talk instead of watching TV.
- Talk when you take a walk together.
- Talk while you work together on household chores.
- Talk in the car while traveling to activities.

Summing It Up

In good times and bad, couples need each other. Good communication does not mean that your family won't have any problems, or that your partner will always like what you have to say. Good communication means the chances of solving problems are much higher if you and your partner can express yourselves openly and freely with each other.

For couples today, there is an abundance of information on how to sustain healthy, happy marital relationships. From how-to books to advice given on television and radio, couples are bombarded with strategies, tips, and techniques focused on “what to do” in their relationships. Most of this information assumes that if couples follow a few short rules, then they can have happy relationships. What most fail to realize is that these new, positive practices won't work without recognizing and addressing what has been done and what is not working. Most information available to couples falls short on giving examples of “what not to do” in a relationship. Communication is the key, but it is difficult to apply effective strategies to harmful interactions.

Four negative patterns of interaction have been demonstrated as major destroyers of marital relationships:

- Criticism
- Contempt
- Defensiveness
- Stonewalling

Criticism

Criticism is using hurtful or judgmental comments aimed at your partner's character or personality. With criticism, the blame is placed on the person and not the problematic behavior. Criticism tends to be a repetitive cycle—a single critical moment can end up in a continued exchange. Most critical statements can be recognized by the phrases, “you always” or “you never.” The following are some examples of criticism:

- You never finish any project that you start. You're so lazy.
- When we go out to eat, you always embarrass me with your table manners.

Contempt

Contempt is a more complex negative interaction. It is an effort to psychologically abuse your partner through disrespectful statements and actions. Contempt has both verbal and non-verbal deliveries. Verbal examples of contempt include sarcasm, hostile humor, and mockery. For example, nonverbal displays of contempt include rolling of the eyes and sucking of the teeth during conflict. Contempt sends your partner a message of scorn—that they are inferior and worthless.

Defensiveness

Defensiveness is often a natural response to receiving criticism and contempt. When faced with criticism and contempt, most people find a need to defend themselves. However, couples can be defensive even when criticism is constructive. Defensiveness may be a response to previous, current, and/or future attacks. If one or both persons are acting defensively, it is most likely the case they are not listening. Defensiveness may take many forms including:

- Making excuses for behavior
- Repeating a statement for effect
- Denying responsibility for actions
- Answering a complaint with another complaint

Stonewalling

The final negative pattern of interaction is stonewalling. As the name implies, this occurs when partners “put a wall” around themselves, either physically or psychologically. Stonewalling is often used to decrease conflict, and when delivered in moderation, can be healthy. On the other hand, continual failure to respond and/or engage in conversation escalates rather than reduces conflict. Examples of stonewalling include:

- Leaving the room
- Putting a physical barrier between you and your partner (newspaper, book, child)
- Focusing intently on something other than your partner during a discussion
- Failure to actively listen
- Responding with a blank stare

What can be done?

All of the above can become patterns of interaction within a relationship. One negative interaction leads to another, often in a repetitive cycle. The following suggestions can be used to break the cycle and promote a healthy relationship:

1. Eliminate criticism. Use complaints. It is okay to complain about troublesome behaviors. Discussing your feelings about the behavior is okay as long as there are no personal attacks. Use the word I instead of you and describe how the behavior makes you feel. Talk about the behavior and not the person.
    - Example: “When we go out to eat, you always embarrass me,” becomes “I feel hurt and ashamed when you make fun of me in public.
2. Build on your friendship base. Validate your partner and his/her feelings, thoughts, needs, and desires, etc.
    - Example: "I recognize that you need to talk more about our relationship. What is on your mind?”
3. Take accountability and responsibility for your own actions. Do not make excuses. Apologize and correct the behavior (if

possible).
    - Example: “I'm sorry that I yelled at you earlier. I've been under a lot of pressure at work, but it is unfair to take it out on you.”
4. Use reflective listening. Repeat what your partner has stated and then respond. Show them that you are listening and hearing them.
    - Example: Partner 1: "I would appreciate it if you would talk to me before you discipline the kids. That way we can be a united front." Partner 2: "What I'm hearing is that you would like for us to talk about disciplining the kids before I make any decisions. I think that is a good idea.
5. Continue dating. Make a point to rekindle the dating aspect of your relationship.
    - Example: Go for walks, hold hands, act silly, etc. Find ways to show appreciation to your partner throughout the day (i.e., e-mails, notes, phone calls, etc.)
6. Seek help if needed. If you can identify these negative interactions in your relationship or you think you may need help, see a licensed marriage and family therapist or other professional. Do not try and fix everything on your own.
    - Example: Talk to a trusted family member, friend, or your local extension agent in order to find resources in your area.

Before a couple can learn and/or practice new routines in their relationship, they must rid themselves of the old ways that aren't working. It is important to first identify negative patterns and destructive behaviors and target them for change. At that point, the couple can begin rebuilding their relationship.

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6.4: Marriage

Marriage is very popular among U.S. adults, in part because it does offer many rewards that unmarried people don't enjoy. Marriage has become socially controversial in part because of the intense political efforts to legalize marriage for same-sex couples. Regardless of your moral position on the issue of same-sex marriage, you can see the political quest for it as an indicator of just how rewarding it is to be legally a “married couple.”

There are numerous studies and books on the benefits of marriage to married individuals. Below are the Top Ten Benefits of Being Married in Contrast to Being Single:

1. Better physical and emotional health
2. More wealth and income
3. Positive social status
4. More and safer sex
5. Life-long continuity of intimate relationships
6. Safer circumstances for children
7. Longer life expectancy
8. Lower odds of being crime victims
9. Enhanced legal and insurance rights and benefits (tax, medical, and inheritance)
10. Higher self-reported happiness

Marriage is a legal union between a man and a woman as recognized by most of the United States. Internationally, and in certain U.S. political regions, a man and another man or a woman and another woman can be legally recognized as a married couple. What are typical marriage structures? The U.S. and world-wide culturally preferred marriage type today is monogamy. Monogamy is the marriage form permitting only one spouse at a time. Almost all who have married in the U.S. have done so monogamously since the original colonies in the 1600s. Monogamy implies a 1:1 relationship and is typically desired both by married couples and by opposite and same-sex cohabiters.

Polygyny is a form of marriage permitting more than one wife at the same time. Polygyny is still common and legal in many African, Middle Eastern, Muslim, and Indian nations. It was a deep part of China's history and prior to World War II it was common for a Chinese man to have multiple wives and many children.

Polyandry is a marriage form permitting more than one husband at the same time. This is historically and currently rare, and, if or when it was practiced, it often includes the marriage of one wife to a set of brothers with all husbands having sexual access to the wife. Polyandry was found among some Pacific Island cultures and among the pre-Taliban Afghanis.

What if a person marries, divorces, marries, divorces, etc.? Serial Monogamy or Serial Polygamy is the process of establishing intimate marriage or cohabiting relationships that eventually dissolve and are followed by another intimate marriage or cohabiting relationship that eventually dissolve, etc. in a series. Thus polygamists have simultaneous multiple spouses while serial monogamists or serial polygamists have multiple spouses in a sequence of relationships. Millions of U.S. adults will experience serial marriages and divorces. Many marry then divorce, yet still want to be married again. Many others who suffered through their parents’ unhealthy marriages and divorces also want to marry, knowing firsthand how risky that might be.

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6.5: Cohabitation

Cohabitation is the heterosexual, bisexual, and homosexual moving in together of two partners without going through the formalities of legal marriage. Although similar in form and function, cohabitating couples live differently in many significant day-to-day aspects when compared to married couples. Also, many cohabiting couples eventually choose to marry, but their risk of divorce is higher than among couples that never cohabited.

Cohabitation has been studied extensively for the last three decades, especially in contrast between cohabiting and married couples. Clear findings consistently show that cohabiting and marriage are two different creatures. Those who cohabit have less clarity on the intention and direction of the relationship than married couples. Further, people who cohabit, then later marry, are more likely to divorce than those who never cohabited. In 2010 the U.S. Center for Disease Control reported that cohabitation is very common “Among both men and women aged 15-44 who had ever cohabited and or married, the largest proportion cohabited before their first marriage. Approximately 28% of men and women cohabited before their first marriage, whereas 23% of women and 18% of men married without ever cohabiting. About 15% of men and women had only cohabited (without ever marrying), and less than seven percent of men and women first cohabited after their first marriages ended.” This report also stated that some of the cohabitation relationships dissolved while others transitioned to marriage. Less educated cohabiters cohabited longer while college- graduated cohabiters transitioned to marriage more.

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6.6: Marrieds and Non-Marrieds

There are known benefits to being married and in a long-term relationship rather than being single, divorced, or cohabiting. The list below shows health benefits from the cohabitation and marriage study of the National Survey of Family Growth. Better mental and physical health with better medical insurance coverage prove to be crucial qualities for marrieds. As far as children are concerned, having better care and better adult outcomes are crucial factors.

Health Benefits Known to be an Advantage among Married Persons in the U.S.

1. Generally better mental and physical health outcomes
2. Longer lives
3. Higher rates of health insurance coverage
4. Lower prevalence of cardiovascular disease
5. Better health and well-being of children
6. Children born to unmarried mothers are at greater risk for poverty, teen childbearing, poor school achievement, and marital disruption in adulthood than children born to married mothers

There are also known financial benefits when comparing marrieds to non-marrieds. More wealth accumulation, higher assets, and higher monthly income are consistent among marrieds. The first thing you notice is that marrieds have consistently higher annual incomes. In 2007 specifically, marrieds had $28,231 more income than single men and $42,293 more than single women. The difference is even more pronounced if both incomes are taken into consideration for dual income marrieds (i.e., in 2007 dual income couples had $86,435 which is $42,077 higher than single men and $56,139 more than single women).

Married people are also safer and less prone to get into trouble than others. There is a buffering effect that accompanies having a life-long devoted spouse who helps deflect stress and hardships on a daily basis. Thus some of the health benefits of longer life, less suicide, more stable health coverage, and less illness and addiction. Also, marrieds have more social support, more continuity in long-term relationships, and especially more closeness for men in intimate family relationships. Husbands are less likely to abuse and be violent toward their wives than are boyfriends and partners. Married people have clear life-long goals and tend to buy homes, invest, and plan for retirement more than others. The government and military recognize spouses and reward them with tax breaks, benefits, and other sources of coverage and support more than others. In later life, many elderly report that their family relationships are very supportive and important to them. Studies show that the elderly enjoy their human investment in their children and grandchildren that yields emotional and social rewards throughout their golden years.

Known Benefits Enjoyed by Married Couples in Comparison to Non-Married Persons.

1. Less likely to become victims of crime
2. Less likely to commit crimes
3. Less addiction
4. Fewer accidents (especially among men)
5. Less suicide
6. Better stress management because spouse is a buffer to life's stresses
7. More social and emotional support (less loneliness)
8. More intimate connections to family members
9. Long-term continuity in family relationships of children, in-laws, grandchildren, etc.
10. Lower risk of domestic violence for women
11. Longer life expectancies
12. More and better self-rated sex
13. More emotional and financial security (for both spouses)
14. Less uncertainty about direction of life and goals
15. More cost effective to live in married versus single circumstances
16. Tax deductions
17. More military benefits
18. More accumulated belongings and investments
19. More medical benefits
20. More legal rights

To legally marry in the United States today, one simply goes to the local county or state office and applies for a state marriage license. The state also claims authority in granting divorce rights to couples. Divorce is the legal dissolution of a previously granted marriage. Most marriages still endure, and the odds are that divorce won't happen to most marriages. It is a myth that one in two marriages eventually ends in divorce. There are a few myths about U.S. divorce trends that will be dispelled in this chapter. You might have heard the myth of the Seven Year Itch where divorce happens prior to or shortly after the 7th year. Current government estimates indicate that about 75% of couples make their ten-year anniversary in their first marriage. The myths are false, but divorce does happen more today than it did 50 years ago and more people today are currently divorced than were currently divorced 50 years ago.

Ten Actions to Minimize the Risk of Divorce:

1. Wait until at least 20 years old to marry, 25 is better.
2. Avoid premarital pregnancy and don't marry just because of a pregnancy.
3. Become proactive in maintaining your marriage (books, seminars, counseling).
4. Understand risks of cohabitation (cohabitation ≠ divorce).
5. Once married, leave the marriage market; don't keep an eye open for something better.
6. Learn to compromise with each other. Work around those irreconcilable differences.
7. Keep a positive outlook and look beyond today.
8. Take your time in selecting a mate. Don't rush into marriage.
9. Take the media with a grain of salt. Don't assume your marriage will be like the headlines.
10. Focus on the positive benefits of being married and don't dwell on the negatives.

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6.7: Violence in Relationships

Violence is a serious public health problem in the United States. From infants to the elderly, it affects people in all stages of life. In the United States, violence accounts for approximately 51,000 deaths annually. In 2007, more than 18,000 people were victims of homicide and more than 34,000 took their own life. Estimating the size of this economic burden is helpful in understanding the resources that could be saved if cost-effective violence prevention efforts were applied. The cost of these deaths totaled to $47.2 billion ($47 billion in work loss costs and $215 million in medical treatment). The number of violent deaths tells only part of the story. Many more survive violence and are left with permanent physical and emotional scars. Violence also erodes communities by reducing productivity, decreasing property values, and disrupting social services.

Understanding Violence

Interpersonal violence is defined as the actual or threatened intentional use of force— physical, sexual, or emotional—against another person, group, or community. It may result in physical injury, psychological harm, or even death. Violence also includes suicide and nonfatal acts of self-harm.

Unfortunately, violence is a part of our daily life. It exists in all corners of our nation. It affects us all regardless of our age, gender, race, ethnicity, or socio-economic status. More than 50,000 violent deaths occur each year in the United States. The deaths only tell part of the story. Millions of others are left with debilitating physical and emotional injuries. These injuries negatively affect the health of victims for the rest of their lives.

Violence also erodes the fabric of our communities. It can threaten productivity in the workplace, decrease the value of our homes and businesses, and disrupt essential public and social services. The economic cost of violence is staggering. In 2000, the medical costs and productivity losses associated with nonfatal violence-related injuries and deaths were estimated at more than $70 billion each year. The total burden to society is far greater.

The good news is that violence is a problem with a solution. It can be prevented by using a thoughtful and systematic approach. While the field of violence prevention is still developing, our knowledge of “what works” increases every day.

Types of Violence

- Child Maltreatment (e.g., child abuse and neglect)
- Intimate Partner Violence (e.g., violence by a current or former spouse, boy/girlfriend)
- Sexual Violence (e.g., rape, sexual assault, sexual harassment)
- Suicide (e.g., fatal and nonfatal suicide behavior)
- Youth Violence (e.g., bullying, gang violence, peer violence)

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6.8: Sexual Violence

Sexual Violence (SV) refers to sexual activity where consent is not obtained or freely given. Anyone can experience SV, but most victims are female. The person responsible for the violence is typically male and is usually someone known to the victim. The person can be, but is not limited to, a friend, coworker, neighbor, or family member.

There are many types of SV. Not all include physical contact between the victim and the perpetrator (person who harms someone else) – for example, sexual harassment, threats, and peeping. Other SV, including unwanted touching and rape, includes physical contact.

SV can impact health in many ways. Some ways are serious and can lead to long-term health problems. These include chronic pain, headaches, stomach problems, and sexually transmitted diseases.

SV can have an emotional impact as well. Victims often are fearful and anxious. They may replay the attack over and over in their minds. They may have problems with trust and be wary of becoming involved with others. The anger and stress that victims feel may lead to eating disorders and depression. Some even think about or attempt suicide.

SV is also linked to negative health behaviors. For example, victims are more likely to smoke, abuse alcohol, use drugs, and engage in risky sexual activity.

Why is sexual violence a public health problem?

SV is a significant problem in the United States:

- Among high school students surveyed nationwide, about 8% reported having been forced to have sex. The percentage of those having been forced to ever have sex was higher among female (11%) than male (5%) students.
- An estimated 20% to 25% of college women in the United States have experienced an attempted or complete rape during their college career
- Nearly 1 in 5 women and 1 in 71 men in the United States have been raped at some time in their lives.

These numbers underestimate the problem. Many cases are not reported because victims are afraid to tell the police, friends, or family about the abuse. Victims also think that their stories of abuse will not be believed and that police cannot help them. They may be ashamed or embarrassed. Victims may also keep quiet because they have been threatened with further harm if they tell anyone.

Certain factors can increase the risk for SV. However, the presence of these factors does not mean that SV will occur.

Risk factors for perpetration (harm to someone else):

- Being male
- Having friends that are sexually aggressive
- Witnessing or experiencing violence as a child
- Alcohol or drug use
- Being exposed to social norms, or shared beliefs, that support sexual violence.

It is important to understand what factors protect people or put them at risk for experiencing or perpetrating violence. Why are risk and protective factors useful? They help identify where prevention efforts need to be focused.

Risk factors do not cause violence. The presence of a risk factor does not mean that a person will always experience violence. Victims are never responsible for the harm inflicted upon them.

- Risk Factor - Characteristic that increases the likelihood of a person becoming a victim or perpetrator of violence.
- Protective Factor - Characteristic that decreases the likelihood of a person becoming a victim or perpetrator of violence because it provides a buffer against risk.

How can we prevent sexual violence?

The ultimate goal is to stop SV before it begins. Efforts at many levels are needed to accomplish this. Some examples include:

- Engaging high school students in mentoring programs or other skill-based activities that address healthy sexuality and dating relationships.
- Helping parents identify and address violent attitudes and behaviors in their kids.
- Creating policies at work, at school, and in other places that address sexual harassment.
- Developing mass media (e.g., radio, TV, magazines, newspapers) messages that promote norms, or shared beliefs, about healthy sexual relationships.

Sexual Violence: Risk and Protective Factors

Risk factors are associated with a greater likelihood of sexual violence (SV) perpetration. They are contributing factors and may or may not be direct causes. Not everyone who is identified as "at risk" becomes a perpetrator of violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming a perpetrator of SV. Understanding these multilevel factors can help identify various opportunities for prevention.

Risk Factors for Perpetration

Individual Risk Factors

- Alcohol and drug use
- Coercive sexual fantasies
- Impulsive and antisocial tendencies
- Preference for impersonal sex
- Hostility towards women
- Hypermasculinity
- Childhood history of sexual and physical abuse
- Witnessed family violence as a child

Relationship Factors

- Association with sexually aggressive and delinquent peers
- Family environment characterized by physical violence and few resources
- Strong patriarchal relationship or familial environment
- Emotionally unsupportive familial environment

Community Factors

- Lack of employment opportunities
- Lack of institutional support from police and judicial system
- General tolerance of sexual violence within the community
- Weak community sanctions against sexual violence perpetrators

Societal Factors

- Poverty
- Societal norms that support sexual violence
- Societal norms that support male superiority and sexual entitlement
- Societal norms that maintain women's inferiority and sexual submissiveness
- Weak laws and policies related to gender equity
- High tolerance levels of crime and other forms of violence

Sexual Violence: Prevention Strategies

Sexual violence is a serious problem that can have lasting, harmful effects on victims and their family, friends, and communities. The goal of sexual violence prevention is simple-to stop it from happening in the first place. However, the solutions are just as complex as the problem.

Prevention efforts should ultimately decrease the number of individuals who perpetrate sexual violence and the number of individuals who are sexual violence victims. Many prevention approaches aim to reduce risk factors and promote protective factors for sexual violence. In addition, comprehensive prevention strategies should address factors at each of the levels that influence sexual violence -the individual, relationship, community, and society.

The most common prevention strategies currently focus on the victim, the perpetrator, or bystanders.

- Strategies that aim to equip the victim with knowledge, awareness, or self-defense skills are referred to as risk reduction techniques.
- Strategies targeting the perpetrator attempt to change risk and protective factors for sexual violence in order to reduce the likelihood that an individual will engage in sexually violent behavior.
- The goal of bystander prevention strategies is to change social norms supporting sexual violence and empower men and women to intervene with peers to prevent an assault from occurring.
- Other prevention strategies may target social norms, policies, or laws in communities to reduce the perpetration of sexual violence across the population.

Effective and Promising Programs

Unfortunately, little is known about what works to prevent sexual violence. To date, only one prevention program, Safe Dates, has been shown in a randomized controlled trial to prevent or interrupt sexual violence perpetration. Other programs are accumulating evidence for effectiveness and are moving towards or are currently conducting rigorous evaluations. Until more is known about what works and for whom, program planners can use prevention principles to strengthen their approach and evaluation to determine the effectiveness of new or existing programs.

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6.9: Intimate Partner Violence

Figure 6.9.1 Couple

Intimate partner violence (IPV) is a serious, preventable public health problem that affects millions of Americans. The term “intimate partner violence” describes physical, sexual, or psychological harm by a current or former partner or spouse. This type of violence can occur among heterosexual or same-sex couples and does not require sexual intimacy.

The goal is to stop IPV before it begins. There is a lot to learn about how to prevent IPV. We do know that strategies that promote healthy behaviors in relationships are important. Programs that teach young people skills for dating can prevent violence. These programs can stop violence in dating relationships before it occurs. IPV can vary in frequency and severity. It occurs on a continuum, ranging from one episode that might or might not have lasting impact to chronic and severe episodes over a period of years. There are four main types of IPV:

1. **Physical violence** is the intentional use of physical force with the potential for causing death, disability, injury, or harm. Physical violence includes, but is not limited to, scratching; pushing; shoving; throwing; grabbing; biting; choking; shaking; aggressive hair pulling; slapping; punching; hitting; burning; use of a weapon; and use of restraints or one’s body, size, or strength against another person. Physical violence also includes coercing other people to commit any of the above acts.
2. **Sexual violence** is divided into five categories. Any of these acts constitute sexual violence, whether attempted or completed. Additionally all of these acts occur without the victim’s freely given consent, including cases in which the victim is unable to consent due to being too intoxicated (e.g., incapacitation, lack of consciousness, or lack of awareness) through their voluntary or involuntary use of alcohol or drugs.
    1. **Rape or penetration of victim** – This includes completed or attempted, forced or alcohol/drug-facilitated unwanted vaginal, oral, or anal insertion. Forced penetration occurs through the perpetrator’s use of physical force against the victim or threats to physically harm the victim.
    2. **Victim was made to penetrate someone else** – This includes completed or attempted, forced or alcohol/drug-facilitated incidents when the victim was made to sexually penetrate a perpetrator or someone else without the victim’s consent.
    3. **Non-physically pressured unwanted penetration** – This includes incidents in which the victim was pressured verbally or through intimidation or misuse of authority to consent or acquiesce to being penetrated.
    4. **Unwanted sexual contact** – This includes intentional touching of the victim or making the victim touch the perpetrator, either directly or through the clothing, on the genitalia, anus, groin, breast, inner thigh, or buttocks without the victim’s consent
    5. **Non-contact unwanted sexual experiences** – This includes unwanted sexual events that are not of a physical nature that occur without the victim’s consent. Examples include unwanted exposure to sexual situations (e.g., pornography); verbal or behavioral sexual harassment; threats of sexual violence to accomplish some other end; and /or unwanted filming, taking or disseminating photographs of a sexual nature of another person.
3. **Stalking** is a pattern of repeated, unwanted, attention and contact that causes fear or concern for one’s own safety or the safety of someone else (e.g., family member or friend). Some examples include repeated, unwanted phone calls, emails, or texts; leaving cards, letters, flowers, or other items when the victim does not want them; watching or following from a distance; spying; approaching or showing up in places when the victim does not want to see them; sneaking into the victim’s home or car; damaging the victim’s personal property; harming or threatening the victim’s pet; and making threats to physically harm the victim.
4. **Psychological Aggression** is the use of verbal and non-verbal communication with the intent to harm another person mentally or emotionally, and/or to exert control over another person. Psychological aggression can include expressive aggression (e.g., namecalling, humiliating); coercive control (e.g., limiting access to transportation, money, friends, and family; excessive monitoring of whereabouts); threats of physical or sexual violence; control of reproductive or sexual health (e.g., refusal to use birth control; coerced pregnancy termination); exploitation of victim’s vulnerability (e.g., immigration status, disability); exploitation of perpetrator’s vulnerability; and presenting false information to the victim with the intent of making them doubt their own memory or perception (e.g., mind games).

Risk Factors for Intimate Partner Violence

Persons with certain risk factors are more likely to become perpetrators or victims of intimate partner violence (IPV). Those risk factors contribute to IPV but might not be direct causes. Not everyone who is identified as “at risk” becomes involved in violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming an IPV perpetrator or victim. Understanding these multilevel factors can help identify various opportunities for prevention.

Individual Risk Factors

- Low self-esteem
- Low income
- Low academic achievement
- Young age
- Aggressive or delinquent behavior as a youth
- Heavy alcohol and drug use
- Depression
- Anger and hostility
- Antisocial personality traits
- Borderline personality traits
- Prior history of being physically abusive
- Having few friends and being isolated from other people
- Unemployment
- Emotional dependence and insecurity
- Belief in strict gender roles (e.g., male dominance and aggression in relationships)
- Desire for power and control in relationships
- Perpetrating psychological aggression
- Seeing or being a victim of physical or psychological abuse (consistently one of the strongest predictors of perpetration)
- History of experiencing poor parenting as a child
- History of experiencing physical discipline as a child

Relationship Factors

- Marital conflict-fights, tension, and other struggles
- Marital instability-divorces or separations
- Dominance and control of the relationship by one partner over the other
- Economic stress
- Unhealthy family relationships and interactions

Community Factors

- Poverty and associated factors (e.g., overcrowding)
- Low social capital-lack of institutions, relationships, and norms that shape a community's social interactions
- Weak community sanctions against IPV (e.g., unwillingness of neighbors to intervene in situations where they witness violence)

Societal Factors

- Traditional gender norms (e.g., women should stay at home, not enter workforce, and be submissive; men support the family and make the decisions)

Protecting Yourself from Relationship Violence

It can be hard to know if your relationship is headed down the wrong path. While it's not always possible to prevent relationship violence, there are steps you can take to protect yourself.

If you think your partner might be controlling or abusive, it's important to:

- Trust your feelings. If something doesn't seem right, take it seriously.
- Learn the warning signs of someone who might become controlling or violent.
- Get help. Talk to experts in relationship violence.

If your partner is controlling or abusive, it's better to get help now than to wait. Controlling or violent relationships usually get

worse over time.

Remember: if your partner hurts you, it's not your fault.

What is relationship violence?

Relationship violence is when one person in a relationship is abusive or controlling toward the other person – especially when they disagree about something.

Relationship violence is sometimes called dating violence, **domestic violence**, or **intimate partner violence**. In some relationships, both partners act in abusive or controlling ways. When many people think about relationship violence, they think about physical violence, like hitting or pushing. But people can also use other methods, like threats or insults, to control their partners.

Relationship violence can include:

- Physical violence, like pushing, hitting, or throwing things
- Sexual violence, like forcing or trying to force someone to do something sexual
- Threats of physical or sexual violence, which may include threatening to hurt another person or a pet
- Emotional abuse, like embarrassing a partner or keeping that person away from family and friends

If you feel controlled by or afraid of your partner – even if you haven't been hurt physically – trust yourself. There are people who can help you figure out what to do next.

How do I know if my relationship might become violent?

Relationship violence can start slowly and be hard to recognize at first. For example, when people first start dating, it's common to want to spend a lot of time together. But spending less time with other people can also be a sign that your partner is trying to control your time.

Try asking yourself these questions:

- Does my partner respect me?
- Does my partner blame me for everything that goes wrong?
- Does my partner make most of the decisions in our relationship?
- Am I ever afraid to tell my partner something?
- Do I ever feel forced to do things that I don't want to do?
- Have I ever done anything sexual with my partner when I didn't want to?
- Does my partner promise to change and then keep doing the same things?

What if I'm not sure if my relationship is violent?

It's okay if you aren't sure – you can still get help. Domestic violence agencies have counselors who are experts at helping people with questions about their relationships. You don't even have to give your name.

If you have questions about your relationship, call the National Domestic Violence Hotline at 1-800-799-SAFE (1-800-799-7233) or chat online with a trained advocate.

If you are in danger right now, call 911.

Take Action!

If you think your partner is controlling or abusive, take steps to protect yourself.

Trust your instincts.

You are the expert on your life and relationships. If you think your relationship is unhealthy or you are worried about your safety, trust your gut.

Plan for your safety.

If you are in a relationship with someone who is violent or might become violent, make a plan to keep yourself safe. This is important whether you are planning to leave your partner or not.

Start with a phone call.

If you need help or have questions about your relationship, call the National Domestic Violence Hotline at 1-800-799-SAFE (1-800-799-7233). You'll be able to find a domestic violence agency near you or talk to a counselor over the phone. ***If you are in danger right now, call 911.***

What kind of help can I get?

Domestic violence agencies provide:

- Emotional support
- Safety planning
- A safe place to stay in an emergency
- Legal help
- Help with housing

What about cost?

Domestic violence agencies offer free services, like hotlines, counseling, and help finding resources such as housing or lawyers.

Healthy vs. unhealthy relationships

Sometimes a relationship might not be abusive, but it might have some serious problems that make it unhealthy. If you think you might be in an unhealthy relationship, you should be able to talk to your partner about your concerns. If you feel like you can't talk to your partner, try talking to a trusted friend, family member, or counselor. Consider calling a confidential hotline to get the support you need and to explore next steps. If you're afraid to end the relationship, call a hotline for help (1-800-799-SAFE).

Signs of an unhealthy relationship include:

- Focusing all your energy on your partner
- Dropping friends and family or activities you enjoy
- Feeling pressured or controlled a lot
- Having more bad times in the relationship than good
- Feeling sad or scared when with your partner

Signs of a healthy relationship include:

- Having more good times in the relationship than bad
- Having a life outside the relationship, with your own friends and activities
- Making decisions together, with each partner compromising at times
- Dealing with conflicts by talking honestly
- Feeling comfortable and able to be yourself
- Feeling able to take care of yourself
- Feeling like your partner supports you

If you feel confused about your relationship, a mental health professional can help.

Remember, you deserve to be treated with respect.

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7: WOMEN HEALTH

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7.1: History and Current Issues in Women's Health

Chapter Objectives:

- Outline events that had, or continue to have, a significant impact on women's health
- Explore topics that impact your own personal health
- Discuss current issues regarding health care for women in the US
- Explore how health care options for women in the US compare to healthcare options in other countries
- Explore factors that impact a woman's access to quality and affordable health care
- Identify criteria for finding valid and reliable health information on the Internet

Women's Health History

I'm interested in women's health because I am a woman. I would be a darn fool to not be on my own side. ~Maya Angelou

Communities and countries and ultimately the world are only as strong at the health of their women. – Michelle Obama

Development of Women's Health Care in the US



If you had to pick just one, what event, discovery, development or invention do you feel has had the greatest impact on women's health? Ideas such as birth control or women's right to vote, Roe vs Wade or even Title IX may quickly come to mind. What about safe birthing practices or the women's health movement of the 1970's? Consider that women from minority groups are now better represented in the health care field? In reading the following articles about the history of health care in the US, reflect on how our choices today may be different if not for these developments.

Article: History of Women's Health Movement in the 20th Century

Understanding Personal Health History

Considering how significant events in our collective health history impact resources and accessibility is the first step. Next, we need to explore how current health accessibility, education, and regulations impact our personal wellness and health choices today. As you begin to ask yourself about choices you make for your health now and information you will need for future health choices, it is important to explore criteria for defining health and wellness as well as understanding how to seek valid and reliable

sources of health information.

Broad Perspectives of Health

The most widely used of the broader definitions of health if from the World Health Organization (WHO), which defines **health** "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity". This classic definition is important, as it identifies the vital components of health. Well-being includes the presence of positive emotions and moods, the absence of negative emotions, satisfaction with life, fulfillment and positive functioning. In simple terms, well-being can be described as judging life positively and feeling good. Well-being is associated with numerous health, job, family, and economically related benefits. For example, higher levels of well-being are associated with decreased risk of disease, illness, and injury; better immune functioning; speedier recovery; and increased longevity. Individuals with high levels of well-being are more productive at work and are more likely to contribute to their communities. Many practitioners have expanded their focus to include wellness at the positive end of the health continuum. Wellness is being in good physical and mental health. Because mental health and physical health are linked, problems in one area can impact the other. At the same time, improving your physical health can also benefit your mental health, and vice versa. It is important to make healthy choices for both your physical and mental well-being. Remember that **wellness** is not just the absence of illness or stress. One can still strive for wellness even while experiencing these challenges in life. To more fully understand the meaning of health, it is important to understand each of its individual components of wellness.

The Six Dimensions of Wellness

Think of each dimension as a continuum that can include more healthful or less healthful behaviors. Goals can be set to move each individual marker towards better balance rather then expecting perfection in all areas.

Physical

Body functioning; recognizing the need for physical activity, healthy foods, and adequate sleep. Avoiding unhealthy habits.

Social

Developing a sense of connection, belonging, and sustained support system. Having positive relationships

Intellectual

Recognizing creative abilities and finding ways to expand knowledge and skills. Being open-minded.

Emotional

Coping effectively with life and expressing emotions in an appropriate manner.

Spiritual

Having a sense of purpose and meaning in life; establishing peace, harmony, and balance in our lives.

Environmental

Occupying pleasant, healthy, and safe environments that support wellbeing. Positively impacting the quality of our surroundings (including protecting and preserving nature).

Learning about the Six Dimensions of Wellness can help a person choose how to make healthful choices a part of everyday life. Wellness strategies are practical ways to start developing healthy habits that can have a positive impact on physical and mental health.

Determinants of Health

The range of personal, social, economic, and environmental factors that influence health status are known as **determinants of health**. What makes some people healthy and others unhealthy? We may know what actions promote health but for various reasons may not have access to the tools necessary to make long term, positive changes. How can we create a society in which everyone has a chance to live a long, healthy life?

Determinants of health are factors that contribute to a person's current state of health. These factors may be biological, socioeconomic, psychosocial, behavioral, or social in nature. Scientists generally recognize five determinants of health of a population:

Policymaking

Policies at the local, state, and federal level affect individual and population health. Increasing taxes on tobacco sales, for example, can improve population health by reducing the number of people using tobacco products.

Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. For example, the 1966 Highway Safety Act and the National Traffic and Motor Vehicle Safety Act authorized the Federal Government to set and regulate standards for motor vehicles and highways. This led to an increase in safety standards for cars, including seat belts, which in turn reduced rates of injuries and deaths from motor vehicle accidents.

Does all policy contribute positively to health for all? We will be exploring this question more in future chapters.

Social Factors

Social determinants of health reflect the social factors and physical conditions of the environment in which people are born, live, learn, play, work, and age. Also known as social and physical determinants of health, they impact a wide range of health, functioning, and quality-of-life outcomes. Examples of social determinants include:

- Availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods
- Social norms and attitudes, such as discrimination
- Exposure to crime, violence, and social disorder, such as the presence of trash
- Social support and social interactions
- Exposure to mass media and emerging technologies, such as the Internet or cell phones
- Socioeconomic conditions, such as concentrated poverty
- Quality schools
- Transportation options
- Public safety
- Residential segregation

Examples of physical determinants include:

- Natural environment, such as plants, weather, or climate change
- Built environment, such as buildings or transportation
- Worksites, schools, and recreational settings
- Housing, homes, and neighborhoods
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities
- Aesthetic elements, such as good lighting, trees, or benches

Poor health outcomes are often made worse by the interaction between individuals and their social and physical environment. For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with state and national averages. Poor air quality can worsen asthma symptoms, especially in children.

Health Services

Both access to health services and the quality of health services can impact health. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas.

Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment.

Barriers to accessing health services include:

- Lack of availability
- High cost
- Lack of insurance coverage
- Limited language access

These barriers to accessing health services lead to:

- Unmet health needs
- Delays in receiving appropriate care
- Inability to get preventive services
- Hospitalizations that could have been prevented

Individual Behavior

Individual behavior also plays a role in health outcomes. For example, if an individual quits smoking, his or her risk of developing heart disease is greatly reduced. Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country.

Examples of individual behavior determinants of health include:

- Diet
- Physical activity
- Alcohol, smoking, vaping, and other drug use
- Hand washing

Biology and Genetics

Some biological and genetic factors affect specific populations more than others. For example, older adults are biologically prone to being in poorer health then adolescents due to the physical and cognitive effects of aging.

Sickle cell disease is a common example of a genetic determinant of health. Sickle cell is a condition that people inherit when both parents carry the gene for sickle cell. The gene is most common in people with ancestors from West African countries, Mediterranean countries, South or Central American countries, Caribbean islands, India, and Saudi Arabia.

Examples of biological and genetic social determinants of health include:

- Age
- Sex
- HIV status
- Inherited conditions, such as sickle-cell anemia, hemophilia, and cystic fibrosis
- Carrying the BRCA1 or BRCA2 gene, which increases risk for breast and ovarian cancer
- Family history of heart disease

Health Disparities

Although the term disparities is often interpreted to mean racial or ethnic disparities, many dimensions of disparity exist in

the United States, particularly in health. If a health outcome is seen to a greater or lesser extent between populations, there is disparity. Race or ethnicity, sex, sexual identity, age, disability, socioeconomic status, and geographic location all contribute to an individual's ability to achieve good health. It is important to recognize the impact that social determinants have on health outcomes of specific populations. Healthy People strives to improve the health of all groups.

To better understand the context of disparities, it is important to understand more about the U.S. population. In 2008, the U.S. population was estimated at 304 million people.

- In 2008, approximately 33%, or more than 100 million people, identified themselves as belonging to a racial or ethnic minority population.
- In 2008, 51%, or 154 million people, were women.
- In 2008, approximately 12%, or 36 million people not living in nursing homes or other residential care facilities, had a disability.
- In 2008, an estimated 70.5 million people lived in rural areas (23% of the population), while roughly 233.5 million people lived in urban areas (77%).
- In 2018, an estimated 4% of the U.S. population ages 18 to 44 identified themselves as lesbian, gay, bisexual, or transgender.

Healthy People 2020 defines health equity as the "attainment of the highest level of health for all people". Achieving health equity requires valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices, and the elimination of health and health care disparities."

Health disparities adversely affect groups of people who have systematically experienced greater obstacles to health based on their racial or ethnic group; religion; socioeconomic status; gender; age; mental health; cognitive, sensory, or physical disability; sexual orientation or gender identity; geographic location; or other characteristics historically linked to discrimination or exclusion."

Over the years, efforts to eliminate disparities and achieve health equity have focused primarily on diseases or illnesses and on health care services. However, the absence of disease does not automatically equate to good health. Powerful, complex relationships exist between health and biology, genetics, and individual behavior, and between health and health services, socioeconomic status, the physical environment, discrimination, racism, literacy levels, and legislative policies. These factors, which influence an individual or population's health, are known as determinants of health.

For all Americans, other influences on health include the availability of and access to:

- High-quality education (including *quality* health education)
- Nutritious food
- Decent and safe housing
- Affordable, reliable public transportation
- Culturally sensitive health care providers
- Health insurance
- Clean water and non-polluted air

Risk Factors and Levels of Disease Prevention

Part of learning how to take charge of one's health requires understanding risk factors for different diseases. **Risk factors** are things in life that increase your chances of getting a certain disease. Some risk factors are beyond your control. A person may be born with them or have exposure with no fault assigned.

Some risk factors that you have little or no control over include:

- Family history of a disease
- Sex
- Ancestry

Some controllable risk factors include:

- What you eat
- How much physical activity you get

- Whether you use tobacco or vape
- How much alcohol you drink
- Whether you misuse drugs



In fact, it has been estimated that almost 35 percent of all U.S. early deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (for example, eating more fruits and vegetables and less red meat)
- Getting more physical activity

A person can have one risk factor for a disease or many. The more risk factors a person has, the more likely they will get the disease. For example, if people eat healthy, exercise on a regular basis, and control blood pressure, their chances of getting heart disease are less than those of diabetics, smokers, and sedentary people. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

Levels of Disease Prevention

Prevention includes a wide range of activities — known as "interventions" — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviors that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- Legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)
- Education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- Immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent re-injury or

recurrence, and implementing programs to return people to their original health and function to prevent long-term problems.

Examples include:

- Regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- Daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- Suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- Cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- Support groups that allow members to share strategies for living well
- Vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

Current Issues in Women's Health

Understanding health history, factors that influence wellness and behaviors that improve personal wellness all contribute to a persons current state of health. Now, lets look at current issues or policy in our society that impact a person's access to health care or influence health care choices.

Podcast: How the US Fails Women When it Comes to Health

Valid and Reliable Health Resources

How can you learn more about your own personal health history, disparities, risk factors and possible impact on your life now? As you begin to seek information to improve your own wellness, it is important to understand where to find reliable health information. As you know, anyone can create a a web page and post any information they choose for public perusal. Some of this information, subtly or not so subtly, may have an ulterior motive in selling products, influencing your actions or even your vote. So, when looking for information to care for your own health, how do you discern useful and accurate information from the rest? In other words, who are you willing to trust with your health?

Article: How To Find Reliable Health Information on the Internet

Interactive Tool: Trust It or Trash It

Check for Understanding

1. Reflecting on the reading, what event, development or discovery do you feel has had the greatest impact on women's health?
2. What current issues in women's health are of particular interest to you and why?
3. What are the dimensions of wellness and how might these factors influence each other?
4. What are the determinants of health and give examples of how these determinist may impact your personal health.
5. What is a risk factor an what is the difference between uncontrollable and controllable risk factors?
6. What are the three levels of disease prevention?
7. How does US health care compare to that of other developed countries? Name one area the US is doing well and one area we are failing.
8. What factors might impact a woman's access to quality, affordable health care?
9. When researching health information online, what are at least 4 things you should know about the article to judge validity and reliability?

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7.2: Female Reproductive Anatomy and Physiology

Chapter Objectives

- Explore common methods of sex education in the US and potential benefits/drawbacks
- Identify anatomical structures of the female reproductive system
- Describe hormonal and physiological changes that take place during ovulation and menstruation
- Describe the hormonal and physiological changes that take place during fertilization and implantation
- Explore dysfunction in female reproductive anatomy and potential symptoms/testing

The Female Reproductive System

"Menstrual blood is the only source of blood that is not traumatically induced. Yet, in modern society, this is the most hidden blood, the one so rarely spoken of and almost never seen, except privately by women. ~ Judy Grahn

Sex Education in the US

How did you first learn about your private body? When did you learn how it functioned and how to care for it? For many, these are discussions that take place at home when parents feel their child is old enough to *need* this information. It is often coined "the talk" and is dreaded by old and young alike.

Maybe your parents did not discuss such things but you received a "handy pamphlet" or a 45-minute video in 5th grade to explain your assigned gender along with some rules for future actions. Maybe books, the internet, friends or older siblings were your guide. Rarely are children taught about their own sexual anatomy in a open and comfortable way. Why do we maintain this stigma with certain parts of our bodies?

Consider your own thoughts and beliefs on when children should learn about sexual anatomy and physiology, sexuality, and safe sex. How will the experiences surrounding way a child learns about their sexual health impact future health choices?

Female Reproductive Anatomy

The female reproductive system functions to produce a female egg (gamete), reproductive hormones, support a developing fetus and deliver it into the outside world. Unlike its male counterpart, the female reproductive system is located primarily inside the pelvic cavity (Figure 1). Let's look at some of the structures of the female reproductive system.

External Female Genitalia

The external female reproductive structures are referred to collectively as the **vulva** (Figure 2). The **mons pubis** is a pad of fat that is located over the pubic bone. After puberty, it becomes covered in pubic hair. The **labia majora** (labia = "lips"; majora = "larger") are folds of hair-covered skin that begin just posterior to the mons pubis. The thinner and more pigmented **labia minora** (labia = "lips"; minora = "smaller") lie inside the labia majora. Labia majora and minora serve to protect the female urethra and the entrance to the female reproductive tract.

The forward portions of the labia minora come together to encircle the **clitoris** (or glans clitoris), an organ that originates from the same cells as the glans penis and has abundant nerves that make it important in sexual sensation and orgasm. The **hymen** is a thin membrane that sometimes partially covers the entrance to the vagina. An intact hymen cannot be used as an indication of "virginity"; even at birth, this is only a partial membrane, as menstrual fluid and other secretions must be able to exit the body, regardless of penile–vaginal intercourse. The vaginal opening is located between the opening of the urethra and the anus. It is flanked by outlets to the **Bartholin's glands** (or greater vestibular glands).

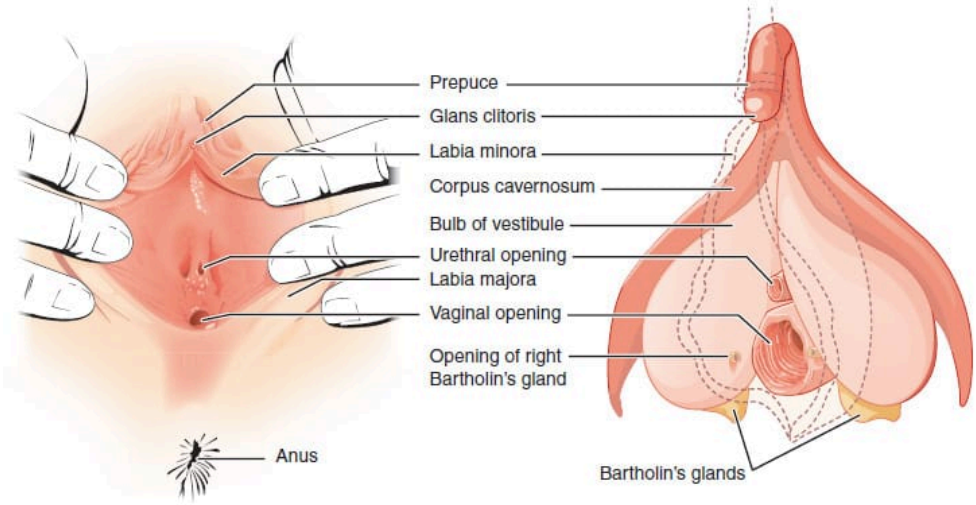


Figure 2. The Vulva. The external female genitalia are referred to collectively as the vulva.

Internal Female Anatomy

The **vagina**, Figure 1, is a muscular canal (approximately 10 cm long) that serves as the entrance to the reproductive tract. It also serves as the exit from the uterus during menses and childbirth. The thin, perforated hymen can partially surround the opening to the vaginal orifice. The hymen can be ruptured with strenuous physical exercise, penile–vaginal intercourse, and childbirth. The Bartholin's glands and the lesser vestibular glands (located near the clitoris) secrete mucus, which keeps the vestibular area moist.

The vagina is home to a normal population of microorganisms that help to protect against infection by bacteria, yeast, or other organisms that can enter the vagina. In a healthy woman, the most predominant type of vaginal bacteria is from the genus *Lactobacillus*. This family of beneficial bacterial flora secretes lactic acid, and thus protects the vagina by maintaining an acidic pH (below 4.5). Potential pathogens are less likely to survive in these acidic conditions. Lactic acid, in combination with other vaginal secretions, makes the vagina a self-cleansing organ. Douching—or washing out the vagina with fluid—can disrupt the normal balance of healthy microorganisms, and actually increase a woman's risk for infections and irritation. Indeed, the American College of Obstetricians and Gynecologists recommend that women do not douche, and that they allow the vagina to maintain its normal healthy population of protective microbial flora.

The **ovaries** are the female gonads (organ that produces female sex cells/eggs) (see Figure 1) each about the size of an almond. The ovaries are located within the pelvic cavity and attached to the uterus via the ovarian ligament (not the fallopian tubes).

The **uterine tubes** (also called fallopian tubes or oviducts) serve as passage for the ovum from the ovary to the uterus. Each of the two uterine tubes is close to, but not directly connected to, the ovary. The middle region of the tube, called the **ampulla**, is where fertilization often occurs. Unlike sperm, oocytes lack flagella (tail), and therefore cannot move on their own. So how do they travel into the uterine tube and toward the uterus? High concentrations of estrogen that occur around the time of ovulation induce contractions of the smooth muscle along the length of the uterine tube. These contractions occur every 4 to 8 seconds, and the result is a coordinated movement that sweeps the surface of the ovary and the pelvic cavity.

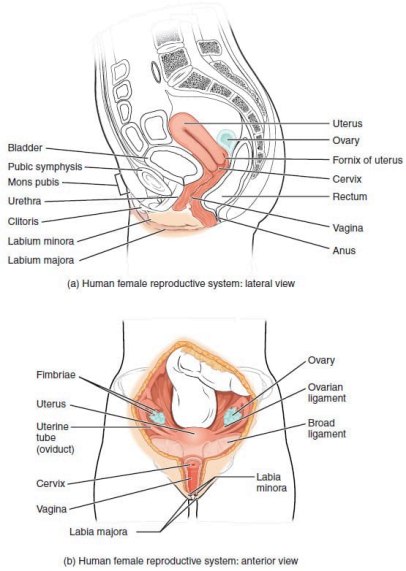


Figure 1. Female Reproductive System. The major organs of the female reproductive system are located inside the pelvic cavity.

Optional Link: Watch this video to observe ovulation and its initiation in response to the release of FSH and LH from the pituitary gland.

If the oocyte is successfully fertilized, the resulting zygote will begin to divide into two cells, then four, and so on, as it makes its way through the uterine tube and into the uterus. There, it will implant and continue to grow. If the egg is not fertilized, it will simply degrade—either in the uterine tube or in the uterus, where it may be shed with the next menstrual period.

Optional Link: Watch this series of videos to look at the movement of the oocyte through the ovary. The cilia in the uterine tube promote movement of the oocyte.

The **uterus** is the muscular organ that nourishes and supports the growing embryo. Its average size is approximately approximately 2 in. by 3 in. when a female is not pregnant. It has three sections. The highest point is called the **fundus**. The middle section of the uterus is called the **body of uterus**. The **cervix** is the narrow bottom portion of the uterus that projects into the vagina. The cervix produces mucus secretions that become thin and stringy under the influence of estrogen which can facilitate sperm movement through the reproductive tract.

The wall of the uterus is made up of three layers. The **perimetrium** (outer layer), **myometrium** (muscle layer) **and endometrium** (part of this layer is shed during menses)**.** Most of the uterus is myometrial tissue, and the muscle fibers run horizontally, vertically, and diagonally, allowing the powerful contractions that occur during labor and the less powerful contractions (or cramps) that help to expel menstrual blood during a woman's period.

Female Reproductive Physiology – The Menstrual Cycle

Menstruation

The menstrual cycle is the process by which a woman's body gets ready for the chance of a pregnancy each month. The average menstrual cycle is 28 days from the start of one to the start of the next, but it can range from 21 days to 35 days. Most menstrual periods last from three to five days. In the United States, most girls start menstruating at age 12, but girls can start menstruating between the ages of 8 and 16. **Menarche** is a term referring to the first occurrence of mensuration.

When a woman menstruates, her body sheds the lining of the uterus (part of the endometrium). Menstrual blood flows from the uterus through the small opening in the cervix and passes out of the body through the vagina (see how the menstrual cycle works below).

The regular occurrence of menses is called the menstrual cycle. Having a regular menstrual cycle is a sign that reproductive organs are working properly. In addition to preparing the body for a pregnancy, this cycle provides important body chemicals (hormones) for a number of body functions related and not related to pregnancy.

In the first half of the cycle, levels of estrogen start to rise. Estrogen plays an important role bone health and supports growth and thickening in the lining of the uterus. This endometrial lining will nourish the embryo if a pregnancy occurs. At the same time the lining of the womb is growing, an ovum will mature in one of the ovaries. At about day 14 of an average 28-day cycle, the egg leaves the ovary. This is called **ovulation**.

After the egg has left the ovary, it travels through the fallopian tube to the uterus. Hormone levels rise and help prepare the uterine lining for pregnancy. A woman is most likely to get pregnant during the 3 days before or on the day of ovulation. Keep in mind, women with cycles that are shorter or longer than average may ovulate before or after day 14.

A woman becomes pregnant if the egg is fertilized by a man's sperm cell and attaches to the uterine wall. If the egg is not fertilized, hormone levels drop the thickened lining of the uterus is shed during the menstrual period.

The Menstrual Cycle

- Day 1 starts with the first day of a period. This occurs after hormone levels drop at the end of the previous cycle, signaling blood and tissues lining the uterus to break down and shed from the body. Bleeding lasts about 5 days.
- Usually by Day 7, bleeding has stopped. Leading up to this time, hormones cause fluid filled pockets called follicles to develop on the ovaries. Each follicle contains an egg.
- Between Day 7 and 14, one follicle will continue to develop and reach maturity. The lining of the uterus starts to thicken, waiting for a fertilized egg to implant. The lining is rich in blood and nutrients.
- Around Day 14 (in a 28-day cycle), hormones cause the mature follicle to burst and release an egg from the ovary, a process called ovulation.
- Over the next few days, the egg travels down the fallopian tube towards the uterus. If a sperm unites with the egg, the fertilized egg will continue down the fallopian tube and attach to the lining of the uterus.
- If the egg is not fertilized, hormone levels will drop around Day 25. This signals the next menstrual cycle to begin. The egg will be shed with the next period.

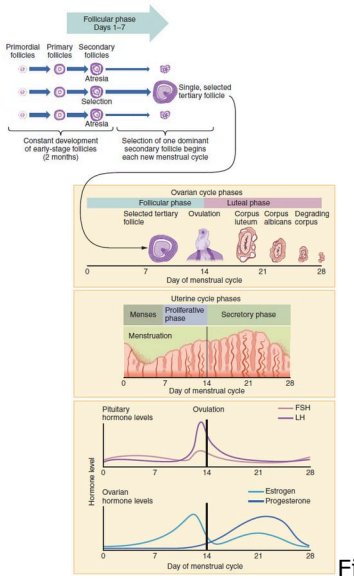


Figure 7. Hormone Levels in Ovarian and Menstrual Cycles. The correlation of the hormone levels and their effects on the female reproductive system is shown in this timeline of the ovarian and menstrual cycles. The menstrual cycle begins at day one with the start of menses. Ovulation occurs around day 14 of a 28-day cycle, triggered by the LH surge.

Female Reproductive Physiology – Sexual Response Cycle and Fertility

Let us consider a research-based paradigm developed by Masters and Johnson (1966) which they called the sexual response cycle. The sexual response cycle is a model that outlines the three phases most people experience when they engage in sexual intercourse: excitement, plateau, and then orgasm. Masters and Johnson were quick to point out that each individual has a unique and varied sexual response, so much so, that no two sexual encounters would be expected to be perfectly identical between the same people. Nevertheless, these three phases are very common among most people.

As sexual intercourse begins both males and females pass through three phases. **Excitement** phase is when blood flows to the

pelvis bringing, more lymphatic fluid and plasma to the region. Because of hormonal and psychological stimuli there is generally swelling in sexual anatomy such as the penis, vaginal walls and clitoris. While this is happening, the **plateau** phase begins which is when more hormones are released, moisture increases, heart rate increases, intensity of sensory perception increases (touch, smell, sight, hearing, and taste). In the orgasm phase an electrical build up of energy is released that is associated with a rhythmic contraction of the pelvic floor muscles, the urinary and anal sphincters, and of various glands for males. This is called an **orgasm**. After the orgasm finishes, resolution eventually allows sexual anatomy to return to pre-excitement conditions.

Sexual response in a female would typically follow a pattern similar to this one:

- **Excitement phase:** Blood and lymphatic fluids increase swelling inside the vagina. Hormones are secreted which lead to a mild uterine contractions which raise the uterus away from the pubic bone. The labia swell and the clitoris becomes hard. The vaginal tissues secrete moisture and the vagina itself lengthens and expands slightly inward.
- **Plateau phase:** Begins as excitement continues, causing the labia and clitoris to become fully swollen, and the uterus to become elevated. The vagina is lengthened into the body, and, just before orgasm, lubrication ceases.
- **Orgasm**: The pelvis of the female experiences a series of contractions which occur every 8/10ths of second and can number anywhere from 1-20 or more in the sequence. The contractions include anal and urinary sphincter muscles, smooth muscles in the inward portion of the vagina, and the puboccocceygeus muscles. Further, an electrical sensation surges from the clitoris radiating throughout the body and stimulates the pleasure centers of the brain and a release of the hormone called Oxytocin (the “boding hormone”). When the orgasm ends, the body eventually returns to its pre-excitement state. In general, females have the capacity to experience more contractions over a longer period of time than do males.

Females have been found to have much more capacity for sexual intercourse than males. This means females can have more sexual intercourse, more often, and with more orgasms than can the average male.

The Sexual Experience

Even though the physiological component of sexuality is common between sexes, the anatomical male and female sex drives may not be identical. Studies consistently show that sexual desire for women is more sensitive to the context (meaningful or intimate connection) and the social and cultural environment (quality of relationships, stresses of the day, etc.). This is not surprising given the potential long term “cost” of a sexual encounter for a female. While a male (biologically) always has the opportunity to walk away from a sexual encounter without consequence of pregnancy and/or child rearing, a female does not.

Female Anatomical and Physiological Dysfunction

Pelvic Inflammatory Disease (PID)

The open-ended structure of the uterine tubes can have significant health consequences if bacteria or other contagions enter through the vagina and move through the uterus, into the tubes, and then into the pelvic cavity. If this is left unchecked, a bacterial infection (sepsis) could quickly become life-threatening. The spread of an infection in this manner is of special concern when unskilled practitioners perform abortions in non-sterile conditions. Sepsis is also associated with sexually transmitted bacterial infections, especially gonorrhea and chlamydia. These increase a woman’s risk for pelvic inflammatory disease (PID), infection of the uterine tubes or other reproductive organs. Even when resolved, PID can leave scar tissue in the tubes, leading to infertility.

Endometriosis

Endometriosis is a disorder in which endometrial cells implant and proliferate outside of the uterus—in the uterine tubes, on the ovaries, or even in the pelvic cavity.
UCLA Health: Endometriosis

Yeast Infection (Vaginal Candidiasis)

A yeast infection is a fungal infection that may cause irritation of the vulva and discharge from the vagina. Yeast infections are fairly common in women affecting approximately 75% of women at some time in their life and easily treated.

UCLA Health: Yeast Infection

PMS

Premenstrual syndrome is a group of symptoms that cause physical and emotional effects between ovulation and a period. The intensity of symptoms varies from mild in some women to debilitating in others.

UCLA Health: PMS

PCOS/Ovarian cysts

Ovarian *cysts* are fluid-filled sacs in or on an ovary. Polycystic ovarian syndrome (PCOS) is a hormonal disorder that may cause numerous cyst to develop on the ovaries (potentially) impacting ovulation. Women with PCOS may have infrequent or prolonged menstrual periods or excess male hormone levels.

UCLA Health: PCOS

Fibroid tumors

Fibroids are abnormal growths that develop in or on the muscle wall of a woman's uterus. These tumors can become quite large and cause abdominal pain and/or infertility.

UCLA Health: Fibroids

Check for Understanding

1. Will the resources available to an individual when learning about sexual health affect the choices that person makes regarding their own sexual health?
2. What is one possible reason for the preponderance of evidence showing the importance of connection and context in the female sexual experience?
3. What types of dysfunction may impact female sex organs? What can be done to reduce risk, treat or manage these conditions?

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7.3: Nutrition and Fitness

Chapter Objectives

- List the macronutrients and micronutrients essential to body function and describe specific functions in the body
- Discuss nutrients deficiencies common in women and how these deficiency may impact future health
- List types of fitness training important to maintaining physical wellness
- Calculate personal caloric balance using BMR and AMR

Exercise is a celebration for what your body can do, not a punishment for what you ate. ~ Sachin Pinate

Nutrition and Healthy Eating

After learning about anatomical structures in chapter 2 we continue with methods and behaviors that keep body systems healthy and lower risk of disease or dysfunction. The foods we eat affect all dimensions of health and wellness. Many of the health issues associated with poor eating habits are a result of an energy imbalance or lack of nutrients. Most Americans are obtaining more energy from food than they actually need to function in their daily lives and fewer vitamins and minerals.

Nutrients

Ideally, when we consume and obtain energy from our food, we will primarily eat nutrient dense foods. A nutrient is a compound that provides a needed function in the body. The six **Essential Nutrients** are the nutrients that our bodies need in order to survive. They can be broken into two categories: macronutrients and micronutrients.

Macronutrients are nutrients needed in larger amounts. There are four macronutrients which include:

- Carbohydrates: 4 calories per gram
- Fats (lipids): 9 calories per gram
- Protein: 4 calories per gram
- Water: contains 0 calories

As can be seen, carbohydrates, protein, and fats provide energy. However, there is another energy source in the diet that is not a nutrient- alcohol. Alcohol has 7 calories per gram.

Micronutrients are nutrients needed in smaller amounts, but they are still considered essential. There are two groups of micronutrients which are:

- Vitamins
- Minerals

Carbohydrates

Carbohydrates provide energy for the body as well as fiber for digestive health and blood sugar regulation. Many natural carbohydrates such as fruits, vegetables and whole grains provide essential vitamins and minerals.

Although grains and starchy foods are most often associated with carbohydrates, almost all foods do contain some carbohydrates. Some dietary examples of carbohydrate rich foods are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta. There are many different types of carbohydrates, but the three main types are: simple, complex, and alternative sugar sweeteners.

Simple Carbohydrates

Simple carbohydrates provide quick energy for the body with a spike in blood sugar. If used before exercise or activity this energy can be beneficial and if taken in as fruit and veggies, also very nutritious. However, empty simple sugars, such as candy,

cause a rise and then drop in blood sugar that may leave a person hungry a short time later without providing the body necessary vitamins and minerals for growth and maintenance.

Food manufacturers are always searching for cheaper ways to produce food. One method that has been popular is the use of high-fructose corn syrup as an alternative to sucrose (table sugar). High-fructose corn syrup contains 55% fructose which is similar to sucrose. Nevertheless, because an increase in high-fructose corn syrup consumption has coincided with the increase of obesity in the US, there is a lot of controversy surrounding its use. In reading labels, one will usually see high-fructose corn syrup plus other sugars listed which could be adding to the obesity epidemic.

High-Fructose Corn Syrup

Food manufacturers are always searching for cheaper ways to produce their products. One extremely popular method for reducing costs is the use of high-fructose corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose, which is the same as sucrose. Nevertheless, because increased consumption of high-fructose corn syrup has coincided with increased obesity in the United States, a lot of controversy surrounds its use.

The New York Times article linked below discusses the growing popularity of sugar compared to high fructose corn syrup: "Sugar is Back on Food Labels, This Time as a Selling Point"

Complex Carbohydrates

Complex Carbohydrates contain many sugar molecules while simple carbohydrates contain only one or two sugars. Complex Carbohydrates are called polysaccharides. Poly means "many," and thus polysaccharides are made of more than 10 sugar molecules. There are two classes of food based polysaccharides: starch and fiber. Starch is a main source of fuel for the cells. After cooking, starch becomes digestible for humans. Raw starch may resist digestion. Examples of starch foods are corn, potatoes, rice, beans, pasta, and grains. Fiber is indigestible matter that survives digestion in the small intestine and stays intact in the large intestine. It is divided into two categories: soluble and insoluble. Soluble means it can be dissolved in water, and insoluble means it does not dissolve in water.

- **Soluble fibers** are fermentable fibers. It is believed that these fibers decrease blood cholesterol and sugar levels thus lowering the risk of heart disease and diabetes II.
- **Insoluble fibers** are non-fermentable, and it is believed that this type of fiber decreases the risk of constipation and colon cancer because it increases stool bulk and reduces transit time. This reduced transit time means shorter exposure to consumed carcinogens in the intestine which may lower cancer risk.

The goal for a day's fiber intake is 25-40 grams depending on one's caloric intake. Suggestions would be to buy high fiber foods. Read the Nutrition Facts' label for how much fiber is in the product for one serving. Drink lots of fluids when eating fiber. Try to eat a minimum of five plant foods for fiber each day.

Carbohydrates have become, surprisingly, quite controversial. However, it is important to understand that carbohydrates are a diverse group of compounds that have a multitude of effects on bodily functions. Thus, trying to make blanket statements about carbohydrates is not a good idea.

Fats (Lipids)

Lipids, commonly referred to as fats, have a poor reputation among most people. "Fat free" labeling on packaging is often perceived as healthy. We do need to consume certain fats, and we should try to incorporate these fats into our diets for their health benefits. However, consumption of certain fats is also associated with a greater risk of developing chronic disease(s). There are different categories of lipids:

- Triglycerides
- Oils
- Cholesterol

Fats (lipids) are the most concentrated source of energy at 9 calories per gram. Fats provide long term stored energy (in the from of triglycerides), insulation, cushion, and help the body absorb fat-soluble vitamins. Depending on the fatty acid structure a lipid may be monounsaturated, polyunsaturated, or saturated.

Triglycerides

Triglycerides are molecules made of glycerol and fatty acids. They are the major form of energy storage in animals.

Triglycerides perform the following functions in our bodies:

- Provide energy
- Primary form of energy storage in the body
- Insulate and protect
- Aid in the absorption and transport of fat-soluble vitamins.

Structures of Fatty Acids

Fatty acids are components of triglycerides. They are like the brick in a brick wall. Each individual brick is needed to make the overall wall. There are two basic types of fatty acids:

- **saturated fatty acid**
- **unsaturated fatty acid**

These molecules differ in structure and food sources. Saturated fats are typically found in animal products such as poultry, meat and dairy and are solid at room temperature. Unsaturated fats are typically found in plants and vegetable oils and are liquid at room temperature. There are also **monounsaturated fatty acids** (MUFAs) and **polyunsaturated fatty acids** (MUFAs), which have a healthy affect on cholesterol levels.

There are two essential fatty acids, which are:

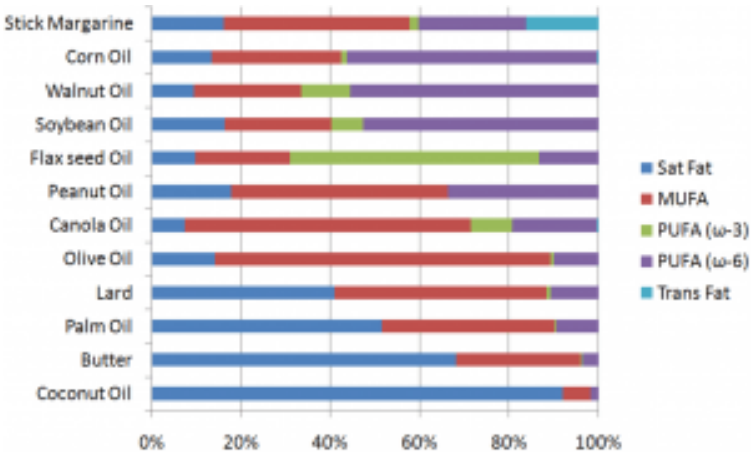
- **linoleic acid (omega-6)**
- **alpha-linolenic (omega-3)**

These fatty acids are essential because the body cannot synthesize them. The essential fatty acids are critical to human health as they play important roles in every system of the body. Good food sources of omega-6 include whole grains, fresh fruits and veggies, fish, olive oil, and garlic. Good food sources of omega-3 include flax seed, egg yolk, and chia seeds.

Trans-fatty acids

Trans-fatty acids – like Crisco- are hydrogenated vegetable oils. In an artificial chemical process hydrogen is added to natural vegetable oils to make them more solid at room temperature, and more heat resistant for cooking, thus, hydrogenated oils are more resistant to heat degradation. The body doesn't have an efficient process for using trans-fats, so they get stored for the long term. The figure below shows the fatty acid composition of certain oils and oil-based foods. As can be seen, most foods contain a mixture of fatty acids.

Figure 1. Different Types of Fat



Cholesterol

Cholesterol is a type of lipid found in the blood. It has many functions and is a structural part of all body cells, including brain and nerve tissue. Cholesterol is needed to form hormones, bile, and vitamin D. Many foods contain cholesterol, but primarily it is found in foods of animal origin. Some meats are higher in cholesterol than others.

The body needs cholesterol, but it produces all of the cholesterol that it needs. It is almost impossible to avoid consuming outside sources of cholesterol, but it is possible and advisable to limit cholesterol intake by avoiding foods high in cholesterol. Elevated levels of LDL ("bad cholesterol") in the blood can increase the risk of artery and heart disease.

The human body contains two types of cholesterol: low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

LDL: The "Bad" Cholesterol

LDL is cholesterol that usually enters the human body through consuming food that contains cholesterol. LDL is considered the "bad cholesterol" because it bonds with triglycerides and stores it within the tissues. This is the leading cause of plaque in the arteries and can lead to restricted blood flow and possible cardiac arrest. This process takes place over several years with continuous eating of saturated fats, smoking, diabetes, and high blood pressure.

Figure 2. Blood flow restricted by the buildup of LDL cholesterol



Cholesterol plaque in the artery

HDL: The "Good" Cholesterol

HDL is produced when a person exercises, and it is considered the "good cholesterol." HDL also bonds with triglycerides, but it is then processed by the body, added to feces, and expelled through the colon. In other words, HDL helps the body to process excess triglycerides thus managing the amount of excess fat in the overall system. The best way to increase HDL in the body is to exercise regularly.

A Lipid Panel is a series of tests that measures the amount of cholesterol in the blood. A small sample of blood is drawn from the patient for this test. One number is for "total cholesterol." This number will show the total fats in the blood. The HDL will show the good fats; LDL will show the bad fats; Triglycerides will show good or bad fats depending on the number above or below 150.

Adult Blood Cholesterol and Triglyceride Target Numbers:

- Total Cholesterol < 200 mg/dl
- Total HDL > 35
- Total LDL < 100
- Total Triglycerides < 150

Proteins

Proteins are another major macronutrient. They are similar to carbohydrates in that they are made up of small repeating units, but instead of sugars, proteins are made up of **amino acids**. Protein makes up approximately 20 percent of the human body and is present in every single cell. The word protein is a Greek word, meaning "of utmost importance." Proteins are called the workhorses of life as they provide the body with structure and perform a vast array of functions. You can stand, walk, run, skate, swim, and more because of your protein-rich muscles. Protein is necessary for proper immune system function, digestion, and hair and nail growth, and is involved in numerous other body functions. In fact, it is estimated that more than one hundred thousand different proteins exist within the human body.

What Is Protein?

Proteins, simply put, are macromolecules composed of amino acids. **Amino acids** are commonly called protein's building blocks.

The functions of proteins are very diverse because there are 20 distinct amino acids that form long chains. For example, proteins can function as enzymes or hormones. Enzymes, one type of protein, are produced by living cells and are catalysts in biochemical reactions (like digestion). Enzymes can function to break molecular bonds, to rearrange bonds, or to form new bonds. An example of an enzyme is salivary amylase which breaks down amylose, a component of starch.

Amino Acids Function

Amino acids are combined in order to form all of the protein the human body needs. In fact, the body makes proteins itself, but it needs amino acids from food to construct proteins that the body uses. Antibodies, enzymes, muscle proteins, as well as proteins in the skin are all made up of amino acids, some that the body produces and some that must be consumed. Amino acids that the body produces are called **non-essential amino acids**. There are eleven non-essential amino acids: alanine, arginine, asparagine, aspartate, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine. In Nutrition, the term essential is used to name nutrients that the body doesn't produce itself; essential nutrients including **essential amino acids** must be consumed. There are nine essential amino acids: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

Complete and Incomplete Proteins

As a way of simplifying protein, sources are described as either complete or incomplete. **Complete proteins** – such as eggs, tuna fish, peanut butter, almonds – contain most if not all of the essential amino acids. **Incomplete proteins** – such as spinach, beans, wheat germ – contain just a few of the essential amino acids.

Most plant-based proteins are categorized as incomplete proteins, but vegetarians should not be concerned about protein intake because a person can consume all of the essential amino acids by combining food sources. For example a person can eat beans and quinoa with a spinach salad and consume the essential amino acids.

Water

Water is made up of hydrogen and oxygen (H_2O) and doesn't provide energy for the body (calories). Humans are approximately 65% water! The body needs water to regulate temperature, moisten tissues in the mouth, eyes, and nose, lubricate joints, protect organs, prevent constipation, reduce the burden on kidneys and liver by helping to flush out waste, and to dissolve nutrients as part of the digestive process.

Although a person can survive for several weeks without food, the body cannot survive longer than a few days without fluids. A loss of water equivalent to:

- 1% of body weight is enough to cause thirst and to impact the ability to concentrate
- 4% loss of hydration results in dizziness and reduced muscle power
- 6% loss of fluids causes the heart to race and sweating ceases
- 7% loss of hydration results in collapse and subsequent death if fluids are not replaced

Water Intake

In a normal diet, fluid is gained via food as well as in drinks. Water, along with some herbal teas and low sugar juices hydrate the body. However, alcoholic, high sugar, and caffeinated drinks may not contribute to body fluids as alcohol, sugar and caffeine are diuretics, substances that increases the output of urine by the body.

Fluid loss occurs in various ways throughout the body with urination being the primary method. Perspiration (sweating), and respiration (breathing) also removes fluid from the body. Water intake and water loss should be balanced in order to prevent dehydration and to maintain a healthy body. The recommended daily **intake** is 10-13 cups of fluid from food and drink for adult males and 7-9 cups of fluid for adult females or half your body weight in ounces.

Vitamins

Vitamins are organic compounds that are essential for normal physiologic processes in the body. Before their detailed chemical structures were known, vitamins were named by being given a letter. They are generally still referred to by that letter as well as by their chemical name, for example, vitamin C or ascorbic acid.

Vitamins are categorized as either water-soluble or fat-soluble based on how they are dissolved in the body. **Water soluble vitamins** are dissolved in water and absorbed during digestion. Excess water-soluble vitamins are excreted through urine. **Fat-soluble vitamins** are absorbed through the digestive process with the help of fats (lipids). Excess fat-soluble vitamins can build up in the body and become toxic. Vitamin supplements can be dangerous particularly with fat-soluble vitamins because people can overdose.

A balanced diet includes all of the vitamins and minerals a person needs daily.

Water-Soluble Vitamins

There are nine water-soluble vitamins: Vitamin C, and eight Vitamin B's.

Fat-Soluble Vitamins

There are four fat-soluble vitamins: Vitamins A, D, E, and K.

Minerals

Minerals are essential, non-caloric nutrients that are in all of our food and are essential for normal physiologic processes in the body. Minerals are micronutrients, which means humans only need to eat them in small quantities. Minerals assist body functions that range from bone strength to regulating your heartbeat.

When plants take up the water through their roots, dissolved minerals from within the soil are absorbed by the plant. When people eat plants, they are ingesting minerals found in the plant. Animals are able to concentrate minerals in their tissues, so meats and other foods derived from animals often contain a higher concentration of minerals.

There are two categories of minerals: major minerals and trace minerals. The classification of a mineral as major or trace depends on how much of the mineral the body needs.

Major minerals include:

- Calcium
- Phosphorus
- Sodium
- Potassium
- Magnesium

Trace minerals include:

- Iron
- Fluoride
- Zinc

- Copper
- Iodine
- Manganese
- Chloride
- Selenium

Vitamin and Mineral Supplements

Vitamin and mineral supplements exist, but are not as effective as getting minerals from whole foods. There are two types of supplement: whole food supplements and synthetic supplements.

Whole food supplements are produced by taking vitamins and minerals straight from natural sources: soil, rocks, or plant/food sources; whereas, synthetic minerals are made in a lab. While synthetic mineral supplements mimic the chemical structure of vitamins and minerals, they are probably not exact copies. That means the body may not recognize the synthetic mineral structure and does not absorb the mineral efficiently. No supplements, including vitamins and minerals, are approved by the FDA. Only prescription drugs are approved by the FDA. A healthy balanced diet can provide all the vitamins and minerals needed.

Food and Metabolism

The amount of energy that is needed or ingested per day is measured in calories. A **calorie** is the amount of heat it takes to raise 1 g of water by 1 °C. On average, a person needs 1500 to 2000 calories per day to sustain (or carry out) daily activities. The total number of calories needed by one person is dependent on his/her body mass, % lean mass, age, height, gender, activity level, and the amount of exercise per day. If exercise is a regular part of one's day, more calories are required. As a rule, people underestimate the number of calories ingested and overestimate the amount they burn through exercise. This can lead to ingestion of too many calories per day. The accumulation of an extra 3500 calories adds one pound of weight. If an excess of 200 calories per day is ingested, one extra pound of body weight will be gained every 18 days. At that rate, an extra 20 pounds can be gained over the course of a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns about 100 calories.

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. In fact, the breakdown of carbohydrates requires the least amount of energy; whereas, the processing of proteins demands the most energy. In general, the amount of calories ingested and the amount of calories burned determines the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything one ingests, so when considering calorie intake, beverages must also be considered.

Planning a Diet

The definition of diet is anything that is consumed by a particular person or people on a regular basis. That means if someone routinely drinks coffee in the morning, that is part of his/her diet. If a person consistently eats a Big Mac from McDonald's, that is part of his/her diet.

It is clear that food choices influence short-term and long-term health. That is why it is so important to make wise choices in what one eats on a regular basis. If a person chooses to have a diet high in calories without balancing energy use, that person can expect to put on unhealthy weight. A diet that is high in fiber, with the appropriate amount of calories and proper amounts of the macronutrients, will contribute to a healthy body.

any times, the term diet is thought of as a method to lose weight or to change body shape. However, it is important to focus on the nutritional concepts listed below, so long-term health can be achieved.

Decisions about nutrition can be difficult. Knowing and using scientific research can lead to better health. Public health organizations have developed tools based on nutritional science to help people design healthy diets. These tools should be used as guidelines for each individual with the awareness that everyone is different and therefore has different needs. Everyone, regardless of age, size, shape, physique, can benefit from learning and utilizing the following tools:

Acceptable Macronutrient Distribution Range

The Acceptable Macronutrient Distribution Range (AMDR) describes the proportions of daily caloric intake that should be

carbohydrates, lipids, and proteins. Basically the AMDR provides guidelines on how many macronutrient calories one should consume a day.

According to the AMDR, the range of caloric intake in a daily diet should be:

- Carbohydrates: 45-65%
- Lipids: 20-35%
- Proteins: 10-35%

These ranges give enough variance to serve all genders and activity levels.

Dietary Reference Intakes

The Dietary Reference Intakes (DRI's) are reference values of nutrient intake that help with nutrition planning and assessment of healthy individuals. There are four measures that together comprise the DRI:

- Recommended Dietary Allowance (RDA): the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (about 97%) healthy individuals in a group. This is the basic quantity of a nutrient recommended.
- Adequate Intake (AI): a value based on observed or experimentally determined approximations of nutrient intake by a group (or groups) of healthy people—used when an RDA cannot be determined. This is the minimum amount of a nutrient needed for maintaining health.
- Tolerable Upper Intake Level (UL): the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the risk of adverse effects increases. This is the maximum that would be consumed prior to developing negative effects of eating too much. This is not a level that is met, but rather one that is avoided to prevent a decrease in health.
- Estimated Average Requirement (EAR): a nutrient intake value that is estimated to meet the requirement of half the healthy individuals in a group. These nutrient values should be used as goals for dietary intake for health.

4 Key Concepts for Personalizing a Healthy Diet

Personalizing meal plans can be extremely beneficial psychologically as well as physically. Knowing that one is eating healthy reduces some of the subconscious doubts about doing what needs to be done to be well. However, as with every healthy practice, there can be pitfalls. To help avoid these, there are 4 approaches that can be taken:

1. Assessing and changing your current diet
2. Staying committed to a healthy diet
3. Try additions and substitutions to bring your current diet closer to your goals
4. Plan ahead for challenging situations

Planning Healthy Meals

Individual requirements for nutrients vary considerably depending on factors such as age and gender. Other relevant factors are size, metabolic rate, and occupation. A farmer would have a different dietary need than someone in a sedentary occupation. The body also has stores of certain nutrients (fat-soluble vitamins, for example) so that variations in daily intake of such nutrients can be accommodated.

When considering dietary needs, various techniques have been established by health officials to assist people in choosing foods and food amounts wisely. **Choose My Plate** is a graphic representation of what a healthy plate of food might look like.

Other tools, such as **meal planning guides** can easily be found and utilized online or through apps.

Nutrition Labels

Perhaps one of the most effective tools provided to consumers is the nutrition label that is, by law, on all food packaging. This information can be useful for evaluating the nutrient content of food and planning healthy meals.

In the United States, the Food and Drug Administration (FDA) requires packaged foods to have a label that helps consumers make

educated decisions about the foods they purchase. The label provides caloric, macronutrient, and some micronutrient content of the food. Labels also indicate ingredients and manufacturer information.

FYI: Food labels do not provide all nutritional information; they just include the basics to help consumers make healthy food decisions.

Information On Food Labels

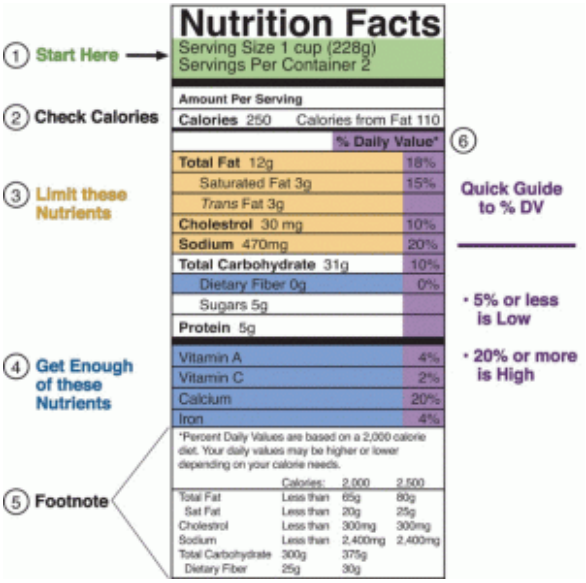
- **Name of product:** Sometimes the name of the product includes important information. For example some brands are vegetarian, kosher, gluten-free, etc. It is also important to compare/contrast ingredients in generic and brand name foods
- **Serving Size:** It's important to pay attention to how many servings a package contains. Many packages contain multiple servings.

Figure 4. Using your hand to determine serving size



- **Calories**: Pay attention to whether the caloric content of the food is per serving or per package. Also, some food labels indicate calories before or after preparation.
- **Fats**: The food label includes all fats. Note that the label indicates different types of fats.
- **Cholesterol**: Dietary cholesterol is a major factor in cardiovascular health. Limiting the intake of cholesterol can prevent heart disease.
- **Sodium**: Another major factor in promoting good health is limiting the amount of sodium intake to less than 2000mg per day.
- **Carbohydrates**: The food label includes simple and complex carbohydrates. Note that the label indicates different types of carbohydrates. Carbohydrates should make up 45-65% of a persons diet while keeping grams of sugar below 25-30 grams per day.
- **Proteins**: Protein intake needs to be carefully monitored because over or under consumption of protein can cause severe issues.
- **Vitamins and Minerals**: There are four vitamins and minerals (Vitamin D, Calcium, Iron, and Potassium) that are required on food labels; however, the label might include more than these four.
- **Ingredients**: The ingredients are listed in order of their content per volume. If sugar is listed as the first ingredient, there is more sugar in the food than any other ingredient. The last ingredient has the least amount in the food.
- **Name of manufacturer**: In addition to the Nutrition Facts, the food label includes the name and contact information for the manufacturer as required by law.
- **Allergens**: Food manufacturers are required to draw specific attention to common allergens such as nuts, milk products, soy, etc. There is no specific location for allergen information, but it should be someplace on the packaging.

Figure 5. Nutrition Facts



To learn additional details about all of the information contained within the Nutrition Facts panel, see the following website: http://www.fda.gov/Food/ResourcesForYou/Consumers/NFLPM/ucm274593.htm

Dietary Food Trends

Hundreds of years ago, when food was less accessible and daily life required much more physical activity, people worried less about obesity and more about simply getting enough to eat. In today's industrialized nations, conveniences have solved some problems and introduced new ones, including the hand-in-hand obesity and diabetes epidemics. Fad diets gained popularity as more North Americans struggled with excess pounds. However, new evidence-based approaches that emphasize more holistic measures are on the rise. These new dietary trends encourage those seeking to lose weight to eat healthy, whole foods first, while adopting a more active lifestyle. These sound practices put dietary choices in the context of wellness and a healthier approach to life.

Table 2: The Pros and Cons of Seven Popular Diets

Diet	Pros	Cons
DASH Diet	• Recommended by the National Heart, Lung, and Blood Institute, the American Heart Association, and many physicians • Helps to lower blood pressure and cholesterol • Reduces risk of heart disease and stroke • Reduces risk of certain cancers • Reduces diabetes risk	• There are very few negative factors associated with the DASH diet
Gluten-Free Diet	• Reduces the symptoms of gluten intolerance, such as chronic diarrhea, cramping, constipation, and bloating • Promotes healing of the small intestines for people with celiac disease, preventing malnutrition • May support weight loss • May be beneficial for other autoimmune diseases, such as Parkinson's disease, rheumatoid arthritis, and multiple sclerosis • May be helpful for Types 1 and 2 diabetes and anemia	• Risk of folate and iron deficiencies • Special gluten-free products can be hard to find and expensive • Requires constant vigilance and careful food label reading, since gluten is found in many products

Low-Carb Diet	• Restricts refined carbohydrates, such as white flour and white sugar • May temporarily improve blood sugar or blood cholesterol levels	• Not entirely evidence-based • Results in higher fat and protein consumption
Mediterranean Diet	• A reduced risk of cardiovascular disease and mortality • A lower risk of cancer • De-emphasizes processed foods and emphasizes whole foods and healthy fats • Lower sodium intake, due to fewer processed foods • Emphasis on monosaturated fats leads to lower cholesterol • Highlighting fruits and vegetables raises consumption of antioxidants	• Does not specify daily serving amounts • Potential for high fat and high calorie intake as nuts and oils are calorie-dense foods • Drinking one to two glasses of wine per day may not be healthy for those with certain conditions
Raw Food Diet	• Emphasizes whole foods • Focuses on nutritionally-rich foods • High in fiber	• Not entirely evidence-based • Very restrictive and limits protein and healthy fat intake • Could encourage the development of foodborne illness • Extremely difficult to follow • Can cause deficiencies in essential vitamins
Vegetarianism and Veganism	• May reduce cancer risk • May reduce heart disease risk • May reduce obesity risk • May help prevent Type 2 diabetes • Helps with weight reduction and weight maintenance	• Guidelines regarding fat and nutrient consumption must be followed • Requires vigilance to watch out for hidden animal products • Requires negotiating meals and holidays with meat-eating friends and family

Weight Management

Achieving and sustaining appropriate body weight across the lifespan is vital to maintaining good health and quality of life. Many behavioral, environmental, and genetic factors have been shown to affect a person's body weight. Calorie balance over time is the key to weight management. Calorie balance refers to the relationship between calories consumed from foods and beverages and calories expended in normal body functions (i.e., metabolic processes) and through physical activity. People cannot control the calories expended in metabolic processes, but they can control what they eat and drink, as well as how many calories they use in physical activity.

Calories consumed must equal calories expended for a person to maintain the same body weight. Consuming more calories than expended will result in weight gain. Conversely, consuming fewer calories than expended will result in weight loss. This can be achieved over time by eating fewer calories, being more physically active, or, best of all, a combination of the two.

Maintaining a healthy body weight and preventing excess weight gain throughout the lifespan are highly preferable to losing weight after weight gain. Once a person becomes obese, reducing body weight back to a healthy range requires significant effort over a span of time, even years. People who are most successful at losing weight and keeping it off do so through continued attention to calorie balance.

The current high rates of overweight and obesity among virtually all subgroups of the population in the United States demonstrate that many Americans are in calorie imbalance—that is, they consume more calories than they expend. To curb the obesity

epidemic and improve their health, Americans need to make significant efforts to decrease the total number of calories they consume from foods and beverages and increase calorie expenditure through physical activity. Achieving these goals will require Americans to select a healthy eating pattern that includes nutrient-dense foods and beverages they enjoy, meets nutrient requirements, and stays within calorie needs. In addition, Americans can choose from a variety of strategies to increase physical activity.

Key Recommendations

- Prevent and/or reduce overweight and obesity through improved eating and physical activity behaviors.
- Control total calorie intake to manage body weight. For people who are overweight or obese, this will mean consuming fewer calories from foods and beverages.
- Increase physical activity and reduce time spent in sedentary behaviors.
- Maintain appropriate calorie balance during each stage of life—childhood, adolescence, adulthood, pregnancy and breastfeeding, and older age.

Balancing Calories and Eating Healthfully

Understanding Calories Needs

The total number of calories a person needs each day varies depending on a number of factors, including the person's age, gender, height, weight, and level of physical activity. This number is called **basal metabolic rate**, or the base number of calories to survive and carry out basic functions. In addition, a desire to lose, maintain, or gain weight affects how many calories should be consumed. Estimates range from 1,600 to 2,400 calories per day for adult women and 2,000 to 3,000 calories per day for adult men, depending on age and physical activity level. Within each age and gender category, the low end of the range is for sedentary individuals; the high end of the range is for active individuals. Due to reductions in basal metabolic rate that occurs with aging, calorie needs generally decrease for adults as they age. Estimated needs for young children range from 1,000 to 2,000 calories per day, and the range for older children and adolescents varies substantially from 1,400 to 3,200 calories per day, with boys generally having higher calorie needs than girls. These are only estimates, and more accurate calorie needs may be determined using the Harris Benedict Equation shown below:

- Step 1 – Calculating the Harris–Benedict BMR

The original Harris–Benedict equations published in 1918 and 1919.

BMR calculation for men	BMR = 66 + (6.2 x weight in pounds) + (12.7 x height in inches) – (6.76 x age in years)
BMR calculation for women	BMR = 655 + (4.35 x weight in pounds) + (4.7 x height in inches) – (4.7 x age in years)

- Step 2 – Determine Recommended Intake

The following table enables calculation of an individual's recommended daily kilocalorie intake to maintain current weight.[4]

Little to no exercise	Daily kilocalories needed = BMR x 1.2
Light exercise (1–3 days per week)	Daily kilocalories needed = BMR x 1.375
Moderate exercise (3–5 days per week)	Daily kilocalories needed = BMR x 1.55
Heavy exercise (6–7 days per week)	Daily kilocalories needed = BMR x 1.725
Very heavy exercise (twice per day, extra heavy workouts)	Daily kilocalories needed = BMR x 1.9

Knowing one's daily calorie needs may be a useful reference point for determining whether the calories that a person eats and drinks are appropriate in relation to the number of calories needed each day. The best way for people to assess whether they are eating the appropriate number of calories is to monitor body weight and adjust calorie intake and participation in physical activity based on changes in weight over time. 3500 calories is equal to 1 pound of fat. A calorie deficit of 500 calories or more per day is a common initial goal for weight loss for adults. However, maintaining a smaller deficit can have a meaningful influence on body weight over time. The effect of a calorie deficit on weight does not depend on how the deficit is produced—by reducing calorie intake, increasing expenditure, or both. Yet, in research studies, a greater proportion of the calorie deficit is often due to

decreasing calorie intake with a relatively smaller fraction due to increased physical activity.

*Table 2. Estimated Calorie Needs Per Day By Age, Gender, and Physical Activity Level**

Estimated amounts of calories needed to maintain calorie balance for various gender and age groups at three different levels of physical activity. The estimates are rounded to the nearest 200 calories. An individual's calorie needs may be higher or lower than these average estimates.

gender	age (years)	sedentary	**Physical activity level*** moderately active	active
child (female and male)	2–3	1,000–1,200c	1,000–1,400c	1,000–1,400c
female	4–8	1,200–1,400	1,400–1,600	1,400–1,800
	9–13	1,400–1,600	1,600–2,000	1,800–2,200
	14–18	1,800	2,000	2,400
	19–30	1,800–2,000	2,000–2,200	2,400
	31–50	1,800	2,000	2,200
	51+	1,600	1,800	2,000–2,200
male	4–8	1,200–1,400	1,400–1,600	1,600–2,000
	9–13	1,600–2,000	1,800–2,200	2,000–2,600
	14–18	2,000–2,400	2,400–2,800	2,800–3,200
	19–30	2,400–2,600	2,600–2,800	3,000
	31–50	2,200–2,400	2,400–2,600	2,800–3,000
	51+	2,000–2,200	2,200–2,400	2,400–2,800

a. Based on Estimated Energy Requirements (EER) equations, using reference heights (average) and reference weights (healthy) for each age/gender group. For children and adolescents, reference height and weight vary. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. EER equations are from the Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.

b. Sedentary means a lifestyle that includes only the light physical activity associated with typical day-to-day life. Moderately active means a lifestyle that includes physical activity equivalent to walking about 1.5 to 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life. Active means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3 to 4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

c. The calorie ranges shown are to accommodate needs of different ages within the group. For children and adolescents, more calories are needed at older ages. For adults, fewer calories are needed at older ages.

d. Estimates for females do not include women who are pregnant or breastfeeding.

Individual Foods and Beverages and Body Weight

For calorie balance, the focus should be on total calorie intake. As individuals vary a great deal in their dietary intake, the best advice is to monitor diet and replace foods higher in calories with nutrient-dense foods and beverages relatively low in calories. The following guidance may help individuals control their total calorie intake and manage body weight:

- Increase intake of whole grains, vegetables, and fruits: adults who eat more whole grains, particularly those higher in dietary fiber, have a lower body weight compared to adults who eat fewer whole grains. Increased intake of vegetables and/or fruits may protect against weight gain.
- Reduce intake of sugar-sweetened beverages: This can be accomplished by drinking fewer and/or consuming smaller portions. Children and adolescents who consume more sugar-sweetened beverages have higher body weight compared to those who drink less. Sugar-sweetened beverages provide excess calories and few essential nutrients to the diet and should only be consumed occasionally.

Developing Healthy Eating Patterns

Because people consume a variety of foods and beverages throughout the day as meals and snacks, a growing body of research has begun to describe overall eating patterns that help promote calorie balance and weight management. One aspect of these patterns that has been researched is the concept of **calorie density**, or the amount of calories provided per unit of food weight. Foods high in water and/or dietary fiber typically have fewer calories per gram and are lower in calorie density, while foods higher in fat are generally higher in calorie density. A dietary pattern low in calorie density is characterized by a relatively high intake of vegetables, fruit, and dietary fiber and a relatively low intake of total fat, saturated fat, and added sugars. Eating patterns that are low in calorie density improve weight loss and weight maintenance, and also may be associated with a lower risk of type 2 diabetes in adults.

Although total calories consumed is important for calorie balance and weight management, it is important to consider the nutrients and other healthful properties of food and beverages, as well as their calories, when selecting an eating pattern for optimal health.

- When choosing carbohydrates, Americans should emphasize naturally occurring carbohydrates, such as those found in whole grains, beans and peas, vegetables, and fruits, especially those high in dietary fiber, while limiting refined grains and intake of foods with added sugars.
- For protein, plant-based sources and/or animal-based sources can be incorporated into a healthy eating pattern. However, some protein products, particularly some animal-based sources, are high in saturated fat, so non-fat, low-fat, or lean choices should be selected.
- Fat intake should emphasize monounsaturated and polyunsaturated fats, such as those found in seafood, nuts, seeds, and oils.

Americans should move toward more healthful eating patterns. Overall, as long as foods and beverages consumed meet nutrient needs and calorie intake is appropriate, individuals can select an eating pattern that they enjoy and can maintain over time. Individuals should consider the calories from all foods and beverages they consume, regardless of when and where they eat or drink.

Calorie Balance: Physical Activity

Physical activity is the other side of the calorie balance equation and should be considered when addressing weight management. Regular participation in physical activity not only reduces risk of disease, it also helps people maintain a healthy weight and prevent excess weight gain. Further, physical activity, particularly when combined with reduced calorie intake, may aid weight loss and maintenance of weight loss.

Physical Fitness

Being physically active is one of the most important steps that Americans of all ages can take to improve their health. Physical activity is beneficial for healthy people, people at risk of developing chronic diseases, and people with current chronic conditions or disabilities. Studies by the US Department of Health and Human Services have examined the role of physical activity in many groups—men and women, children, teens, adults, older adults, people with disabilities, and women during pregnancy and the postpartum period. These studies have focused on the role that physical activity plays in many health outcomes, such as coronary

artery disease, diabetes, stroke, osteoporosis, high blood sugar, high cholesterol and depression.

Health Benefits Associated with Regular Physical Activity

Table 1

Health Benefits Associated with Regular Physical Activity in Adults and Older Adults		
Strong Evidence	**Moderate to Strong Evidence**	**Moderate Evidence**
• Lower risk of early death • Lower risk of coronary heart disease • Lower risk of stroke • Lower risk of high blood pressure • Lower risk of adverse blood lipid profile • Lower risk of type 2 diabetes • Lower risk of metabolic syndrome • Lower risk of colon cancer • Lower risk of breast cancer • Prevention of weight gain • Weight loss, particularly when combined with reduced calorie intake • Improved cardiorespiratory and muscular fitness • Prevention of falls • Reduced depression • Better cognitive function (for older adults)	• Better functional health (for older adults) • Reduced abdominal obesity	• Lower risk of hip fracture • Lower risk of lung cancer • Lower risk of endometrial cancer • Weight maintenance after weight loss • Increased bone density • Improved sleep quality

These studies have also prompted questions as to what type and how much physical activity is needed for various health benefits. That led to the development of The Physical Activity Guidelines for Americans, which gives guidance on the amount of physical activity that will provide health benefits for all Americans. Although some health benefits seem to begin with as little as 60 minutes (1 hour) a week, research shows that a total amount of 150 minutes (2 hours and 30 minutes) a week of moderate-intensity aerobic activity, such as brisk walking, consistently reduces the risk of many chronic diseases and other adverse health outcomes. For more details on the Physical Activity Guidelines for Americans please see the table below:

Table 3

For Important Health Benefits Adults Need at Least:		
2 hours and 30 minutes (150 minutes) of moderate aerobic activity every week (i.e., brisk walking) every week;	AND	Muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs hips, back, abdomen, chest, shoulders, and arms)

For Important Health Benefits Adults Need at Least:
OR
1 hour and 15 minutes (75 minutes) of vigorous intensity aerobic activity (i.e., jogging or running) every week;
OR
An equivalent mix of moderate-and-vigorous-intensity aerobic activity

Although the Guidelines focus on the health benefits of physical activity, these benefits are not the only reason why people are active. Physical activity gives people a chance to have fun, be with friends and family, enjoy the outdoors, improve their personal appearance, and improve their fitness so that they can participate in more intensive physical activity or sporting events. Some people are active because it gives them certain health benefits (such as feeling more energetic). The Guidelines encourage people to be physically active for any and all reasons that are meaningful for them. Nothing in the Guidelines is intended to mean that health benefits are the only reason to do physical activity.

Health Related Components of Physical Fitness

In many studies related to physical fitness and health, researchers have focused on **exercise**, as well as on the more broadly defined concept of **physical activity**. Physical activity is defined by the World Health Organization as any bodily movement produced by skeletal muscles that requires energy expenditure, while exercise is a form of physical activity that is planned, structured, repetitive, and performed with the goal of improving health or fitness. So, although all exercise is physical activity, not all physical activity is exercise. Although physical activity and exercise are defined concepts, the ultimate focus of the health related components of physical fitness is to provide a framework for components that are necessary for good health. They are cardiorespiratory (CR) endurance (also called aerobic endurance), flexibility, muscular strength, muscular endurance, and body composition.

Cardiorespiratory Endurance

- ***Aerobic endurance:*** The ability of the heart, blood vessels, and lungs to work together to accomplish three goals: 1) deliver oxygen to body tissues; 2) deliver nutrients; 3) remove waste products. CR endurance exercises involve large muscle groups in prolonged, dynamic movement (ex. running, swimming, etc)

Table 4

Examples of Different Aerobic Physical Activities and Intensities	
Moderate Intensity	**Vigorous Intensity**
· Walking briskly (3 miles per hour or faster, but not race-walking) · Water aerobics · Bicycling slower than 10 miles per hour · Tennis (doubles) · Ballroom dancing · General gardening	· Racewalking, jogging, or running · Swimming laps · Tennis (singles) · Aerobic dancing · Bicycling 10 miles per hour or faster · Jumping rope · Heavy gardening (continuous digging or hoeing, with heart rate increases) · Hiking uphill or with a heavy backpack

Muscular Strength and Endurance

- ***Muscular strength***: The ability of muscles to exert maximal effort.
- ***Muscular endurance***: The ability of muscles to exert submaximal effort repetitively (contract over and over again or hold a contraction for a long time).

Activities for Muscular Strength and Endurance

These kind of activities, which includes **resistance training** and lifting weights, causes the body's muscles to work or hold against an applied force or weight. These activities often involve relatively heavy objects, such as weights, which are lifted multiple times to train various muscle groups. Muscle-strengthening activity can also be done by using elastic bands or body weight for resistance (climbing a tree or doing push-ups, for example). Activities for Muscular Strength and Endurance also has three components:

Muscle-strengthening activities provide additional benefits not found with aerobic activity. The benefits of muscle-strengthening activity include increased bone strength and muscular fitness. Muscle-strengthening activities can also help maintain muscle mass during a program of weight loss.

Flexibility

Flexibility is the ability of moving a joint through the range of motion. Flexibility is an important part of physical fitness. Stretching exercises are effective in increasing flexibility, and thereby can allow people to more easily do activities that require greater flexibility. Flexibility activities also reduce risk of joint pain as well as muscle and joint injury. Time spent doing flexibility activities by themselves does not count toward meeting the aerobic or muscle-strengthening Guidelines. Although there are not specific national guidelines for flexibility, adults should do flexibility exercises at least two or three days each week to improve range of motion. This can be done by holding a stretch for 10-30 seconds to the point of tightness or slight discomfort. Repeat each stretch two to four times, accumulating 60 seconds per stretch.

Body Composition

The percentage of the body composed of lean tissue (muscle, bone, fluids, etc.) and fat tissue. Changes in body composition usually occur as a result of improvements in the other components of health related physical fitness, as well as changes in eating habits.

Adding Physical Activity to Your Life

Overcoming Barrier to Being Physical Active

Given the health benefits of regular physical activity, we might have to ask why two out of three (60%) Americans are not active at recommended levels.

Many technological advances and conveniences that have made our lives easier and less active, as well as many personal variables, including physiological, behavioral, and psychological factors, may affect our plans to become more physically active. In fact, the 10 most common reasons adults cite for not adopting more physically active lifestyles are (Sallis and Hovell, 1990; Sallis et al., 1992):

- Do not have enough time to exercise
- Find it inconvenient to exercise
- Lack self-motivation
- Do not find exercise enjoyable
- Find exercise boring
- Lack confidence in their ability to be physically active (low self-efficacy)
- Fear being injured or have been injured recently
- Lack self-management skills, such as the ability to set personal goals, monitor progress, or reward progress toward such goals
- Lack encouragement, support, or companionship from family and friends, and
- Do not have parks, sidewalks, bicycle trails, or safe and pleasant walking paths convenient to their homes or offices.

Understanding common barriers to physical activity and creating strategies to overcome them may help you make physical activity part of your daily life.

Creating Your Own Fitness Program

The first step to implementing a fitness program is to identify your goals. Goals should be Specific, Measurable, Attainable, Realistic and Time-bound (SMART). Progress can be difficult to track if goals are vague and open-ended, such as *"I will exercise more."* Here is an example of a SMART goal for fitness:

- Specific: *"I will walk for 30 minutes a day 3-5 days per week"*
- Measurable: *"I will improve my resting heart rate over the next month"*
- Attainable: *"I have the ability to se aside 30 minutes on 3-5 days per week to walk"*
- Realistic: *"I will increase my walking to 45 minutes per day in one month"*
- Time Bound: *"I will try this walking program for one month and then reassess my goals"*

You can also make a SMART Goal in one statement, such as *"I will walk for 30 minutes 3-5 days per week for the next month in order to improve my resting heart rate."*

Achieving Your Physical Activities: The Possibilities are endless

These examples show how it's possible to meet the Guidelines by doing moderate-intensity or vigorous-intensity activity or a combination of both. Physical activity at this level provides substantial health benefits.

Ways to get the equivalent of 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic physical activity a week plus muscle-strengthening activities:

- Thirty minutes of brisk walking (moderate intensity) on 5 days, exercising with resistance bands (muscle strengthening) on 2 days;
- Twenty-five minutes of running (vigorous intensity) on 3 days, lifting weights on 2 days (muscle strengthening);
- Thirty minutes of brisk walking on 2 days, 60 minutes (1 hour) of social dancing (moderate intensity) on 1 evening, 30 minutes of mowing the lawn (moderate intensity) on 1 afternoon, heavy gardening (muscle strengthening) on 2 days;
- Thirty minutes of an aerobic dance class on 1 morning (vigorous intensity), 30 minutes of running on 1 day (vigorous intensity), 30 minutes of brisk walking on 1 day (moderate intensity), calisthenics (such as sit-ups, push-ups) on 3 days (muscle strengthening);

- Thirty minutes of biking to and from work on 3 days (moderate intensity), playing softball for 60 minutes on 1 day (moderate intensity), using weight machines on 2 days (muscle-strengthening on 2 days); and
- Forty-five minutes of doubles tennis on 2 days (moderate intensity), lifting weights after work on 1 day (muscle strengthening), hiking vigorously for 30 minutes and rock climbing (muscle strengthening) on 1 day.

Increase Physical Activity Gradually Over Time

Scientific studies indicate that the risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity. The size of this gap is called the amount of overload. Creating a small overload and waiting for the body to adapt and recover reduces the risk of injury. When amounts of physical activity need to be increased to meet the Guidelines or personal goals, physical activity should be increased gradually over time, no matter what the person's current level of physical activity. The following recommendations give general guidance for inactive people and those with low levels of physical activity on how to increase physical activity:

- Start with relatively moderate-intensity aerobic activity. Avoid vigorous-intensity activity, such as shoveling snow or running until you feel comfortable at this intensity. Adults with a low level of fitness may need to start with light activity, or a mix of light- to moderate-intensity activity.
- First, increase the number of minutes per session (duration), and the number of days per week (frequency) of moderate-intensity activity. Later, if desired, increase the intensity.
- Pay attention to the relative size of the increase in physical activity each week, as this is related to injury risk. For example, a 20-minute increase each week is safer for a person who does 200 minutes a week of walking (a 10 percent increase), than for a person who does 40 minutes a week (a 50 percent increase).

Support your activity by eating whole, nutritious foods and drinking plenty of water. Healthy eating and physical activity reduces risk of disease, improves self-perception and adds to an overall sense of wellbeing. How can you add some of these behaviors into your everyday life?

Check for Understanding

1. What are the macronutrients and what function do they serve in the body?
2. What modifications can a person make to improve the micronutrient content in their diet?
3. What is a safe caloric deficit for weight loss that still allows for adequate nutrient intake and successful weight loss?
4. What components of fitness are important to include in a fitness plan?
5. What are some simple ways a person could increase the amount of physical activity in their daily routine?

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7.4: Body Image and Self Care

Chapter Objectives

- Discuss variations and modifications to female body types
- Explore how the “ideal body” changes based on societal factors
- Discuss internal and external factors that may shape body image
- Explore unhealthy mean used to achieve the “ideal” body
- Discuss ways an individual can foster the growth of health body image

Body Image and Self Care

“Hating our bodies is something we learn, and it sure as hell is something we can unlearn.” ~Megan Jayne Crabbe

Body Image

Have you ever listened to a little kid talk about their body? They are amazed by everything it does and would never think about listing all the things that are “wrong” with it or hate it. The human body is an wondrous machine that can do amazing things. It houses the brain, allows us to run, jump, climb, compete, explore, build or play. In addition, the female body has the unique ability to grow and nourish new life.

Yet, eighty-five percent of college females report that they believe they are either slightly or seriously overweight (when the actual number of those with higher than healthy body composition is somewhere around twenty percent . Body dissatisfaction is associated with excessive dieting, disordered eating, increased depression, and low self-esteem.

One of the greatest difficulties we have as a society is achieving and maintaining a healthy body image. Body image is how you see yourself when you look in the mirror or when you picture yourself in your mind. It encompasses:

- What you believe about your own appearance (including your memories, assumptions, and generalizations).
- How you feel about your body, including your height, shape, and weight.
- How you sense and control your body as you move. How you feel *in* your body, not just about your body.

Below are examples of negative and positive body image:

Negative Body Image

- A distorted perception of your shape–you perceive parts of your body unlike they really are.
- You are convinced that only other people are attractive and that your body size or shape is a sign of personal failure.
- You feel ashamed, self-conscious, and anxious about your body.
- You feel uncomfortable and awkward in your body.

Positive Body Image

- A clear, true perception of your shape–you see the various parts of your body as they really are.
- You celebrate and appreciate your natural body shape and you understand that a person’s physical appearance says very little about their character and value as a person.
- You feel proud and accepting of your unique body and refuse to spend an unreasonable amount of time worrying about food, weight, and calories.
- You feel comfortable and confident in your body.

Video: Body Image: Not Just About Your Body

The “Ideal” Body

What sets the criteria for the ideal body? Femininity or masculinity? Ability to perform manual labor or likelihood of easily birthing babies? We will explore the chemistry of sexual attraction in later chapters but it is interesting to note that body ideals vary significantly depending on gender, area of the world and time in history.

Video: Women’s Ideal Body Types Throughout History

Video: Men’s Standards of Beauty Around the World

Body Types and Variations

High body image satisfaction is strongly influenced by anthropometric measurements (1). However, not all bodies have to potential to meet measurements that society deems “ideal. Human bodies can be classified into three different body types. Endomorph, Ectomorph and Mesomorph. These three types are genetically predetermined and provide a framework for overall body size, ease of body fat storage and muscle build.

Quiz: Are you an Endomorph, Ectomorph or Mesomorph?

Aspects of Body Image and Factors Influencing Body Image

So, if we understand that children usually have a positive body image, we need to look at what causes or influences might be at work to affect this initial positive state. Think back to your own childhood. Do you remember your parents talking about the strength and health of their own bodies, or rather the need to lose some weight and the attributes they disliked? Did you receive pressure from family members to cut your hair a certain way, dress in certain clothes, or lose a few pounds, maybe even under the guise of concern for your health/well being? Peers, parents, family and media certainly influence our view of ourselves and what we *should* be as well.

PDF: What is Body Image

Body Image, Social Media and Eating Disorders

Body Image and Gender Dysphoria

We have examined body size, shape, body fat percentage and other physical characteristics but body image can also be heavily impacted by societal gender influences or categorization.

Dysphoria vs Dysmorphia and impacts on the LBGTQ+ community

Eating Disorders

People with negative body image have a greater likelihood of developing an eating disorder and are more likely to suffer from feelings of depression, isolation, low self-esteem, and obsessions with weight loss.

Anorexia Nervosa

Anorexia nervosa, or anorexia, is a type of eating disorder that mainly affects adolescent girls and young women, but can also affect men. A person with this disease has an intense fear of gaining weight and severely limits food intake. Individual may:

- Have a low body weight
- Refuse to keep a normal body weight
- Be extremely afraid of becoming fat
- Believe they are fat even if they are very thin
- Women may miss three (menstrual) periods in a row

Anorexia affects your health because it can damage many parts of your body. A person with anorexia will have many of these

signs:

- Loses a lot of weight
- Talks about weight and food all the time
- Moves food around the plate; doesn't eat it
- Weighs food and counts calories
- Follows a strict diet
- Won't eat in front of others
- Ignores/denies hunger
- Uses extreme measures to lose weight (self-induced vomiting, laxative abuse, diuretic abuse, diet pills, fasting, excessive exercise)
- Thinks they are fat when they are too thin
- Gets sick a lot
- Weighs self several times a day
- Feels depressed or irritable
- Doesn't socialize
- Wears baggy clothes to hide appearance

A health care team of doctors, nutritionists, and therapists will help the patient get better. They will:

- Help bring the person back to a normal weight
- Treat any psychological issues related to anorexia
- Help the person get rid of any actions or thoughts that cause the eating disorder

Bulimia Nervosa

Bulimia nervosa, or bulimia, is a type of eating disorder. Someone with bulimia eats a lot of food in a short amount of time (bingeing) and then tries to get rid of the calories by purging. Purging might be done in these ways:

- Making oneself throw up
- Taking laxatives (pills or liquids that increase how fast food moves through your body and leads to a bowel movement)

A person with bulimia may also use these ways to prevent weight gain:

- Exercising a lot (more than normal)
- Restricting her eating or not eating at all (like going without food for a day)
- Taking diuretics (pills that make you urinate)

Bulimia is more than just a problem with food. It's a way of using food to feel in control of other feelings that may seem overwhelming. Purging and other behaviors to prevent weight gain are ways for people with bulimia to feel more in control of their lives and to ease stress and anxiety.

Unlike anorexia, when people are severely underweight, people with bulimia may be underweight, overweight, or have a normal weight. This makes it harder to know if someone has this disease. However, someone with bulimia may have these signs:

- Thinks about food a lot
- Binges (normally in secret)
- Throws up after bingeing
- Uses laxatives, diet pills, or diuretics to control weight
- Is depressed
- Is unhappy and/or thinks a lot about her body shape and weight
- Eats large amounts of food quickly
- Goes to the bathroom all the time after she eats (to throw up)
- Exercises a lot, even during bad weather, fatigue, illness, or injury
- Unusual swelling of the cheeks or jaw area
- Cuts and calluses on the back of the hands and knuckles from making herself throw up
- White enamel of teeth wears away making teeth look clear
- Doesn't see friends or participate in activities as much. Has rules about food — has "good" foods and "bad" foods

Treatments

Some research suggests that the use of medicines — such as antidepressants, antipsychotics, or mood stabilizers — may work for those living with anorexia or bulimia. It is thought that these medicines help the mood and anxiety symptoms that often co-exist with disordered eating. Psychotherapy, sometimes known as “talk therapy”, can also help in the treatment of eating disorders. It uses different ways of communicating to change a patient’s thoughts or behavior.

Fostering Healthy Body Image

When pressure to look, act and be a certain way is all around us, and in us as well, the ability to maintain emotional and physical wellness and balance is tough. The key: Remembering that you and your body are on the same team.

10 Steps to Positive Body Image

We all may have our days when we feel awkward or uncomfortable in our bodies, but the key to developing positive body image is to recognize and respect our natural shape and learn to overpower negative thoughts and feelings with positive, affirming, and accepting ones. In addition, seek guidance in living with disordered eating dysphoria or dysmorphia. For more information you can visit the website for the National Eating Disorder Association. Their message is simple: **Accept yourself. Accept your body.**

Check for Understanding

1. What factors may impact body image as we grow?
2. What does the difference between body dysmorphia and dysphoria mean to the LGBTQ+ community?
3. What are the impacts of disordered eating and how can a person seek help for living with an eating disorder?
4. What behaviors foster healthy body image?

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7.5: Healthy Relationships and Sexuality

Chapter Objectives

- Explore attributes of a healthy romantic and/or sexual relationship
- Discuss potentially unhealthy relationship situations
- Evaluate possible courses of action to address or leave an unhealthy relationship

"The world is not to be divided into sheep and goats, and not all things are black nor all things white. It is a fundamental of taxonomy that nature rarely deals with discrete categories. Only the human mind invents categories and tries to force facts into separated pigeon-holes. The living world is a continuum in each and every one of its aspects. The sooner we learn this concerning human sexual behavior, the sooner we shall reach a sound understanding of the realities of sex." ~ Alfred Kinsey

Gender and Sexuality

Sex and gender have potentially been two of the most socially significant factors in the history of the world. Sex is one's biological classification as male or female, which is biologically determined at the moment the sperm fertilizes the egg. **Sex** can be precisely defined at the genetic level with females having two X chromosomes (XX), while males posses an XY pairing. The female's eggs contain only an X chromosome, while the male's sperm contains half X and half Y chromosomes. Therefore, the sperm that fertilizes the egg determines whether a person has XX (female) or XY (male) pairing of chromosomes. The main difference between sexes is the reproductive body parts assigned to each (including their functions and corresponding hormones).

Gender is culturally-based and varies in a thousand subtle ways across the many diverse cultures of the world. Gender has been shaped by social norms, politics, religion, philosophy, language, tradition and other cultural forces for many years. Gender identity is our personal internal sense of our own place on the gender continuum. Every society has a slightly different view of what it means to be of a certain gender.

Sexual Scripts

A script is what actors read or study and what guides their behavior in a certain role. A script is a blueprint for what we "should do" in our roles. Sexual scripts are blueprints and guidelines for what we define as our role in sexual expression, sexual orientation, sexual behaviors, sexual desires, and the sexual component of our self-definition. All of us are sexual beings, yet none of us is exactly identical to another in our sexual definitions and script expectations. Having said that, keep in mind that we are not just born with sexual scripts in place; they are learned. Sexual socialization is the process by which we learn how, when, where, with whom, why, and with which motivations we are sexual beings.

We are all born with drives, which are biological needs that demand our attention and behavioral responses to them. The most powerful drives are circulation, breathing, voiding waste, eating, drinking, sleeping, and sexual involvement. Sexual drives are biological urges to participate in sexual activity and in certain sexual roles. Sexual scripts, once learned, will shape how that drive is answered. Sexuality is learned via culture and socialization. There are as many unique sexual scripts as there are people, yet some of these scripts have common themes and can be viewed as a collective pattern or trend in the larger social level.

Many of us learn our sexual scripts in a passive way. In other words, we don't learn from experience, but from a synthesis of concepts, images, ideals, and sometimes misconceptions. For example, the commonly held belief that men and women are two different creatures, perhaps even from different planets, was a very successful fad in recent years that led an entire generation to believe that men might be from "Mars" while women might be from "Venus."

Some traditional sexual scripts that have been studied include a number of problematic assumptions. Some of these assumptions include but are not limited to: the man must be in charge, the woman must not enjoy (or let on that she enjoys) the sexual experience, the man is a performer whose skills are proven effective upon arrival of his partner's orgasm, and men are sexual while women are not. Numerous studies have shown that most of these traditional scripts are not realistic, healthy, conducive to open communication, nor negotiation of sexual needs and desires for couples. In sum, rather, these traditional notions can be an undermining influence in a couple's intimacy. Scripts that are more contemporary include these simple ideas:

1) A person needs to ownership of their own sexual experiences.

2) Both partners need to learn to communicate openly and honestly about their feelings.

3) Both partners need to learn to meet one another's desires, needs, and wishes while making sure that their own needs are being met.

Sex and Gender

When filling out official documents, you are often asked to provide your name, birth date, and sex or gender. But have you ever been asked to provide your sex *and* your gender? Sociologists and most other social scientists view sex and gender as conceptually distinct. S*ex* denotes biological characteristics and exists along a spectrum from male to female. *Gender,* on the other hand, denotes social and cultural characteristics that are assigned to different sexes. Sex and gender are not always synchronous, meaning they do not always line up in an easy-to-categorize way.

"Sex" refers to physiological differences found among male, female, and various intersex bodies. Sex includes both *primary sex characteristics* (those related to the reproductive system) and *secondary sex characteristics* (those that are not directly related to the reproductive system, such as breasts and facial hair). In humans, the biological sex of a child is determined at birth based on several factors, including chromosomes, gonads, hormones, internal reproductive anatomy, and genitalia. Biological sex has traditionally been conceptualized as a binary in Western medicine, typically divided into male and female. However, anywhere from 1.0 to 1.7% of children are born intersex, having a variation in sex characteristics (including chromosomes, gonads, or genitals) that do not allow them to be distinctly identified as male or female. Due to the existence of multiple forms of intersex conditions (which are more prevalent than researchers once thought), many view sex as existing along a spectrum, rather than simply two mutually exclusive categories.



Figure 3. Female and Male Sex Symbols

Gender

A person's sex, as determined by his or her biology, does not always correspond with their gender; therefore, the terms "sex" and "gender" are not interchangeable. "Gender" is a term that refers to social or cultural distinctions associated with being male, female, or intersex. Typically, babies born with male sex characteristics (s*ex)* are assigned as boys (*gender);* babies born with female sex characteristics (s*ex)* are assigned as girls (*gender).* Because our society operates in a binary system when it comes to gender (in other words, seeing gender as only having two options), many children who are born intersex are forcibly assigned as either a boy or a girl and even surgically "corrected" to fit a particular gender.

Gender identity is a person's sense of self as a member of a particular gender. Individuals who identify with a role that corresponds to the sex assigned to them at birth (for example, they were born with male sex characteristics, were assigned as a boy, and identify today as a boy or man) are **cisgender**. Those who identify with a role that is *different* from their biological sex (for example, they were born with male sex characteristics, were assigned as a boy, but identify today as a girl, woman, or some other gender altogether) are often referred to as **transgender**. The term "transgender" encompasses a wide range of possible identities, including agender, genderfluid, genderqueer, two-spirit, androgynous, and many others.



Figure 4. The Transgender Sex Symbol

Cultural Variations of Gender

Since the term “sex” refers to biological or physical distinctions, characteristics of sex will not vary significantly between different human societies. For example, persons of the female sex, in general, regardless of culture, will eventually menstruate and develop breasts that can lactate. Characteristics of gender, on the other hand, may vary greatly between different societies. For example, in American culture, it is considered feminine (or a trait of the female gender) to wear a dress or skirt. However, in many Middle Eastern, Asian, and African cultures, dresses or skirts (often referred to as sarongs, robes, or gowns) can be considered masculine. Similarly, the kilt worn by a Scottish male does not make him appear feminine in his culture.

Sexual Identity and Orientation

Human beings are socialized into their adult roles and learn their sexual identities along with their gender roles, work roles, and family roles. Sexual orientation is the sexual preference one has for their partner: male, female, both, or neither. There are a few common sexual orientations that can be seen at the societal and personal level. **Heterosexuality** is the sexual attraction between a male and a female. **Homosexuality** is a sexual attraction between a male to another male or a female to another female. **Bisexuality** is a sexual attraction to both male and female sexual partners. **Pansexuality** is sexual, romantic, or emotional attraction towards people regardless of their sex or gender identity.

Sexual desire is the attractions we have for sexual partners and experience that exist independent of our behaviors. Sexual behaviors are our actual sexual actions and interactions. It is important to note that orientations, desires, and behaviors are not always the same thing. They do overlap at times. For example, a heterosexual male may have had a homosexual experience in the past, or not. He may at times desire males and females regardless of his actual sexual activities. A lesbian female may have had a short-term heterosexual relationship, yet define herself as a lesbian.

The Janus Report reported their findings on sexual behaviors and sexual orientation. Their sample reported 22% of men and 17% of women said yes to the question, “Have you had a homosexual experience?” Janus also reported that 91% of men and 95% of women claimed to be heterosexual; four percent of men and two percent of women claimed to be homosexual; and five percent of men and three percent of women claimed to be bisexual. Generally speaking Janus and Laumann found that the U.S. is a very sexual nation. They reported that very few men and women reported never having had vaginal sexual intercourse (less than five percent). They reported that men typically have sex sooner than women and that most had sex by age 20. Janus specifically reported that only nine percent of men and 17% of women had NO sexual experience before marriage.

Relationships and Communication

Attachments are crucial to human existence and are essentially the emotional context of those relationships we form in life. As an infant you learned to trust those who cared for you; you learned that they returned once they were out of view and were dependable. Eventually, as your cognitive development matures, your brain allows you to love the person you are attached to and

to care for them—whether or not they are caring for you. You learn then that your attachments begin to facilitate your needs and wants being met. How you attached as an infant and young child shape (at least in theory) how you will likely attach as an adult. For example, if you had strong attachments in childhood, then forming adult relationships should be easier for you; if you had weak or interrupted attachments in childhood, then forming adult relationships would be more difficult.

Abraham Maslow, addressed love in terms of how our needs are met by the other person. His basic premise is that we pair-off with those whose love styles fill an unmet childhood need. In other words, Maslow said that if our childhood needs were not met in the basics of survival, safety, food, shelter, love, belonging, and even self-esteem, then we look for an adult companion that can fill those needs for us. It's like an empty cup from our childhood that our adult partner fills for us. Maslow also said that when all those basic needs are met in childhood, we are attracted to an adult partner who compliments our full development into our psychological potential.

Sternberg's Triangular Theory of Love

Robert Sternberg was the "Geometry of Love" psychologist who triangulated love using intimacy, passion, and commitment by measuring the intensity of each and how intense the triangulation was for the couple. To Sternberg it was important to consider how each partner's triangle matched the other partner's. He said that a couple with all three types of love balanced, and in sufficient magnitude, would have a rare yet rewarding type of love that encompassed much of what couples seek in a loving relationship.3 Sternberg's consummate love is a love type that had equal measures of passion, intimacy, and commitment that is satisfactory to both lovers.

In modern day applications of love, various components have been found as the ingredients of love: commitment, passion, friendship, trust, loyalty, affections, intimacy, acceptance, caring, concern, care, selflessness, infatuation, and romance. There is a love type identified that many people are aware of called unconditional love. Unconditional love is the sincere love that does not vary regardless of the actions of the person who is loved.

Theories of Mate Selection

The Social Exchange Theory and its rational choice formula clarify the selection process even further. We strive to maximize rewards and minimize costs in our choices of a mate.

Rewards – Costs = Choice

When we interact with potential dates and mates, we run a mental balance sheet in our heads. She might think, "He's tall, confident, funny, and friends with my friends." As she talks a bit more she might say, "But, he chews tobacco, only wants to party, and just flirted with another woman while we were talking." The entire time we interact with potential dates and mates we evaluate them on their appearance, disposition, goals and aspirations, and other traits. This while simultaneously remembering how we rate and evaluate ourselves. Rarely do we seek out the best looking person at the party unless we define ourselves as an even match for him or her. More often we rank and rate ourselves compared to others and as we size up and evaluate potentials we define the overall exchange rationally or in an economic context where we try to maximize our rewards while minimizing our losses.

The overall evaluation of the deal also depends to a great extent on how well we feel matched on racial and ethnic traits, religious background, social economic class, and age similarities. The complexity of the date and mate selection process includes many obvious and some more subtle processes.

How do strangers transition from not even knowing one another to eventually cohabiting or marrying? From the very first encounter, two strangers begin a process that either excludes one another as potential dates or mates or includes them and begins the process of establishing intimacy. Intimacy is the mutual feeling of acceptance, trust, and connection to another person, even with the understanding of personal faults of the individual. In other words, intimacy is the ability to become close to one another, to accept one another as is, and eventually to feel accepted by the other. Intimacy is not sexual intercourse, although sexual intercourse may be one of many expressions of intimacy. When two strangers meet they have a stimulus that alerts one or both to take notice of the other.

Effective Communication

Effective communication is critical to successful relationships. Researchers and therapists have found at least nine skills that can

help couples learn to talk effectively about important issues (Gottman 1994; Markman, Stanley, and Blumberg 2010; Schramm and Harris 2011). How we interact about issues such as time spent together/apart, money, health, gender differences, children, family, friends, commitment, trust, and intimacy affects our ability to develop and maintain lasting friendships. If learned well, these nine skills can help put our relationships on a positive trajectory for success.

What Do Couples Talk About?

- Time Together/Apart. Both the quantity and quality of time spent together influence the wellbeing of relationships. Spending time apart participating in other activities also influences the well-being of a relationships.
- Money. Thoughts and talk about money, spending habits, and ability to budget, invest, and plan for the future impact couple financial management processes and practices.
- Health. Couples must talk about many health-related issues, including nutrition, exercise, illness, disease, accidents, health care, mortality, and death.
- Personality. Because some individuals tend to be more task-oriented in their communication styles and others tend to be more process-oriented, task-oriented people tend to want to solve issues immediately, while process-oriented people tend to want to talk about them more and come to a consensus about what should be done.
- Children. How children develop physically, socially, emotionally, intellectually, and spiritually are often topics of discussion. Focusing on the best ways to consistently meet children's needs is considered being child-centered.
- Family/In-Laws/Friends. Couples often talk about situations and circumstances surrounding the interactions they have with their closest relationships.

What do couples argue about?

Because the items listed above are some of the major topics couples talk about, it follows that they are also the same topics that can spur disagreements. For instance, it is a familiar joke that people can have difficulties in their relationships with in-laws. Take for example, "What is the difference between in-laws and outlaws? Answer: One is 'Wanted!'" Sayings such as these underscore the importance of knowing how your relationships with others can affect your marriage and could potentially become the topic of a marital conflict.

Learning and Practicing New Habits

Effective communication isn't easy. Teaching and learning new communication skills take patience as well as practice. Taking the time to talk is important. Your relationship provides a safe place to share feelings, thoughts, fears, dreams, and hopes. Make a special effort to find time to talk to your partner more frequently. In tough times, people feel overwhelmed with worries and responsibilities. Time together as a couple is often the last thing on our minds as we deal with the hassles of daily life. Although you may be busy, stressed, and worried, take the time to focus on your partners' needs and spend quality time together without interruption. Even a few minutes a day talking about what has occurred can be a relief from stress. Be thoughtful by considering whether those difficult or problem-solving discussions could be reserved for other times when you and your partner are not tired or distracted.

Finding Time to Talk

- Spend time talking with limited interruptions.
- Make a date to talk to your partner.
- Plan at least one routine family time each week.
- Talk instead of watching TV.
- Talk when you take a walk together.
- Talk while you work together on household chores.
- Talk in the car while traveling to activities.

Negative Patterns of Interaction

In good times and bad, couples need each other. Good communication does not mean your partner will always like what you have to say. However, chances of solving problems are much higher if you and your partner can express yourselves openly and freely with each other.

For couples today, there is an abundance of information on how to sustain healthy, happy relationships. Most information available

to couples falls short on giving examples of “what not to do” in a relationship. Communication is the key, but it is difficult to apply effective strategies to harmful interactions.

Four negative patterns of interaction have been demonstrated as major destroyers of relationships:

- Criticism
- Contempt
- Defensiveness
- Stonewalling

Criticism

Criticism is using hurtful or judgmental comments aimed at your partner’s character or personality. With criticism, the blame is placed on the person and not the problematic behavior. Criticism tends to be a repetitive cycle—a single critical moment can end up in a continued exchange. Most critical statements can be recognized by the phrases, “you always” or “you never.” The following are some examples of criticism:

- You never finish any project that you start. You’re so lazy.
- When we go out to eat, you always embarrass me with your table manners.

Contempt

Contempt is a more complex negative interaction. It is an effort to psychologically abuse your partner through disrespectful statements and actions. Contempt has both verbal and non-verbal deliveries. Verbal examples of contempt include sarcasm, hostile humor, and mockery. For example, nonverbal displays of contempt include rolling of the eyes and sucking of the teeth during conflict. Contempt sends your partner a message of scorn—that they are inferior and worthless.

Defensiveness

Defensiveness is often a natural response to receiving criticism and contempt. When faced with criticism and contempt, most people find a need to defend themselves. However, couples can be defensive even when criticism is constructive. Defensiveness may be a response to previous, current, and/or future attacks. If one or both persons are acting defensively, it is most likely the case they are not listening. Defensiveness may take many forms including:

- Making excuses for behavior
- Repeating a statement for effect
- Denying responsibility for actions
- Answering a complaint with another complaint

Stonewalling

The final negative pattern of interaction is stonewalling. As the name implies, this occurs when partners “put a wall” around themselves, either physically or psychologically. Stonewalling is often used to decrease conflict, and when delivered in moderation, can be healthy. On the other hand, continual failure to respond and/or engage in conversation escalates rather than reduces conflict. Examples of stonewalling include:

- Leaving the room
- Putting a physical barrier between you and your partner (newspaper, book, child)
- Focusing intently on something other than your partner during a discussion
- Failure to actively listen
- Responding with a blank stare

What can be done?

All of the above can become patterns of interaction within a relationship. One negative interaction leads to another, often in a

repetitive cycle. The following suggestions can be used to break the cycle and promote a healthy relationship:

1. Eliminate criticism. Discussing your feelings about the behavior is okay as long as there are no personal attacks. Use the word I instead of you and describe how the behavior makes you feel. Talk about the behavior and not the person.

- Example: "When we go out to eat, you always embarrass me," becomes "I feel hurt and ashamed when you make fun of me in public.

2. Build on your friendship base. Validate your partner and his/her feelings, thoughts, needs, and desires, etc.

- Example: "I recognize that you need to talk more about our relationship. What is on your mind?"

3. Take accountability and responsibility for your own actions. Do not make excuses. Apologize and correct the behavior (if possible).

- Example: "I'm sorry that I yelled at you earlier. I've been under a lot of pressure at work, but it is unfair to take it out on you."

4. Use reflective listening. Repeat what your partner has stated and then respond. Show them that you are listening and hearing them.

- Example: Partner 1: I would appreciate it if you would talk to me before you discipline the kids. That way we can be a united front."
- Partner 2: What I'm hearing is that you would like for us to talk about disciplining the kids before I make any decisions. I think that is a good idea.

5. Continue dating. Make a point to rekindle the dating aspect of your relationship.

- Example: Go for walks, hold hands, act silly, etc. Find ways to show appreciation to your partner throughout the day (i.e., e-mails, notes, phone calls, etc.)

6. Seek help if needed. If you can identify these negative interactions in your relationship or you think you may need help, see a licensed marriage and family therapist or other professional. Do not try and fix everything on your own.

- Example: Talk to a trusted family member, friend, or your local extension agent in order to find resources in your area.

Before a couple can learn and/or practice new routines in their relationship, they must rid themselves of the old ways that aren't working. It is important to first identify negative patterns and destructive behaviors and target them for change. At that point, the couple can begin rebuilding their relationship.

Violence in Relationships

Violence is a serious public health problem in the United States. From infants to the elderly, it affects people in all stages of life. In the United States, violence accounts for approximately 51,000 deaths annually. In 2007, more than 18,000 people were victims of homicide and more than 34,000 took their own life.
The number of violent deaths tells only part of the story. Many more survive violence and are left with permanent physical and emotional scars. Violence also erodes communities by reducing productivity, decreasing property values, and disrupting social services.

Understanding Violence

Interpersonal violence is defined as the actual or threatened intentional use of force—physical, sexual, or emotional—against another person, group, or community. It may result in physical injury, psychological harm, or even death. Violence also includes suicide and nonfatal acts of self-harm.

Unfortunately, violence is a part of our daily life. It exists in all corners of our nation. It affects us all regardless of our age, gender, race, ethnicity, or socio-economic status.
Violence also erodes the fabric of our communities. It can threaten productivity in the workplace, decrease the value of our homes and businesses, and disrupt essential public and social services. The economic cost of violence is staggering. In 2000,

the medical costs and productivity losses associated with nonfatal violence-related injuries and deaths were estimated at more than $70 billion each year. The total burden to society is far greater.

The good news is that violence is a problem with a solution. It can be prevented by using a thoughtful and systematic approach. While the field of violence prevention is still developing, our knowledge of “what works” increases every day.

Types of Violence

- Child Maltreatment (e.g., child abuse and neglect)
- Intimate Partner Violence (e.g., violence by a current or former spouse, boy/girlfriend)
- Sexual Violence (e.g., rape, sexual assault, sexual harassment)
- Suicide (e.g., fatal and nonfatal suicide behavior)
- Youth Violence (e.g., bullying, gang violence, peer violence)

Intimate Partner Violence

Figure 1. Couple



Intimate partner violence (IPV) is a serious, preventable public health problem that affects millions of Americans. The term “intimate partner violence” describes physical, sexual, or psychological harm by a current or former partner or spouse. This type of violence can occur among heterosexual or same-sex couples and does not require sexual intimacy.

There are four main types of IPV:

Physical violence is the intentional use of physical force with the potential for causing death, disability, injury, or harm. Physical violence includes, but is not limited to, scratching; pushing; shoving; throwing; grabbing; biting; choking; shaking; aggressive hair pulling; slapping; punching; hitting; burning; use of a weapon; and use of restraints or one’s body, size, or strength against another person. Physical violence also includes coercing other people to commit any of the above acts.

- **Sexual violence** is divided into five categories. Any of these acts constitute sexual violence, whether attempted or completed. Additionally all of these acts occur without the victim’s freely given consent, including cases in which the victim is unable to consent due to being too intoxicated or otherwise unable to consent.
  - **Rape or penetration of victim –** This includes completed or attempted, forced unwanted vaginal, oral, or anal insertion. Forced penetration occurs through the perpetrator’s use of physical force against the victim or threats to physically harm the victim. (This includes incidents in which the victim was pressured verbally or through intimidation or misuse of authority to consent or acquiesce to being penetrated.)
  - **Victim was made to penetrate someone else –** This includes completed or attempted, forced incidents when the victim was made to sexually penetrate a perpetrator or someone else without the victim’s consent.
  - **Unwanted sexual contact –** This includes intentional touching of the victim or making the victim touch the perpetrator, either directly or through the clothing, on the genitalia, anus, groin, breast, inner thigh, or buttocks without the victim’s consent
  - **Non-contact unwanted sexual experiences –** This includes unwanted sexual events that are not of a physical nature that occur without the victim’s consent. Examples include unwanted exposure to sexual situations (e.g., pornography); verbal or behavioral sexual harassment; and /or unwanted filming, taking or disseminating photographs of a sexual

nature of another person.
- **Stalking** is a pattern of repeated, unwanted, attention and contact that causes fear or concern for one's own safety or the safety of someone else (e.g., family member or friend). Some examples include repeated, unwanted phone calls, emails, or texts; leaving cards, letters, flowers, or other items when the victim does not want them; watching or following from a distance; spying; approaching or showing up in places when the victim does not want to see them.

Psychological Aggression is the use of verbal and non-verbal communication with the intent to harm another person mentally or emotionally, and/or to exert control over another person. Psychological aggression can include expressive aggression (e.g., name-calling, humiliating); coercive control (e.g., limiting access to transportation, money, friends, and family; excessive monitoring of whereabouts); threats of physical or sexual violence; control of reproductive or sexual health (e.g., refusal to use birth control; coerced pregnancy termination); exploitation of victim's vulnerability (e.g., immigration status, disability); exploitation of perpetrator's vulnerability; and presenting false information to the victim with the intent of making them doubt their own memory or perception (e.g., mind games).

Risk Factors for Intimate Partner Violence

Persons with certain risk factors are more likely to become perpetrators or victims of intimate partner violence (IPV). Those risk factors contribute to IPV but might not be direct causes. Not everyone who is identified as "at risk" becomes involved in violence.

A combination of individual, relational, community, and societal factors contribute to the risk of becoming an IPV perpetrator or victim. Understanding these multilevel factors can help identify various opportunities for prevention.

Individual Risk Factors

- Low self-esteem
- Low income
- Low academic achievement
- Young age
- Aggressive or delinquent behavior as a youth
- Heavy alcohol and drug use
- Depression
- Anger and hostility
- Antisocial personality traits
- Borderline personality traits
- Prior history of being physically abusive
- Having few friends and being isolated from other people
- Unemployment
- Emotional dependence and insecurity
- Belief in strict gender roles (e.g., male dominance and aggression in relationships)
- Desire for power and control in relationships
- Perpetrating psychological aggression
- Seeing or being a victim of physical or psychological abuse (consistently one of the strongest predictors of perpetration)
- History of experiencing poor parenting as a child
- History of experiencing physical discipline as a child

Relationship Factors

- Relationship conflict-fights, tension, and other struggles
- Relationship instability-divorces or separations
- Dominance and control of the relationship by one partner over the other
- Economic stress
- Unhealthy family relationships and interactions

Community Factors

- Poverty and associated factors (e.g., overcrowding)

- Low social capital-lack of institutions, relationships, and norms that shape a community's social interactions
- Weak community sanctions against IPV (e.g., unwillingness of neighbors to intervene in situations where they witness violence)

Societal Factors

- Traditional gender norms (e.g., women should stay at home, not enter workforce, and be submissive; men support the family and make the decisions)

Protecting Yourself from Relationship Violence

It can be hard to know if your relationship is headed down the wrong path. While it's not always possible to prevent relationship violence, there are steps you can take to protect yourself.

If you think your partner might be controlling or abusive, it's important to:

- Trust your feelings. If something doesn't seem right, take it seriously.
- Learn the warning signs of someone who might become controlling or violent.
- Get help. Talk to experts in relationship violence.

If your partner is controlling or abusive, it's better to get help now than to wait. Controlling or violent relationships usually get worse over time.

Remember: if your partner hurts you, it's not your fault.

How Do I Know if My Relationship Might Become Violent?

Relationship violence can start slowly and be hard to recognize at first. For example, when people first start dating, it's common to want to spend a lot of time together. But spending less time with other people can also be a sign that your partner is trying to control your time.

Try asking yourself these questions:

- Does my partner respect me?
- Does my partner blame me for everything that goes wrong?
- Does my partner make most of the decisions in our relationship?
- Am I ever afraid to tell my partner something?
- Do I ever feel forced to do things that I don't want to do?
- Have I ever done anything sexual with my partner when I didn't want to?
- Does my partner promise to change and then keep doing the same things?

It's okay if you aren't sure – you can still get help. Domestic violence agencies have counselors who are experts at helping people with questions about their relationships. You don't even have to give your name.

- **Take Action!** If you think your partner is controlling or abusive, take steps to protect yourself.
- **Trust your instincts.** You are the expert on your life and relationships. If you think your relationship is unhealthy or you are worried about your safety, trust your gut.
- **Plan for your safety.** If you are in a relationship with someone who is violent or might become violent, make a plan to keep yourself safe. This is important whether you are planning to leave your partner or not.
- **Start with a phone call.** If you need help or have questions about your relationship, call the National Domestic Violence Hotline at 1-800-799-SAFE (1-800-799-7233). You'll be able to find a domestic violence agency near you or talk to a counselor over the phone. Services are free. **If you are in danger right now, call 911.**

Healthy vs. Unhealthy Relationships

Sometimes a relationship might not be abusive, but it might have some serious problems that make it unhealthy. If you think you might be in an unhealthy relationship, you should be able to talk to your partner about your concerns. If you feel like you can't

talk to your partner, try talking to a trusted friend, family member, or counselor. Consider calling a confidential hotline to get the support you need and to explore next steps. If you're afraid to end the relationship, call a hotline for help (1-800-799-SAFE).

Signs of an unhealthy relationship include:

- Focusing all your energy on your partner
- Dropping friends and family or activities you enjoy
- Feeling pressured or controlled a lot
- Having more bad times in the relationship than good
- Feeling sad or scared when with your partner

Signs of a healthy relationship include:

- Having more good times in the relationship than bad
- Having a life outside the relationship, with your own friends and activities
- Making decisions together, with each partner compromising at times
- Dealing with conflicts by talking honestly
- Feeling comfortable and able to be yourself
- Feeling able to take care of yourself
- Feeling like your partner supports you

If you feel confused about your relationship, a mental health professional can help. Remember, you deserve to be treated with respect.

Sexual Health

Sexuality is a major part of being human. Love, affection and sexual intimacy all play a role in healthy relationships. They also contribute to a sense of well-being. A number of disorders can affect the ability to have or enjoy sex. Concerns about infertility or fear of unplanned pregnancy can also come into play. In addition, a number of diseases and disorders affect sexual health. These include sexually transmitted diseases and cancer. In men, treatment of prostate cancer can cause erectile dysfunction. In women, cervical, uterine, vaginal, vulvar or ovarian cancer may have sexual effects.

Sexual Dysfunction

Sexual dysfunction can pose public health problems, as it is related to public health issues and affects people's happiness and general well-being.

According to the National Health and Social Life Survey,

- The prevalence of sexual dysfunction was found to be higher among women than men.
- Lack of sexual desire is the most common problem among women
- For men, the most common sexual problem is premature ejaculation, not erectile dysfunction.
- Sexual problems increase with age, but sex-related personal distress decreases.

Reproductive Health

Both the male and female reproductive systems play a role in pregnancy. Problems with these systems can affect fertility and the ability to have children. There are many such problems in men and women. Reproductive health problems can also be harmful to overall health and impair a person's ability to enjoy a sexual relationship.

Your reproductive health is influenced by many factors. These include your age, lifestyle, habits, genetics, use of medicines and exposure to chemicals in the environment. Many problems of the reproductive system can be corrected.

Reproductive health includes a variety of topics, such as:

- Menstruation and menopause
- Pregnancy and preconception care

- Fertility/Infertility
- Contraception

Contraception

An unintended pregnancy is a pregnancy that is either mistimed or unwanted at the time of conception. It is a core concept in understanding the fertility of populations and the unmet need for contraception. Unintended pregnancy is associated with an increased risk of morbidity for women, and with health behaviors during pregnancy that are associated with adverse effects. For example, women with an unintended pregnancy may delay prenatal care, which may affect the health of the infant. Women of all ages may have unintended pregnancies, but some groups, such as teens, are at a higher risk.

Efforts to decrease unintended pregnancy include finding better forms of contraception, and increasing contraceptive use and adherence.

Contraception, (also known as “birth control”, is designed to prevent pregnancy. Some types of birth control include (but are not limited to):

- **Barrier methods**, such as condoms, the diaphragm, and the cervical cap, are designed to prevent the sperm from reaching the egg for fertilization. Intrauterine device, or IUD, is a small device that is inserted into the uterus by a health care provider. The IUD prevents a fertilized egg from implanting in the uterus. An IUD can stay in the uterus for up to 10 years until a health care provider removes it.
- **Hormonal birth control**, such as birth control pills, injections, skin patches, and vaginal rings, release hormones into a woman’s body that interfere with fertility by preventing ovulation, fertilization, or implantation.
- **Sterilization** is a method that permanently prevents a woman from getting pregnant or a man from being able to get a woman pregnant. Sterilization involves surgical procedures that must be done by a health care provider and usually cannot be reversed.

The choice of birth control depends on factors such as a person’s overall health, age, frequency of sexual activity, number of sexual partners, desire to have children in the future, and family history of certain diseases. A woman should talk to her health care provider about her choice of birth control method.

It is important to remember that even though birth control methods can prevent pregnancy, they do not all protect against sexually transmitted diseases or HIV.

Barrier Methods

Barrier method contraception work by placing a block or barrier to prevent sperm from reaching the egg.

Contraceptive Sponge

Before having sex, wet the sponge and place it, loop side down, inside the vagina to cover the cervix. The sponge is effective for more than one act of intercourse for up to 24 hours. It needs to be left in for at least 6 hours after having sex to prevent pregnancy. It must then be taken out within 30 hours after it is inserted.

Women who are sensitive to the spermicide nonoxynol-9 should not use the sponge. The sponge does not protect against sexually transmitted infections (STIs)

Diaphragm, cervical cap, and cervical shield

These barrier methods block the sperm from entering the cervix and reaching the egg.

- The diaphragm is a shallow latex cup.
- The cervical cap is a thimble-shaped latex cup. It often is called by its brand name, FemCap.
- The cervical shield is a silicone cup that has a one-way valve that creates suction and helps it fit against the cervix. It often is called by its brand name, Lea’s Shield.

The diaphragm and cervical cap come in different sizes, and you need a doctor to “fit” you for one. The cervical shield comes

in one size, and you will not need a fitting. Before having sex, add spermicide (to block or kill sperm) to the devices. Then place them inside your vagina to cover your cervix. You can buy spermicide gel or foam at a drug store.

All three of these barrier methods must be left in place for 6 to 8 hours after having sex to prevent pregnancy. The diaphragm should be taken out within 24 hours. The cap and shield should be taken out within 48 hours.

Female condom

This condom is worn by the woman inside the vagina as a barrier to sperm. It is made of thin, flexible, rubber and is packaged with a lubricant. It can be inserted up to 8 hours before having sex. A new condom should be used each time and should not be used at the same time as a male condom.

Male condom

Male condoms are a thin sheath placed over an erect penis to contain sperm. Condoms can be made of latex, polyurethane, or “natural/lambskin”. Natural condoms do not protect against STIs. A new condom needs to be used with each sex act.

Condoms are either:

- Lubricated, which can make sexual intercourse more comfortable
- Non-lubricated, which can also be used for oral sex. It is best to add lubrication to nonlubricated condoms if you use them for vaginal or anal sex. Use of a water-based lubricant, such as K-Y jelly is recommended. (Oil-based lubricants like massage oils, baby oil, lotions, or petroleum jelly will weaken the condom, causing it to tear or break.)

Keep condoms in a cool, dry place. Condoms kept in a warm place (like a wallet or glove compartment) may break down increasing risk of condom failure.

Hormonal methods

Hormonal methods prevent pregnancy by interfering with ovulation, fertilization and/or implantation.

Oral contraceptives – (“The pill”)

The pill contains the hormones estrogen and progestin. It is taken daily to keep the ovaries from releasing an egg. The pill also causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining the egg.

Some women prefer the “extended cycle” pills. These have 12 weeks of pills that contain hormones (active) and 1 week of pills that don’t contain hormones (inactive). While taking extended cycle pills, women only have their period three to four times a year.

Your doctor may advise a person against taking the pill if:

- Older than 35 and smoke
- Have a history of blood clots
- Have a history of breast, liver, or endometrial cancer

The patch

Also called by its brand name, Ortho Evra, this skin patch is worn on the lower abdomen, buttocks, outer arm, or upper body. It releases the hormones progestin and estrogen into the bloodstream to stop the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining with the egg. A new patch is applied once a week for 3 weeks. You don’t use a patch the fourth week in order to have a period.

Shot/injection

The birth control shot is often called by its brand name Depo-Provera. With this method you get injections, or shots, of the hormone progestin in the buttocks or arm every 3 months. A new version of the shot can now be injected under the skin as well. The birth control shot stops the ovaries from releasing an egg in most women. It also causes changes in the cervix that keep the

sperm from joining with the egg.

Vaginal ring

This is a thin, flexible ring that releases the hormones progestin and estrogen. It works by stopping the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining the egg. It is commonly called *NuvaRing*, its brand name. You squeeze the ring between your thumb and index finger and insert it into your vagina. You wear the ring for 3 weeks, take it out for the week that you have your period, and then put in a new ring.

Implantable devices

Implantable devices provide a slow release of hormones that impact ovulation or implantation.

Implantable rod

This is a matchstick-size, flexible rod that is put under the skin of the upper arm. It is often called by its brand name, Implanon. The rod releases a progestin, which causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining an egg. Less often, it stops the ovaries from releasing eggs. It is effective for up to 3 years.

Intrauterine devices or IUDs

An IUD is a small device shaped like a "T" that goes in the uterus. There are two types:

- Copper IUD – The copper IUD goes by the brand name ParaGard. It releases a small amount of copper into the uterus, which prevents the sperm from reaching and fertilizing the egg. If fertilization does occur, the IUD keeps the fertilized egg from implanting in the lining of the uterus. A doctor needs to insert the copper IUD and can stay in your uterus for 5 to 10 years.
- Hormonal IUD – The hormonal IUD goes by the brand name Mirena. It is sometimes called an intrauterine system, or IUS. It releases progestin into the uterus, which keeps the ovaries from releasing an egg and causes the cervical mucus to thicken so sperm can't reach the egg. It also affects the ability of a fertilized egg to successfully implant in the uterus. A doctor needs to insert the hormonal IUD and it can stay in your uterus for up to 5 years.

Sterilization implant

Essure is the first non-surgical method of sterilizing women. A thin tube is used to thread a tiny spring-like device through the vagina and uterus into each fallopian tube. The device works by causing scar tissue to form around the coil. This blocks the fallopian tubes and stops the egg and sperm from joining.

It can take about 3 months for the scar tissue to grow, so it's important to use another form of birth control during this time. Then you will have to return to your doctor for a test to see if scar tissue has fully blocked your tubes.

Surgical sterilization

For women, surgical sterilization closes the fallopian tubes by cutting and tying this pathway. This stops the eggs from going down to the uterus where they can be fertilized. The surgery can be done a number of ways. Sometimes, a woman having cesarean birth has the procedure done at the same time, so as to avoid having additional surgery later.

For men, having a vasectomy keeps sperm from leaving the penis (ejaculate lacks sperm). Sperm stays in the system after surgery for about 3 months. During that time, use a backup form of birth control to prevent pregnancy. A simple test (called semen analysis) can be done to check if all the sperm is absent from ejaculate.

Emergency contraception

Emergency contraception may go by the names Plan B, One-Step or Next Step. It is also called the "morning after pill." Emergency contraception prevents pregnancy after unprotected sex or after contraceptive failure (such as a condom breaking).

Abortion

Abortion is the ending of pregnancy by removing a fetus or embryo before it can survive outside the uterus. An abortion that occurs spontaneously is also known as a miscarriage. The word ***abortion*** is often used to mean only induced abortions though can include removal of fetal tissue that is no longer living if the woman's body does not expel naturally.

When allowed by law, abortion in the developed world is one of the safest procedures in medicine. Modern methods use medication or surgery for abortions. The drug mifepristone in combination with prostaglandin appears to be as safe and effective as surgery during the first and second trimester of pregnancy. Birth control, such as the pill or intrauterine devices, can be used immediately following abortion. When performed legally and safely, induced abortions do not increase the risk of long-term mental or physical problems. In contrast, unsafe abortions (those performed by unskilled individuals, with hazardous equipment, or in unsanitary facilities) cause 47,000 deaths and 5 million hospital admissions each year. The World Health Organization recommends safe and legal abortions be available to all women.

Around 56 million abortions are performed each year in the world, with about 45% done unsafely. Abortion rates have shown steady decrease as access to family planning and birth control increases. As of 2008, 40% of the world's women had access to legal abortions without limits as to reason.

Historically, abortions have been attempted using herbal medicines, sharp tools, with force, or through other traditional methods. Abortion laws and cultural or religious views of abortions are different around the world. In some areas abortion is legal only in specific cases such as rape, problems with the fetus, poverty, risk to a woman's health, or incest. In many places there is much debate over the moral, ethical, and legal issues of abortion. Those who oppose abortion often maintain that an embryo or fetus is a human with a right to life and may compare abortion to murder. Those who favor the legality of abortion often hold that a woman has a right to make decisions about her own body.

Contraception Use

All birth control methods work the best if used correctly and every time there is sexual contact. The misuse of contraceptives is known as human error and is the main reason why effectiveness is determined by typical use and perfect use. Common errors with condom use include putting it on "inside-out" or not leaving enough room at the tip for ejaculate.

Infectious Diseases and Sexually Transmitted Infections (STI's)

STDs are a substantial health challenge facing the United States. CDC estimates that nearly 20 million new sexually transmitted infections occur every year in this country, half among young people aged 15–24, and account for almost $16 billion in health care costs. Each of these infections is a potential threat to an individual's immediate and long-term health and well-being. In addition to increasing a person's risk for acquiring and transmitting HIV infection, STDs can lead to chronic pain and severe reproductive health complications, such as infertility and ectopic pregnancy. Approximately 20 different infections are known to be transmitted through sexual contact. Here are descriptions of some of the most common and well known:

- Chlamydia
- Gonorrhea
- Genital Herpes
- HIV/AIDS
- Human Papillomavirus (HPV)
- Syphilis
- Bacterial Vaginosis
- Trichomoniasis
- Viral Hepatitis

Bacterial STIs

Bacterial STIs are caused by transmission of bacteria and usually affect one are of the body (but can be spread to others). Bacterial infections can be treated with antibiotics.

Chlamydia

Chlamydia is a common STD/STI caused by the bacterium *Chlamydia trachomatis*. Chlamydia can be transmitted during vaginal, oral, or anal sexual contact with an infected partner. While many individuals will not experience symptoms, chlamydia can cause fever, abdominal pain, and unusual discharge of the penis or vagina.

In women, whether or not they are having symptoms and know about their infection, chlamydia can cause pelvic inflammatory disease (PID). PID can lead to permanent damage to the woman's reproductive organs resulting ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

Additionally, if the woman is pregnant, she can pass chlamydia can be passed to her fetus during pregnancy and delivery. If chlamydia is detected early, it can be treated easily with an oral antibiotic.

Gonorrhea

Gonorrhea is caused by the bacterium Neisseria gonorrhoeae, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract. The most common symptoms of gonorrheal infection are a discharge from the vagina or penis and painful or difficult urination.

As with chlamydial infection, the most common and serious complications of gonorrhea occur in women and include pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and the potential spread to the developing fetus if acquired during pregnancy. Gonorrhea can also infect the mouth, throat, eyes, rectum and can spread to the blood, where it can become a life-threatening illness.

In addition, people with gonorrhea can more easily contract HIV, the virus that causes AIDS. People infected with HIV and gonorrhea are also more likely to transmit the HIV virus to someone else.

Gonorrhea is a bacterial STIs that can be treated with antibiotics given either orally or by injection. Current sexual partners should be treated at the same time.

Syphilis

Syphilis infections, caused by the bacterium Treponema pallidum, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres. The first sign of syphilis is a chancre, a painless genital sore that most often appears on the penis or in and around the vagina. Beyond being the first sign of a syphilis infection, chancres make a person two to five times more likely to contract an HIV infection. If the person is already infected with HIV, chancres also increase the likelihood that the virus will be passed on to a sexual partner. These sores typically resolve on their own, even without treatment. However, the body does not clear the infection on its own, and, over time, syphilis may involve other organs, including the skin, heart, blood vessels, liver, bones, and joints in secondary syphilis. If the illness is still not treated, tertiary syphilis can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.

Expectant mothers harboring the bacterium are at an increased risk of miscarriage and stillbirth, and they can pass the infection on to their fetuses during pregnancy and delivery. Infants that acquire congenital syphilis during pregnancy may suffer from skeletal deformity, difficulty with speech and motor development, seizure, anemia, liver disease, and neurologic problems.

If recognized during the early stages, usually within the first year of infection, syphilis can be treated with a single intramuscular injection of antibiotic. A person being treated for syphilis must avoid sexual contact until the chancre sores caused by the bacteria are completely healed to avoid infecting other people.

If a person does not recognize the infection early, or does not seek treatment immediately, longer treatment with antibiotics may be required. If left untreated, the infection can progress even further and potentially cause death. Although antibiotics can prevent the infection from getting worse, they cannot reverse damage that has already occurred.

Bacterial Vaginosis

Bacterial vaginosis is a common, possibly sexually transmitted, vaginal infection in women of reproductive age. While it is healthy and normal for a vagina to have bacteria, just like the skin, mouth, or gastrointestinal (GI) tract, sometimes changes in the balance

of different types of bacteria can cause problems.

Bacterial vaginosis occurs when problematic bacteria that are normally present only in small amounts increase in number, replace normal vaginal lactobacilli bacteria, and upset the usual balance. This situation becomes more likely if a woman douches frequently or has new or multiple sexual partners. The most common sign of a bacterial vaginosis infection is a thin, milky discharge that is often described as having a “fishy” odor. However, some women will have no symptoms at all.

Regardless of symptoms, having bacterial vaginosis increases the risk of getting other STDs/STIs and is also associated with pelvic inflammatory disease (PID), an infection of the female reproductive organs, including the uterus and the fallopian tubes (which carry eggs to the uterus), and postoperative infections. Preterm labor and birth are also possibly more common in women with bacterial vaginosis.

Bacterial vaginosis can be treated with antibiotics, typically metronidazole or clindamycin. Generally, male sexual partners of women with bacterial vaginosis do not need to be treated because treatment of partners has not been shown to reduce the risk of recurrence. Treatment during pregnancy is recommended primarily for women at risk for preterm labor or having a low birthweight infant.

Viral STIs

Viral STIs are cause by transmission of a virus. Viruses infect cells throughout the body and cannot be treated or “cured” with antibiotics. Vaccines have been developed to prevent transmission of some viruses.

Genital Herpes

Genital herpes is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2. When symptomatic, HSV-1 usually appears as fever blisters or cold sores on the lips, but it can also infect the genital region through oral-genital or genital-genital contact. Symptomatic HSV-2 typically causes painful, watery skin blisters on or around the genitals or anus. However, substantial numbers of people who carry these viruses have no or only minimal signs or symptoms.

Neither HSV-1 nor HSV-2 can be cured, and even during times when an infected person has no symptoms, the virus can be found in the body’s nerve cells. Periodically, (usually in response to stress) a person will experience outbreaks in which new blisters form on the skin in the genital area; at those times, the virus is more likely to be passed on to other people.

Pregnant women, especially those who acquire genital herpes for the first time during pregnancy, may pass the infection to their newborns, causing life-threatening neonatal HSV, an infection affecting the infant’s skin, brain, and other organs.

Genital herpes outbreaks can be treated with antiviral drugs. Although this medication can limit the length and severity of outbreaks, it does not cure the infection. In addition, daily suppressive therapy (daily use of antiviral medication) for herpes can reduce the likelihood of transmission to partners. A pregnant woman known to have the infection must take additional care because she can pass the infection to her infant during delivery. Women who first acquire genital HSV during pregnancy are at highest risk of transmission to their infants. If a pregnant woman has an outbreak when she goes into labor, she may need to have a cesarean section (C-section) to prevent the infant from getting the virus during birth.

HIV/AIDS

HIV, or the human immunodeficiency virus, is the virus that causes AIDS (acquired immunodeficiency syndrome). HIV destroys the body’s immune system by killing the blood cells that fight infection. Once HIV destroys a substantial proportion of these cells (CD4 cells), the body’s ability to fight off and recover from infections is compromised. This advanced stage of HIV infection is known as AIDS.

The CD4 count is like a snapshot of how well your immune system is functioning. CD4 cells (also known as CD4+ T cells) are white blood cells that fight infection. The more you have, the better. These are the cells that the HIV virus kills. As HIV infection progresses, the number of these cells declines. When the CD4 count drops below 200 due to advanced HIV disease, a person is diagnosed with AIDS. A normal range for CD4 cells is about 500-1,500. Usually, when a person with low CD4 cells starts HIV medicines, the CD4 cell count increases as the HIV virus is controlled. Most, but not all, people will experience an increase in

CD4 cells with effective HIV treatment.

People whose HIV has progressed to AIDS are very susceptible to opportunistic infections and certain forms of cancer.

AIDS can be prevented by early initiation of antiretroviral therapy in those with HIV infection. Transmission of the virus primarily occurs during unprotected sexual activity and by sharing needles used to inject intravenous drugs, although the virus also can spread from mother to infant during pregnancy, delivery, and breastfeeding.

In 2013, NIH-supported researchers reported that a 2-year-old child who was born with HIV and was treated starting in the first few days of life has had her HIV infection go into remission. This appears to be the first case of functional cure of HIV.

There is no cure for HIV/AIDS. However, research into new treatments has improved outcomes for people living with the disease. A combination of antiretroviral drugs can be given in highly active antiretroviral therapy to control the virus, promote a healthy immune system, help people with the virus live longer lives, and reduce the risk of transmission.

Human Papillomavirus (HPV)

HPV is the most common STD/STI. More than 40 HPV types strains, and all of them can infect both men and women. The types of HPVs vary in their ability to cause genital warts; infect other regions of the body, including the mouth and throat; and cause cancers of the cervix, vulva, penis, and mouth.

Although no cure exists for HPV infection once it occurs, regular screening with a Pap smear test can detect at an early stage most cases cervical cancer that may have been caused by HPV. (A Pap smear test involves a health care provider taking samples of cells from the cervix during a standard gynecologic exam; these cells are examined under a microscope for signs of developing cancer).

A person who has an HPV infection cannot be cured. However, a health care provider can treat genital warts caused by the virus as well as monitor and control a woman's risk of cervical cancer through frequent screening with Pap smear tests.

An available vaccine protects against most (but not all) HPV types that cause cervical cancer. The American Academy of Pediatrics recommends this vaccine for school-aged boys and girls.

Viral Hepatitis

Viral hepatitis is a serious liver disease that can be caused by several different viruses, which can be transmitted through sexual contact.

- Hepatitis A virus (HAV) causes a short-term or self-limited liver infection that can be quite serious, although it does not result in chronic infection. While there are other ways the virus can be transmitted, HAV can be spread from person to person during sexual activity through oral-rectal contact. Vaccination can prevent HAV infection.
  - Usually the infection gets better on its own without requiring treatment. In some cases, however, individuals may have lasting damage to their livers or may have such severe nausea and vomiting that they must be admitted to the hospital.
- Hepatitis B virus (HBV) causes a serious liver disease that can result in both immediate illness and lifelong infection leading to permanent liver scarring (cirrhosis), cancer, liver failure, and death. HBV spreads through both heterosexual and homosexual contact as well as through contact with other bodily fluids, such as blood, through shared contaminated needles used for injecting intravenous (IV) drugs, tattooing, and piercing. Pregnant women with HBV can transmit the virus to their infants during delivery. HBV infection is preventable through vaccination.
  - People with HBV infection will need to see a liver specialist with experience treating individuals with chronic liver disease. These individuals need to take special care not to pass on the virus to their sexual partners, and sexual partners should receive hepatitis B vaccine if not already immune.
- Hepatitis C virus (HCV) can cause an immediate illness affecting the liver, but it more commonly becomes a silent, chronic infection that leads to liver scarring (cirrhosis), cancer, liver failure, and death. HCV is most commonly transmitted through sharing needles or exposure to infected blood. However, it can spread through sexual contact or from mother to fetus during pregnancy and delivery. There is no vaccine for HCV, and treatments are not always effective.
  - As with hepatitis B, individuals with HCV may have a lifelong infection and will always be at risk of passing the virus on to their sexual partners. New treatments are available that can clear the infection in some individuals.

Parasitic STIs

Parasitic infestation result from parasitic transfer from one body to another, and the parasite using the body as a host. Parasitic infestations are treatable but some types require cleaning/sterilization of clothing, bedding and other linens to prevent reinfestation.

Trichomoniasis

Trichomoniasis infection is caused by the single-celled protozoan parasite Trichomonas vaginalis and is common in young, sexually active women. The parasite also infects men, though less frequently. The parasite can be transmitted between men and women as well as between women whenever physical contact occurs between the genital areas. Although *Trichomonas* infections do not always cause symptoms, they can cause frequent, painful, or burning urination in men and women as well as vaginal discharge, genital soreness, redness, or itching in women. Because the infection can occur without symptoms, a person may be unaware that he or she is infected and continue to re-infect a sexual partner who is having recurrent signs of infection. As with bacterial STDs/STIs, all sexual partners should be treated at the same time to avoid re-infection.

Trichomoniasis can be treated with a single dose of an antibiotic, usually either metronidazole or tinidazole, taken by mouth.

Pubic Lice (“crabs”)

Pubic lice — also known as crabs — are small parasites that live on the skin and coarse hairs that are around genitals, and they feed blood. (Pubic lice are different than head lice and infest different areas of the body.)

Pubic lice are spread through personal contact. Sexual intercourse is not necessary for the transmission of pubic lice because lice stay outside the body and infest areas with course hair such as eyelashes, eyebrows, chest hair, armpits, beards, and mustaches. Sometimes pubic lice are spread by using an infected person’s clothes, towels, or bed.

You can treat pubic lice with topical lice treatments.

STD/STI Prevention:

Every year, there are an estimated 20 million new sexually transmitted infections in the United States. Anyone who is sexually active can get an STI.

The Good News: STI’s ARE preventable. Steps can be taken to keep yourself and your partner(s) healthy. Here’s How You Can Avoid (or reduce the risk of) giving or getting an STI:

Practice Abstinence

The surest way to avoid STI’s is to not have sex. This means not having vaginal, oral, or anal sex as well as other activities that involve close personal contact or coming in contact with another person’s body fluids.

Use Condoms

Using a condom correctly every time a person participates is sexual activity can reduce risk of STI transmission. Certain STI’s, like herpes or HPV, can still be transmitted by contact with a partner’s skin (even when using a condom).

Have Fewer Partners

Agree to only have sex with one person who agrees to only have sex with you. Make sure you both get tested to know for sure that neither of you has an STI. This is one of the most reliable ways to avoid STI’s.

Get Vaccinated

Some common STI can be prevented by a vaccine. The HPV vaccine is safe, effective, and can help you avoid HPV-related health

problems like genital warts and some cancers.

Talk With Your Partner

Talk with your sex partner(s) about STI's and staying safe before having sex. It might be uncomfortable to **start the conversation**, but protecting your health is your responsibility.

Get Tested

Many STI's don't have symptoms, but they can still cause health problems.

3. **Talk with your health care provider**
4. **Search for CDC recommended tests**
5. **Find a location to get tested for STDs**

The only way to know for sure if you have an STI is to get tested.

Check for Understanding

1. What is the difference between sex and gender? How are these influence by social constructs?
2. What factors are important for forming healthy relationships? What are some signs of an unhealthy relationship?
3. What methods of contraception can be use to reduce risk of unwanted pregnancy?
4. What methods of protection can be use to reduce risk of STI transmission?
5. What are the three main categories of STIs and how do these differ in transmission and treatment?

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7.6: Pregnancy and Fetal Development

Chapter Objectives

- Identify maternal and fetal changes that occur during each prenatal trimester
- Discuss possible dysfunction or complications that can occur during each trimester of pregnancy
- Describe a typical birth process along with at least four variations that could occur
- Describe the pros and cons associated with homebirth and hospital birth
- Discuss possible causes and symptoms of miscarriage and stillbirth

Pregnancy and Birthing Options

"Making the decision to have a baby (or adopt a child) is momentous. It is to decide forever to have your heart go walking around outside your body." ~ Elizabeth Stone

"That she bear children is not a woman's significance. But that she bear herself, that is her supreme and risky fate." ~ D.H. Lawrence

To Have or Not to Have Children

One of the bigger choices we make as humans is the choice to have and raise children or to not have children. Sometimes it is not a choice at all but the result of circumstances given to us. Why might a person choose to have kids and what would the arguments be for choosing to remain childless? What circumstances might cause someone who so badly wants a child to be without? How might someone deal with an unexpected pregnancy when having a child was not part of the plan?

Video: I Don't Want to Have Children, Stop Telling Me I Will Change My Mind.

Video: The Case for Having Kids.

Pregnancy

A missed period is often the first clue that a woman might be pregnant though she might suspect pregnancy even sooner. Symptoms such as headache, fatigue, and breast tenderness, can occur even before a missed period. The wait to know can be emotional. These days, many women first use home pregnancy tests (HPT) to learn they are pregnant.

All pregnancy tests work by detecting Human Chorionic Gonadotropic (hCG) in the urine or blood only present a woman is pregnant. hCG is made when a fertilized egg implants in the uterus and rapidly builds up in your body during early pregnancy.

Unplanned Pregnancy

In the event of an unplanned pregnancy many thoughts may come to mind. Will your partner welcome the news? Can you afford to care for the baby? Will choices such as past drug use addiction affect the health of the unborn baby? Will having a baby keep me from finishing school or pursuing a career?

First steps to take when a person fins out they are pregnant:

- Start taking care of yourself right away. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) folic acid every. Stop alcohol, tobacco, and drug use.
- Make a doctor's visit to confirm your pregnancy. Discuss your health and issues that could affect your pregnancy. Ask for help quitting smoking. Find out what you can do to take care of yourself and your unborn baby.
- Ask your doctor to recommend a counselor who you can talk to about your situation.
- Seek support in someone you trust and respect.

Trying to Get Pregnant

Some women want children but either cannot conceive or miscarry multiple times. Many couples face **infertility** when trying to start or grow a family. About one-third of the time, it is a female problem. In another one-third of cases, it is the man with the fertility problem. For the remaining one-third, both partners have fertility challenges or no cause is found.

Causes of infertility

Age – Women generally have some decrease in fertility starting in their early 30s. As a woman ages, normal changes that occur in her ovaries and eggs make it harder to become pregnant. Even though menstrual cycles continue to be regular in a woman's 30s and 40s, the eggs that ovulate each month are of poorer quality than those from her 20s. As a woman nears menopause, the ovaries may not release an egg each month, which also can make it harder to get pregnant.

Health problems – Some women have diseases or conditions that affect their hormone levels, which can cause infertility. Women with polycystic ovary syndrome (PCOS) rarely or never ovulate. Failure to ovulate is the most common cause of infertility in women.

Common problems with a woman's reproductive organs, like uterine fibroids, endometriosis, and pelvic inflammatory disease can worsen with age and also affect fertility. These conditions might cause a blockage in the fallopian tubes to be blocked preventing the egg from getting to the uterus.

Lifestyle factors – Certain lifestyle factors also can have a negative effect on a woman's fertility. Examples include smoking, alcohol use, weighing much more or much less than an ideal body weight, a lot of strenuous exercise, and having an eating disorder. Stress also can affect fertility.

When to see your doctor

You should talk to your doctor about your fertility if:

* You are younger than 35 and have not been able to conceive after one year of frequent sex without birth control.

- You are age 35 or older and have not been able to conceive after six months of frequent sex without birth control.
- You believe you or your partner might have fertility problems in the future (even before you begin trying to get pregnant).
- You or your partner has a problem with sexual function or libido.

If you are having fertility issues, your doctor can refer you to a fertility specialist. About 9 in 10 cases of infertility are treated with drugs or surgery. Don't delay seeing your doctor as age also affects the success rates of these treatments. For some couples, adoption or foster care offers a way to share their love with a child and build a family.

Increasing Likelihood of Pregnancy

Being aware of the menstrual cycle and the changes in the body that happen during mensuration can help a woman know when she is likely to get pregnant.

There are ways you can keep track of your fertile times in the menstrual cycle. They are:

- **Basal body temperature method** – Basal body temperature is your temperature at rest as soon as you awake in the morning. A woman's basal body temperature rises slightly with ovulation. So by recording this temperature daily for several months, a woman will be able to predict the most fertile days.
- **Calendar method** – This involves recording your menstrual cycle on a calendar for eight to 12 months. The first day of a period is Day 1. Circle Day 1 on the calendar and record down the total number of days a cycle it lasts each time. Days 12-14 of the cycle will be a woman's most fertile days.
- **Cervical mucus method** (also known as the ovulation method) – This involves being aware of the changes in your cervical mucus throughout the month. The hormones that control the menstrual cycle also change the kind and amount of mucus before and during ovulation. The greatest amount of mucus appears just before ovulation.

Preconception Care: Why Preconception Health Matters

Preconception health is a woman's health before she becomes pregnant. It means knowing how health conditions and risk factors could affect a woman or her unborn baby if she becomes pregnant. For example, some foods, habits, and medicines can harm a baby — even before conception. Some health problems, such as diabetes, also can affect pregnancy.

It is important for any person thinking about their health, but with half of all pregnancies unplanned it is especially important to consider behaviors that may affect the health of a baby. Unplanned pregnancies are at greater risk of preterm birth and low birth weight babies. Despite important advances in medicine and prenatal care, about 1 in 8 babies is born too early. Researchers are trying to find out why and how to prevent preterm birth. But experts agree that women need to be healthy before becoming pregnant. By taking action on health issues and risks before pregnancy, a person can prevent problems that might affect mom or baby later.

Improving Preconception Health

Ideally, couple should prepare for pregnancy at least three months before getting pregnant. Some actions, such as quitting smoking, reaching a healthy weight, or adjusting medicines may need to start even earlier.

The five most important things a woman can do for preconception health are:

- Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) of folic acid every day if you are planning or capable of pregnancy to lower your risk of some birth defects of the brain and spine, including spina bifida.
- Stop smoking and drinking alcohol.
- If you have a medical condition, be sure it is under control. Some conditions that can affect pregnancy or be affected by it include asthma,diabetes, oral health, obesity, or
- Talk to your doctor about any over-the-counter and prescription medicines you are using. These include dietary or herbal supplements. Be sure your vaccinations are up to date.
- Avoid contact with toxic substances or materials that could cause infection at work and at home. Stay away from chemicals and cat or rodent feces.

Anatomical and Physiological Changes that Occur During Pregnancy

A full-term pregnancy lasts approximately 270 days (approximately 38.5 weeks) from conception to birth. Because it is easier to remember the first day of the last menstrual period (LMP) than to estimate the date of conception, obstetricians set the due date as 284 days (approximately 40.5 weeks) from the LMP. This assumes that conception occurred on day 14 of the woman's cycle, which is usually a good approximation. The 40 weeks of an average pregnancy are usually discussed in terms of three **trimesters**, each approximately 13 weeks. We will express embryonic and fetal ages in terms of weeks from conception. The period of time required for full development of a fetus in utero is referred to as **gestation** (gestare = "to carry" or "to bear").

A developing human is referred to as a **zygote** for the first 2 weeks after conception, an **embryo** during weeks 3–8, and a **fetus** from the ninth week of gestation until birth.

Implantation

Following fertilization, the zygote and its associated membranes, continue their travel through the fallopian tube toward the uterus. During its journey to the uterus, the zygote undergoes five or six rapid mitotic cell divisions. At the end of the first week, the blastocyst comes in contact with the uterine wall and adheres to it, embedding itself in the uterine lining (referred to as **implantation).** (Figure 2). Implantation can be accompanied by minor bleeding. The zygote typically implants in the fundus of the uterus or on the posterior wall. However, if the endometrium is not fully developed and ready to receive the zygote, the zygote and associated cells will detach and find a better spot. A significant percentage (50–75 percent) of zygotes fail to implant; when this occurs, the cell bundle is shed with the endometrium during menses. The high rate of implantation failure is one reason why successful pregnancy typically requires several ovulation cycles.

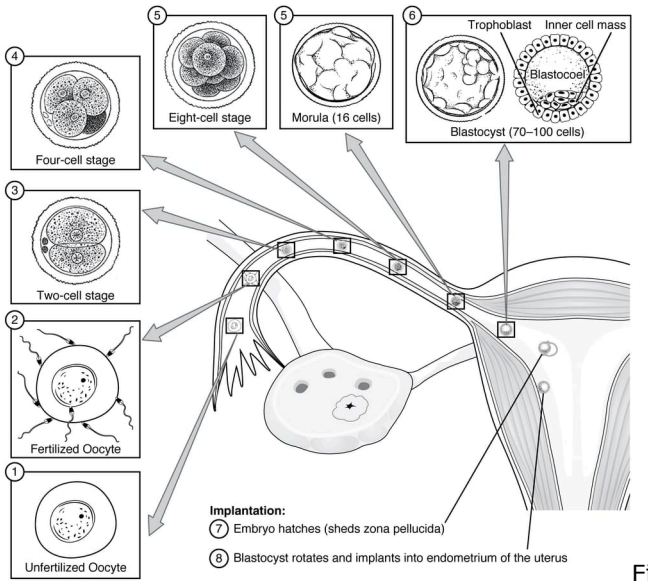


Figure 2. Pre-Embryonic Development. Ovulation, fertilization, pre-embryonic development, and implantation occur at specific locations within the female reproductive system in a time span of approximately 1 week.

Just a few days after implantation, the mass of cells has secreted enough hCG (human growth hormone) for an at-home urine pregnancy test to give a positive result. However, in one to two percent of cases, the embryo implants either outside the uterus or in a region of uterus that can create complications for the pregnancy.

DysfunctionDuring Implantation

In the vast majority of **ectopic pregnancies**, the embryo does not complete its journey to the uterus and implants in the uterine tube, referred to as a tubal pregnancy. However, there are also ovarian ectopic pregnancies (in which the egg never left the ovary) and abdominal ectopic pregnancies (in which an egg was "lost" to the abdominal cavity during the transfer from ovary to uterine tube, or in which an embryo from a tubal pregnancy re-implanted in the abdomen).

Tubal pregnancies can be caused by scar tissue within the tube following a sexually transmitted bacterial infection. The scar tissue impedes the progress of the embryo into the uterus—in some cases "snagging" the embryo and, in other cases, blocking the tube completely. Approximately one half of tubal pregnancies resolve spontaneously. Implantation in a uterine tube causes bleeding, which appears to stimulate smooth muscle contractions and expulsion of the embryo. In the remaining cases, medical or surgical intervention is necessary.

Even if the embryo has successfully found its way to the uterus, it does not always implant in an optimal location (the fundus or the posterior wall of the uterus). Placenta previa can result if an embryo implants close to the internal opening of the cervix. As the fetus grows, the placenta can partially or completely cover the opening of the cervix (Figure 4). Although it occurs in only 0.5 percent of pregnancies, **placenta previa** is the leading cause of antepartum hemorrhage (profuse vaginal bleeding after week 24 of pregnancy but prior to childbirth).

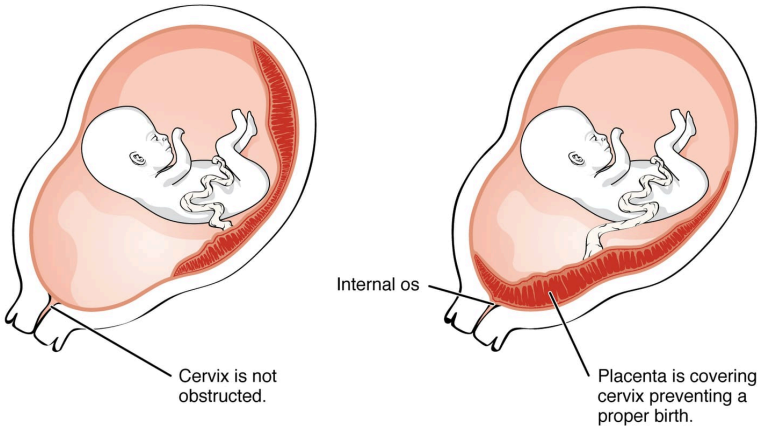


Figure 4. Placenta Previa. An embryo that implants too close to the opening of the cervix can lead to placenta previa, a condition in which the placenta partially or completely covers the cervix.

Development of the Placenta

During the first several weeks of development, the cells of the endometrium (uterus) nourish the embryo. During prenatal weeks 4–12, the developing placenta gradually takes over the role of feeding the embryo, and the endometrial cells are no longer needed. The mature placenta is composed of tissues derived from the embryo, as well as maternal tissues of the endometrium. The placenta connects to the embryo via the **umbilical cord**, which carries deoxygenated blood and wastes from the fetus through two umbilical arteries; nutrients and oxygen are carried from the mother to the fetus through the single umbilical vein.

Embryotic Development

Within the first 8 weeks of gestation, a developing embryo establishes the rudimentary structures of all of its organs and tissues. The heart begins its development in the embryo as a tube-like structure, connected via capillaries. Cells of the primitive tube-shaped heart are capable of electrical conduction and contraction. The heart begins beating in the beginning of the fourth week, although it does not actually pump embryonic blood until a week later, when the oversized liver has begun producing red blood cells. (This is a temporary responsibility of the embryonic liver that the bone marrow will assume during fetal development.) During weeks 4–5, the eye pits form, limb buds become apparent, and the rudiments of the pulmonary system are formed.

During the sixth week, uncontrolled fetal limb movements begin to occur. The gastrointestinal system develops too rapidly for the embryonic abdomen to accommodate it, and the intestines temporarily loop into the umbilical cord. Paddle-shaped hands and feet develop fingers and toes. By week 7, the facial structure is more complex and includes nostrils, outer ears, and lenses (Figure 12). By the eighth week, the head is nearly as large as the rest of the embryo's body, and all major brain structures are in place. The external genitalia are apparent, but at this point, male and female embryos are indistinguishable. Bone begins to replace cartilage in the embryonic skeleton through the process of ossification. By the end of the embryonic period, the embryo is approximately 3 cm (1.2 in) from crown to rump and weighs approximately 8 g (0.25 oz).

Figure 12. Embryo at 7 Weeks. An embryo at the end of 7 weeks of development is only 10 mm in length, but its developing eyes, limb buds, and tail are already visible. (This embryo was derived from an ectopic pregnancy.) (credit: Ed Uthman)

Sexual Differentiation

Sexual differentiation does not begin until the fetal period, during weeks 9–12. Embryonic males and females, though genetically distinguishable, are morphologically identical. Gonads that can develop into male or female sexual organs, are connected to a central cavity called the cloaca via Müllerian ducts (female)and Wolffian ducts (male).

During male fetal development, the gonads become the testes and associated epididymis. The Müllerian ducts degenerate. The Wolffian ducts become the vas deferens.

During female fetal development, the gonads develop into ovaries. The Wolffian ducts degenerate. The Müllerian ducts become the uterine tubes and uterus.

Fetal Development

During weeks 9–12 of fetal development, the brain continues to expand, the body elongates, and ossification of bones continues. Fetal movements are frequent during this period, but are jerky and not well-controlled. The bone marrow begins to take over the process of red blood cell production. The eyes are well-developed by this stage, but the eyelids are fused shut. The fingers and toes begin to develop nails. By the end of week 12, the fetus measures approximately 9 cm (3.5 in) from crown to rump.

Weeks 13–16 are marked by sensory organ development. The eyes move closer together; blinking motions begin, although the eyes remain sealed shut. The lips exhibit sucking motions. The scalp begins to grow hair.

During approximately weeks 16–20, as the fetus grows and limb movements become more powerful, the mother may begin to feel **quickening**, or fetal movements. However, space restrictions limit these movements and typically force the growing fetus into the "fetal position," with the arms crossed and the legs bent at the knees. Oil glands coat the skin with a waxy, protective substance called **vernix** that protects and moisturizes the skin and may provide lubrication during childbirth. A silky hair called **lanugo** also covers the skin during weeks 17–20, but it is shed as the fetus continues to grow. Extremely premature infants sometimes exhibit residual lanugo.

Developmental weeks 21–30 are characterized by rapid weight gain, which is important for maintaining a stable body temperature after birth. During this period, the fetus grows eyelashes. The eyelids are no longer fused and can be opened and closed. The lungs begin producing surfactant, a substance that reduces surface tension in the lungs and assists proper lung expansion after birth. In male fetuses, the testes descend into the scrotum near the end of this period. The fetus at 30 weeks measures 28 cm (11 in) from crown to rump and exhibits the approximate body proportions of a full-term newborn, but still is much leaner.

The fetus continues to lay down fat under the skin from week 31 until birth which causes and the skin transitions from red and

wrinkled to soft and pink. Lanugo is shed, and the nails grow to the tips of the fingers and toes. Immediately before birth, the average crown-to-rump length is 35.5–40.5 cm (14–16 in), and the fetus weighs approximately 2.5–4 kg (5.5–8.8 lbs). Once born, the newborn is no longer confined to the fetal position, so subsequent measurements are made from head-to-toe instead of from crown-to-rump. At birth, the average length is approximately 51 cm (20 in).

Maternal Changes

The 40 weeks of an average pregnancy are usually discussed in terms of three trimesters, each approximately 13 weeks. During the second and third trimesters, the pre-pregnancy uterus—about the size of a fist—grows dramatically to contain the fetus, causing a number of anatomical changes in the mother.

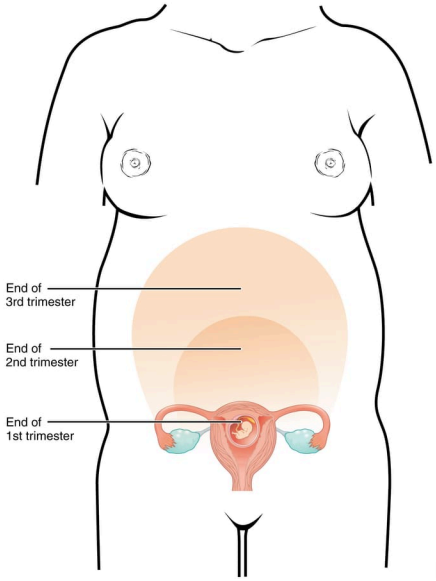


Figure 1. Size of Uterus throughout Pregnancy. The uterus grows throughout pregnancy to accommodate the fetus.

Effects of Hormones

Virtually all of the effects of pregnancy can be attributed in some way to the influence of hormones—particularly estrogens, progesterone, and hCG. Relaxin, another hormone secreted by the placenta, helps prepare the mother's body for childbirth. It increases the elasticity of the pubic joint and pelvic ligaments, making room for the growing fetus and allowing expansion of the pelvic outlet for childbirth. Relaxin also helps dilate the cervix during labor.

Weight Gain

The second and third trimesters of pregnancy are associated with dramatic changes in maternal anatomy and physiology. The most obvious anatomical sign of pregnancy is the dramatic enlargement of the abdominal region, coupled with maternal weight gain. This weight results from the growing fetus as well as the enlarged uterus, amniotic fluid, and placenta. Additional breast tissue and dramatically increased blood volume also contribute to weight gain (Table 2). Surprisingly, fat storage accounts for only approximately 2.3 kg (5 lbs) in a normal pregnancy and serves as a reserve for the increased metabolic demand of breastfeeding.

During the first trimester, the mother does not need to consume additional calories to maintain a healthy pregnancy. However, a weight gain of approximately 0.45 kg (1 lb) per month is common. During the second and third trimesters, the mother's appetite increases, but it is only necessary for her to consume an additional 300 calories per day to support the growing fetus. Most women gain approximately 0.45 kg (1 lb) per week.

Contributors to Weight Gain During Pregnancy (Table 2)		
Component	**Weight (kg)**	**Weight (lb)**
Fetus	3.2–3.6	7–8
Placenta and fetal membranes	0.9–1.8	2–4
Amniotic fluid	0.9–1.4	2–3
Breast tissue	0.9–1.4	2–3
Blood	1.4	4
Fat	0.9–4.1	3–9
Uterus	0.9–2.3	2–5
Total	10–16.3	22–36

Changes in Organ Systems During Pregnancy

As the woman's body adapts to pregnancy, characteristic physiologic changes occur. These changes can sometimes prompt symptoms often referred to collectively as the common discomforts of pregnancy.

Digestive and Urinary System Changes

Nausea and vomiting, sometimes triggered by an increased sensitivity to odors, are common during the first few weeks to months of pregnancy. This phenomenon is often referred to as "**morning sickness**," although the nausea may persist all day. The source of pregnancy nausea is thought to be the increased circulation of pregnancy-related hormones. By about week 12 of pregnancy, nausea typically subsides.

A common gastrointestinal complaint during the later stages of pregnancy is gastric reflux, or heartburn, which results from the upward, constrictive pressure of the growing uterus on the stomach.

The downward pressure of the uterus also compresses the urinary bladder, leading to frequent urination. In addition, the maternal urinary system processes both maternal and fetal wastes, further increasing the total volume of urine.

Circulatory System Changes

Blood volume increases substantially during pregnancy, so that by childbirth, it exceeds its preconception volume by 30 percent, or approximately 1–2 liters. The greater blood volume helps to manage the demands of fetal nourishment and fetal waste removal. In conjunction with increased blood volume, the pulse and blood pressure also rise moderately during pregnancy. As the fetus grows, the uterus compresses underlying pelvic blood vessels, hampering venous return from the legs and pelvic region. As a result, many pregnant women develop varicose veins or hemorrhoids.

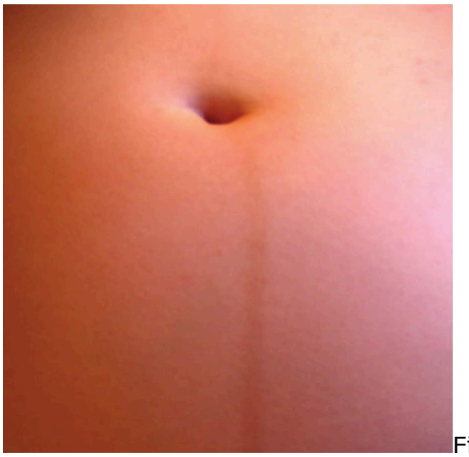
Respiratory System Changes

During the second half of pregnancy, the volume of gas inhaled or exhaled by the lungs per minute increases by 50 percent to compensate for the oxygen demands of the fetus and the increased maternal metabolic rate. The growing uterus exerts upward pressure on the diaphragm, decreasing the volume of each inspiration and potentially causing shortness of breath. During the last several weeks of pregnancy, the pelvis becomes more elastic, and the fetus descends lower in a process called lightening. This typically alleviates shortness of breath.

Skin Changes

The skin stretches extensively to accommodate the growing uterus, breast tissue, and fat deposits on the thighs and hips. Torn connective tissue cause stretch marks on the abdomen, which appear as red or purple marks during pregnancy that fade to a silvery white color in the months after childbirth.

An increase in melanin-stimulating hormone, in conjunction with estrogens, darkens the areolae and creates a line of pigment from the umbilicus to the pubis called the linea nigra (Figure 2). Melanin production during pregnancy may also darken or discolor skin on the face to create a chloasma, or “mask of pregnancy.”


Figure 2. Linea Nigra. The linea nigra, a dark medial line running from the umbilicus to the pubis, forms during pregnancy and persists for a few weeks following childbirth. The linea nigra shown here corresponds to a pregnancy that is 22 weeks along.

Check for Understanding

1. What are some reasons a person may decide to have or not have children?
2. How can a person increase the likelihood of becoming pregnant or contributing to a pregnancy?
3. What are some common causes of infertility?
4. What are some important factors to consider in preconception health?
5. What are the various stages of development by trimester for embryo/fetus?
6. What are some maternal changes during pregnancy?

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7.7: Labor and Childbirth

Chapter Objectives

- identify various stages of labor
- describe components of APGAR score and use in newborn evaluation
- describe various options available in maternal and infant care during and after delivery
- discuss pros and cons of home birth
- discuss pros and cons of hospital birth
- identify

Physiology of Labor

Childbirth typically occurs within a week of a woman's due date, unless the woman is pregnant with more than one fetus, which usually causes her to go into labor early. As a pregnancy progresses into its final weeks, several physiological changes occur in response to hormones that trigger labor.

Progesterone inhibits uterine contractions throughout the first several months of pregnancy. As the pregnancy enters its seventh month, progesterone levels plateau and then drop. Estrogen levels, however, continue to rise (Figure 3). The increasing ratio of estrogen to progesterone makes the the uterine muscle (myometrium) more sensitive to stimuli that promote contractions (because progesterone no longer inhibits them). Some women may feel the result of the decreasing levels of progesterone in late pregnancy as weak and irregular **Braxton-Hicks contractions**, also called false labor. These contractions can often be relieved with rest or hydration.

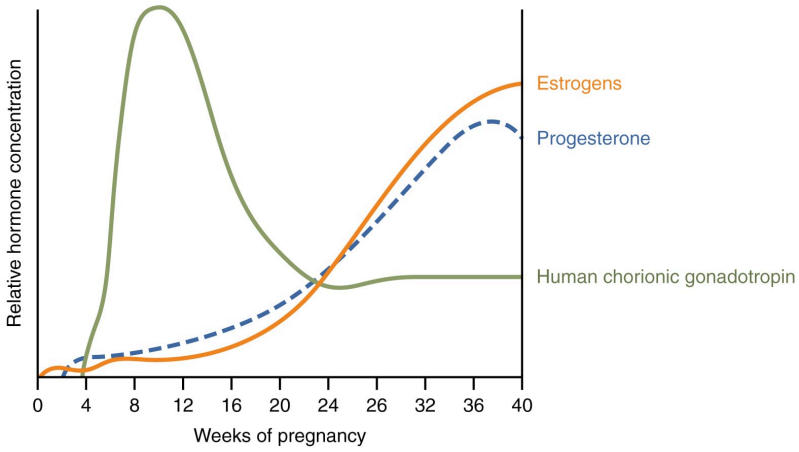


Figure 3. Hormones Initiating Labor. A positive feedback loop of hormones works to initiate labor.

A common sign that labor will be soon is the so-called "bloody show." During pregnancy, a plug of mucus accumulates in the cervical canal, blocking the entrance to the uterus. Approximately 1–2 days prior to the onset of true labor, this plug loosens and is expelled, along with a small amount of blood.

Meanwhile, the pituitary gland has been boosting its secretion of **oxytocin**, a hormone that stimulates the contractions of labor. At the same time, the muscles of the uterus increase sensitivity to oxytocin. Like oxytocin, prostaglandins (chemicals that induce labor) also enhance uterine contractile strength. Given the importance of oxytocin and prostaglandins to the initiation and maintenance of labor, it is not surprising that, when a pregnancy is not progressing to labor and needs to be induced, a pharmaceutical version of these compounds (called **pitocin**) is administered by intravenous drip.

Finally, stretching of the myometrium and cervix by a full-term fetus in the vertex (head-down) position is regarded as a stimulant to uterine contractions. The sum of these changes initiates the regular contractions known as true labor, which become more powerful and more frequent with time. The pain of labor is attributed to myometrial hypoxia during uterine contractions.

Stages of Childbirth

The process of childbirth can be divided into three stages: cervical dilation, expulsion of the newborn, and afterbirth (Figure 4).

Cervical Dilation

For vaginal birth to occur, the cervix must dilate fully to 10 cm in diameter—wide enough to deliver the newborn's head. The dilation stage is the longest stage of labor and typically takes 6–12 hours. However, it varies widely and may take minutes, hours, or days, depending in part on whether the mother has given birth before; in each subsequent labor, this stage tends to be shorter.

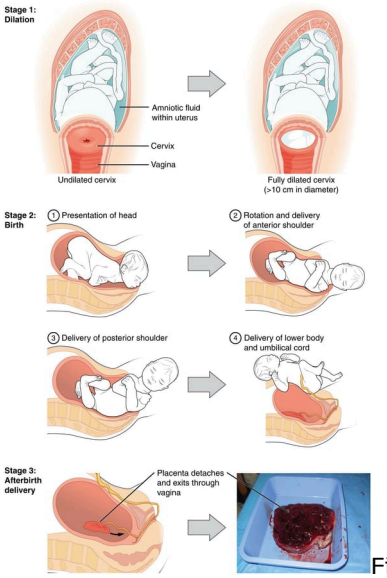


Figure 4. Stages of Childbirth. The stages of childbirth include Stage 1, early cervical dilation; Stage 2, full dilation and expulsion of the newborn; and Stage 3, delivery of the placenta and associated fetal membranes. (The position of the newborn's shoulder is described relative to the mother.)

True labor progresses in a positive feedback loop in which uterine contractions stretch the cervix, causing it to dilate and efface, or become thinner. Cervical stretching induces reflexive uterine contractions that dilate and efface the cervix further. In addition, cervical dilation boosts oxytocin secretion from the pituitary, which in turn triggers more powerful uterine contractions. When labor begins, uterine contractions may occur only every 3–30 minutes and last only 20–40 seconds; however, by the end of this stage, contractions may occur as frequently as every 1.5–2 minutes and last for a full minute.

Each contraction sharply reduces oxygenated blood flow to the fetus. For this reason, it is critical that a period of relaxation occur after each contraction. **Fetal distress**, measured as a sustained decrease or increase in the fetal heart rate, can result from severe contractions that are too powerful or lengthy for oxygenated blood to be restored to the fetus. Such a situation can be cause for an emergency birth with vacuum, forceps, or surgically by **Caesarian section**.

The amniotic membranes rupture before the onset of labor in about 12 percent of women; they typically rupture at the end of the dilation stage in response to excessive pressure from the fetal head entering the birth canal.

Expulsion Stage

The expulsion stage begins when the fetal head enters the birth canal and ends with birth of the newborn. It typically takes up to 2 hours, but it can last longer or be completed in minutes, depending in part on the orientation of the fetus. The vertex presentation is the most common presentation and is associated with the greatest ease of vaginal birth. The fetus faces the maternal spine and the smallest part of the head (the back of top-back of the head) exits the birth canal first.

In fewer than 5 percent of births, the infant is oriented in the **breech** presentation, or buttocks down. In a **complete breech**, both legs are crossed and oriented downward. In a **frank breech** presentation, the legs are oriented upward. Before the 1960s, it was common for breech presentations to be delivered vaginally. Today, most breech births are accomplished by Caesarian section.

Vaginal birth is associated with significant stretching of the vaginal canal, the cervix, and the perineum. Until recent decades, it was routine procedure for an obstetrician to numb the perineum and perform an **episiotomy**, an incision in the posterior vaginal wall and perineum. The perineum is now more commonly allowed to tear on its own during birth. Both an episiotomy and a perineal tear need to be sutured shortly after birth to ensure optimal healing. Although suturing the jagged edges of a perineal tear may be more difficult than suturing an episiotomy, tears heal more quickly, are less painful, and are associated with less damage to the muscles around the vagina and rectum.

Upon birth of the newborn's head, an obstetrician will aspirate mucus from the mouth and nose before the newborn's first breath. Once the head is birthed, the rest of the body usually follows quickly. The umbilical cord is then double-clamped, and a cut is made between the clamps. This completes the second stage of childbirth.

Afterbirth

The delivery of the placenta and associated membranes, commonly referred to as the **afterbirth**, marks the final stage of childbirth. After expulsion of the newborn, the myometrium continues to contract. This movement shears the placenta from the back of the uterine wall. It is then easily delivered through the vagina. Continued uterine contractions then reduce blood loss from the site of the placenta. Delivery of the placenta marks the beginning of the postpartum period—the period of approximately 6 weeks immediately following childbirth during which the mother's body gradually returns to a non-pregnant state. If the placenta does not birth spontaneously within approximately 30 minutes, it is considered retained, and the obstetrician may attempt manual removal. If this is not successful, surgery may be required.

It is important that the obstetrician examines the expelled placenta and fetal membranes to ensure that they are intact. If fragments of the placenta remain in the uterus, they can cause postpartum hemorrhage. Uterine contractions continue for several hours after birth to return the uterus to its pre-pregnancy size in a process called involution, which also allows the mother's abdominal organs to return to their pre-pregnancy locations. Breastfeeding facilitates this process.

Caesarian Section

Cesarean delivery (C-section) is a surgical procedure used to deliver a baby through an incision in the abdomen (and uterus). A C-section might be scheduled ahead of a woman develops complications during pregnancy that may require this procedure for the health and safety of mom and/or baby.

Your health care provider might recommend a C-section if:

- Labor is not progressing – one of the most common reasons for a C-section. Stalled labor might occur if the cervix is not dilating enough to allow for passage of the baby.
- Baby is distress – concerned about changes in baby's heartbeat or other vital signs.
- Baby is in an abnormal position – safest way to deliver the baby if his or her feet or buttocks enter the birth canal first (breech) or the baby is positioned side or shoulder first (transverse).
- Carrying multiples – carrying twins and the leading baby is in an abnormal position (or triplets).
- Placenta previa – placenta covers the opening of the cervix
- Umbilical cord prolapse – a loop of umbilical cord slips through the cervix ahead of the baby.
- Health concern – mom has a severe health problem, such as a heart or brain condition or active genital herpes infection at the time of labor.
- Mechanical obstruction – large fibroid obstructing the birth canal, a severely displaced pelvic fracture or your baby has a condition that can cause the head to be unusually large.
- Previous C-section – depending on the type of incision and other factors, it's often possible to attempt a VBAC (vaginal birth after caesarian). However, your health care provider might recommend a repeat C-section.

Some women request C-sections with their first baby to avoid labor or other possible complications of vaginal birth, or the convenience of a planned delivery. However, this is discouraged because women who have multiple C-sections are at increased risk of placental problems as well as heavy bleeding, which might require surgical removal of the uterus (hysterectomy). Babies born vie C-section usually require more intervention to begin breathing on their own after birth.

Homeostasis in the Newborn: Apgar Score

In the minutes following birth, a newborn must undergo dramatic systemic changes to be able to survive outside the womb. An

obstetrician, midwife, or nurse can estimate how well a newborn is doing by obtaining an Apgar score. The Apgar score was introduced in 1952 by the anesthesiologist Dr. Virginia Apgar as a method to assess the effects on the newborn of anesthesia given to the laboring mother. Healthcare providers now use it to assess the general wellbeing of the newborn, whether or not analgesics or anesthetics were used.

Five criteria—skin color, heart rate, reflex, muscle tone, and respiration—are assessed, and each criterion is assigned a score of 0, 1, or 2. Scores are taken at 1 minute after birth and again at 5 minutes after birth. Each time that scores are taken, the five scores are added together. High scores (out of a possible 10) indicate the baby has made the transition from the womb well, whereas lower scores indicate that the baby may be in distress.

The technique for determining an Apgar score is quick and easy, painless for the newborn, and does not require any instruments except for a stethoscope. A convenient way to remember the five scoring criteria is to apply the mnemonic APGAR, for "appearance" (skin color), "pulse" (heart rate), "grimace" (reflex), "activity" (muscle tone), and "respiration."

Of the five Apgar criteria, heart rate and respiration are the most critical. Poor scores for either of these measurements may indicate the need for immediate medical attention to resuscitate or stabilize the newborn. In general, any score lower than 7 at the 5-minute mark indicates that medical assistance may be needed. A total score below 5 indicates an emergency situation. Normally, a newborn will get an intermediate score of 1 for some of the Apgar criteria and will progress to a 2 by the 5-minute assessment. Scores of 8 or above are normal.

Home Birth

When preparing for pregnancy one of the many choices to be made is who will be attending the birth. Doctors or midwives can attend hospital births and a mother may choose to also have a **Doula** present specifically to support the mother during the birthing process. If the mother and partner would prefer the advantages of a home birth these can be attended by certified midwifes and Doulas. The following article give more information about the pros and cons of choosing a home birth.

Pros and Cons of Home Birth (read article or listen to 4 minute audio)

Pregnancy Loss

Unfortunately, not all pregnancies go as planned. complications may arise that result in miscarriage (loss of a baby before the age of viability) or stillbirth (loss of a baby after the age of viability). There are many different potential causes of miscarriages or stillbirth and as many different emotional reactions and grieving processes for a family involved.

Pregnancy Loss

The M-Word – Shattering the Silence on Miscarriage

Check for Understanding

1. What are the stages of labor and what happens to mom and baby in each stage?
2. What birthing options are available to a mother and partner? Why might a person choose one of these options over another?
3. What are the components of and APGAR score and how is is used?
4. What are the potential physical causes and emotional impacts of pregnancy or infant loss?
5. Why is miscarriage or infant loss not talked about the way other forms of loss are?

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7.8: Breast Health and Female Cancers

Chapter Objectives

- Identify anatomical structures of the female breast
- Describe the physiological processes of the female breast
- List at least 3 factors that increase risk of female cancers
- Describe symptoms and treatment options for female cancers (breast, ovarian and uterine)
- Discuss screening options and recommended frequency for breast, uterine and ovarian cancer

Breast Anatomy

For my mom Kären, A breast cancer warrior and my best example of a strong woman.

“Never be ashamed of a scar. It simply means you were stronger that whatever tried to hurt you” ~Unknown

Anatomical Structure of the Female Breast

The breasts are located far from the other female reproductive organs so they are considered “accessory organs” of the female reproductive system. The function of the breasts is to supply milk to an infant in a process called **lactation**. The external features of the breast include a nipple surrounded by a pigmented **areola** (Figure 9), whose coloration may deepen during pregnancy. The areola is typically circular and can vary in size from 25 to 100 mm in diameter. The areolar region is characterized by small, raised areolar glands that secrete lubricating fluid during lactation to protect the nipple from chafing. When a baby nurses, or draws milk from the breast, the entire areolar region is taken into the mouth.

Breast milk is produced by the **mammary glands**, which are modified sweat glands. The milk itself exits the breast through the nipple via 15 to 20 **lactiferous ducts** that open on the surface of the nipple. These lactiferous ducts each extend to a lobe within the breast itself that contains groups of milk-secreting cells in clusters called **alveoli** (see Figure 9). The clusters can change in size depending on the amount of milk in the alveoli. The alveolar lobes themselves are surrounded by fat tissue, which determines the size of the breast; breast size differs between individuals and does not affect the amount of milk produced. Supporting the breasts are multiple bands of connective tissue called **suspensory ligaments** that connect the breast tissue to the dermis of the overlying skin.

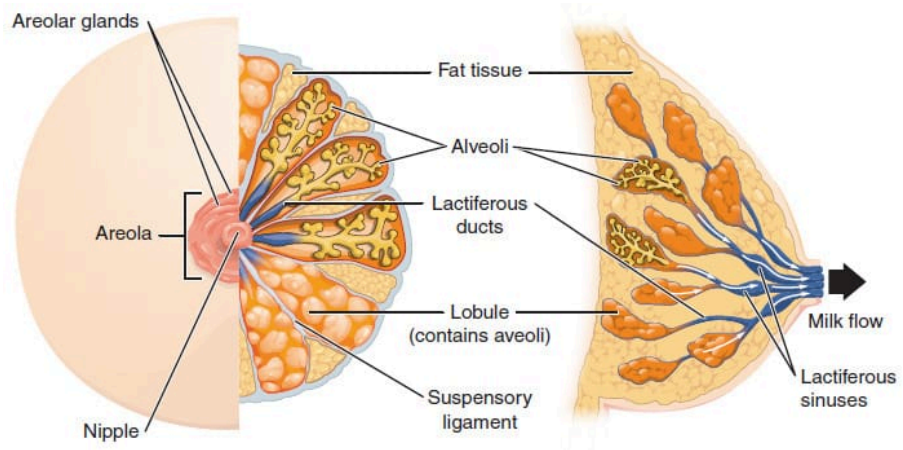


Figure 9. Anatomy of the Breast. During lactation, milk moves from the alveoli through the lactiferous ducts to the nipple.

Physiological Function of the Female Breast

During the normal hormonal fluctuations in the menstrual cycle, breast tissue responds to changing levels of estrogen and

progesterone, which can lead to swelling and breast tenderness in some individuals. If pregnancy occurs, the increase in hormones leads to further development of the mammary tissue and enlargement of the breasts.

Lactation is the process by which milk is synthesized and secreted from the mammary glands of the postpartum female breast in response to an infant sucking at the nipple. Breast milk provides ideal nutrition and passive immunity for the infant, encourages mild uterine contractions to return the uterus to its pre-pregnancy size (i.e., involution), and induces a substantial metabolic increase in the mother, consuming the fat reserves stored during pregnancy.

Structure of the Lactating Breast

The non-pregnant and non-lactating female breast is composed primarily of adipose and collagenous tissue, with mammary glands making up a very minor proportion of breast volume. The mammary gland is composed of milk-transporting ducts, which expand and branch extensively during pregnancy in response to estrogen, growth hormone, cortisol, and prolactin. Moreover, in response to progesterone, clusters of breast alveoli bud from the ducts and expand outward toward the chest wall. Breast alveoli are balloon-like structures lined with milk-secreting cells, or lactocytes. Milk is secreted from the lactocytes, fills the alveoli, and is squeezed into the ducts. Clusters of alveoli that drain to a common duct are called lobules; the lactating female has 12–20 lobules organized radially around the nipple. Milk drains from lactiferous ducts into lactiferous sinuses that meet at 4 to 18 perforations in the nipple, called nipple pores. The small bumps of the areola (the darkened skin around the nipple) are called Montgomery glands. They secrete oil to cleanse the nipple opening and prevent chapping and cracking of the nipple during breastfeeding.

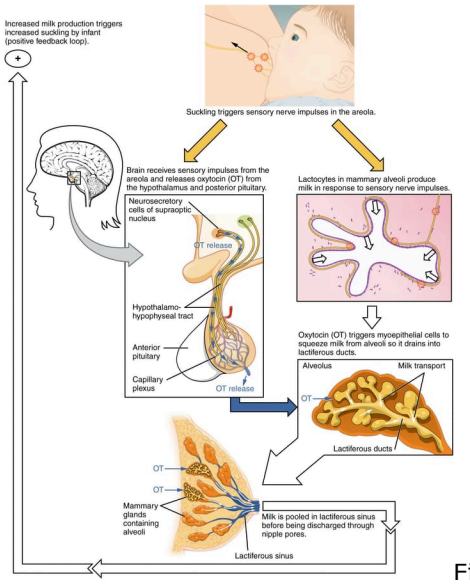


Figure 1. Let-Down Reflex. A positive feedback loop ensures continued milk production as long as the infant continues to breastfeed.

Breastfeeding

Benefits of Breastfeeding

Cancer

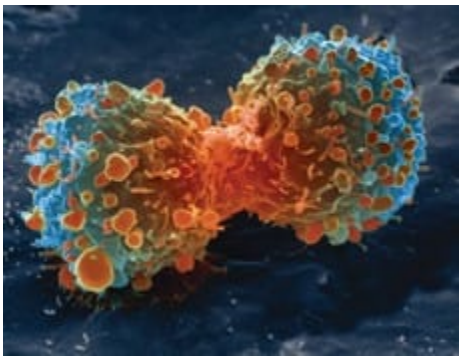


Figure 8. Cancerous Cells

Cancer is the name given to a collection of related diseases. In all types of cancer, some of the body's cells begin to divide without stopping and spread into surrounding tissues. Cancer can start almost anywhere in the human body. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place. When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old or damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may form growths called tumors.

Cancerous tumors are **malignant**, which means they can spread into, or invade, nearby tissues. In addition, as these tumors grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumors far from the original tumor.

Unlike malignant tumors, **benign** tumors do not spread into, or invade, nearby tissues. Benign tumors can sometimes be quite large, however. When removed, they usually don't grow back, whereas malignant tumors sometimes do.

Cancer Terms

- **Neoplasms**: clusters of abnormal cells; aka "tumors." When the neoplasms or tumors grow out and replace normal cells they are said to be "*infiltrating*" or "*metastasizing*" which means traveling to other parts of the body via the blood or lymph.
- **Carcinoma**: most common form; starts in the epithelium.
- **Sarcoma**: forms in connective tissue: bones, muscles, blood vessels.
- **Leukemias**: form in blood-forming tissues: bone marrow, lymph nodes, and the spleen.
- **Lymphomas**: form in the cells of the lymph system (the system that filters out impurities and/or infection).
- Conceptually, cancer is thought to develop via the turning on of genes called "**oncogenes**" or genes that have gone awry. The DNA in these cells replicates at an accelerated rate. "Tumor suppressor genes", which are present in all of us, fail to stop these cells from dividing thereby allowing a tumor to form.
- A "**malignant**" tumor is a cancerous tumor, whereas a "**benign**" tumor is not cancerous and of no imminent danger to the body.

How Cancer Arises

Cancer is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Genetic changes that cause cancer can be inherited from our parents. They can also arise during a person's lifetime as a result of errors that occur as cells divide or because of damage to DNA caused by certain environmental exposures. Cancer-causing environmental exposures include substances, such as the chemicals in tobacco smoke or beauty products, and radiation, such as ultraviolet rays from the sun.

Cancer Stages

Cancers are staged 1-3/4, depending on the cancer and the severity. When detected at stage 1, a person suffering from most

types of cancer has about a 95% of surviving. The odds go down as you get to stage 3 or 4 (some cancers only have 3 stages, others 4). Doctors will often add an 'A' or 'B' to the staging as well, and this can relate to whether or not the cancer has invaded other tissues.

Types of Cancer

This list of common cancer types includes cancers that are diagnosed with the greatest frequency in the United States, excluding non-melanoma skin cancers:

- **Bladder Cancer**: The most common type of bladder cancer is transitional cell carcinoma, also called urothelial carcinoma. Smoking is a major risk factor for bladder cancer. Bladder cancer is often diagnosed at an early stage.
- **Breast Cancer:** Breast cancer is the second most common cancer in women after skin cancer. Mammograms can detect breast cancer early, possibly before it has spread.
- **Colon and Rectal Cancer:** Colorectal cancer often begins as a growth called a polyp inside the colon or rectum. Finding and removing polyps can prevent colorectal cancer.
- **Endometrial Cancer:** Uterine cancers can be of two types: endometrial cancer (common) and uterine sarcoma (rare). Endometrial cancer can often be cured. Uterine sarcoma is often more aggressive and harder to treat.
- **Kidney Cancer:** Kidney cancer can develop in adults and children. The main types of kidney cancer are renal cell cancer, transitional cell cancer, and Wilms tumor. Certain inherited conditions increase the risk of kidney cancer.
- **Leukemia**: Leukemia is a broad term for cancers of the blood cells. The type of leukemia depends on the type of blood cell that becomes cancer and whether it grows quickly or slowly. Leukemia occurs most often in adults older than 55, but it is also the most common cancer in children younger than 15.
- **Lung Cancer:** Lung cancer includes two main types: non-small cell lung cancer and small cell lung cancer. Smoking causes most lung cancers, but nonsmokers can also develop lung cancer.
- **Melanoma:** Skin cancer is the most common type of cancer. The main types of skin cancer are squamous cell carcinoma, basal cell carcinoma, and melanoma. Melanoma is much less common than the other types but much more likely to invade nearby tissue and spread to other parts of the body. Most deaths from skin cancer are caused by melanoma.
- **Non-Hodgkin Lymphoma:** Lymphoma is a broad term for cancer that begins in cells of the lymph system. The two main types are Hodgkin lymphoma and non-Hodgkin lymphoma (NHL). Hodgkin lymphoma can often be cured. The prognosis of NHL depends on the specific type.
- **Pancreatic Cancer:** Pancreatic cancer can develop from two kinds of cells in the pancreas: exocrine cells and neuroendocrine cells, such as islet cells. The exocrine type is more common and is usually found at an advanced stage. Pancreatic neuroendocrine tumors (islet cell tumors) are less common but have a better prognosis.
- **Prostate Cancer:** Prostate cancer is the most common cancer and the second leading cause of cancer death among men in the United States. Prostate cancer usually grows very slowly, and finding and treating it before symptoms occur may not improve men's health or help them live longer.
- **Thyroid Cancer:** Thyroid cancer can be of four main types, which vary in their aggressiveness. Anaplastic thyroid cancer is hard to cure with current treatments, whereas papillary (the most common), follicular, and medullary thyroid cancer can usually be cured.

Cancer incidence and mortality statistics reported by the American Cancer Society and other resources were used to create the list. To qualify as a common cancer for the list, the estimated annual incidence for 2016 had to be 40,000 cases or more.

The most common type of cancer on the list is breast cancer, with more than 249,000 new cases expected in the United States in 2016. The next most common cancers are lung cancer and prostate cancer.

The following table gives the estimated numbers of new cases and deaths for each common cancer type:

Table 2. Cancer Types

Cancer Type	Estimated New Cases	Estimated Deaths
Bladder	76,960	16,390
Breast (Female – Male)	246,660 – 2,600	40,450 – 440
Colon and Rectal (Combined)	134,490	49,190
Endometrial	60,050	10,470

Kidney (Renal Cell and Renal Pelvis) Cancer	62,700	14,240
Leukemia (All Types)	60,140	24,400
Lung (Including Bronchus)	224,390	158,080
Melanoma	76,380	10,130
Non-Hodgkin Lymphoma	72,580	20,150
Pancreatic	53,070	41,780
Prostate	180,890	26,120
Thyroid	64,300	1,980

Risk Factors for Cancer

It is not possible to know exactly why one person develops cancer and another doesn't. But research has shown that certain risk factors may increase a person's chances of developing cancer. (There are also factors that are linked to a lower risk of cancer. These are called protective factors.)

Cancer risk factors include exposure to chemicals or other substances, as well as certain behaviors. They also include things people cannot control, like age and family history. A family history of certain cancers can be a sign of a possible inherited cancer syndrome.

The list below includes the most studied known or suspected risk factors for cancer:

- Age
- Alcohol
- Cancer-Causing Substances
- Chronic Inflammation
- Diet
- Hormones
- Immunosuppression
- Infectious Agents
- Obesity
- Radiation
- Sunlight
- Tobacco



Figure 9. CDC Advertisement

Beauty Products and Cancer, Are You at Risk?

Although some of these risk factors can be avoided, others—such as growing older—cannot. Limiting your exposure to avoidable risk factors may lower your risk of developing certain cancers.

Cancer Prevention

The number of new cancer cases can be reduced and many cancer deaths can be prevented. Research shows that screening for cervical and colorectal cancers as recommended helps prevent these diseases by finding precancerous lesions so they can be treated before they become cancerous. Screening for cervical, colorectal, and breast cancers also helps find these diseases at an early stage, when treatment works best.

Vaccines (shots) also help lower cancer risk. The human papillomavirus (HPV) vaccine helps prevent most cervical cancers and several other kinds of cancer, and the hepatitis B vaccine can help lower liver cancer risk.

A person's cancer risk can be reduced with healthy choices like avoiding tobacco, limiting alcohol use, protecting your skin from the sun and avoiding indoor tanning, eating a diet rich in fruits and vegetables, keeping a healthy weight, and being physically active.

Types of Cancer Treatment



Figure 10. Source: National Cancer Institute – https://www.cancer.gov/about-cancer/treatment/types

There are many types of cancer treatment. The types of treatment will depend on the type of cancer and how advanced it is. Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotherapy and/or radiation therapy.

- Surgery – a procedure in which a surgeon removes cancer from the body.
- Radiation Therapy – uses high doses of radiation to kill cancer cells and shrink tumors.
- Chemotherapy – uses drugs to kill cancer cells.
- Immunotherapy – helps your immune system fight cancer.
- Targeted Therapy – targets the changes in cancer cells that help them grow, divide, and spread.
- Hormone Therapy – slows or stops the growth of breast and prostate cancers that use hormones to grow.
- Stem Cell Transplant – procedures that restore blood-forming stem cells in cancer patients who have had theirs destroyed by very high doses of chemotherapy or radiation therapy.

Female Cancers

Breast Cancer

Breast cancer is a disease in which cells in the breast grow out of control. There are different kinds of breast cancer. The kind of cancer depends on the cells in the breast affected by cancer.

Breast Cancer

Cervical Cancer

Research over many years has confirmed that cervical cancer is most often caused by a sexually transmitted infection with human papillomavirus (HPV). There are over 100 related viruses in the HPV family, and the characteristics of each strain determine the outcome of the infection. In all cases, the virus enters body cells and uses its own genetic material to take over the host cell's metabolic machinery and produce more virus particles.

Risk factors for cervical cancer include having unprotected sex; having multiple sexual partners; a first sexual experience at a younger age, when the cells of the cervix are not fully mature; failure to receive the HPV vaccine; a compromised immune system; and smoking. The risk of developing cervical cancer is doubled with cigarette smoking.

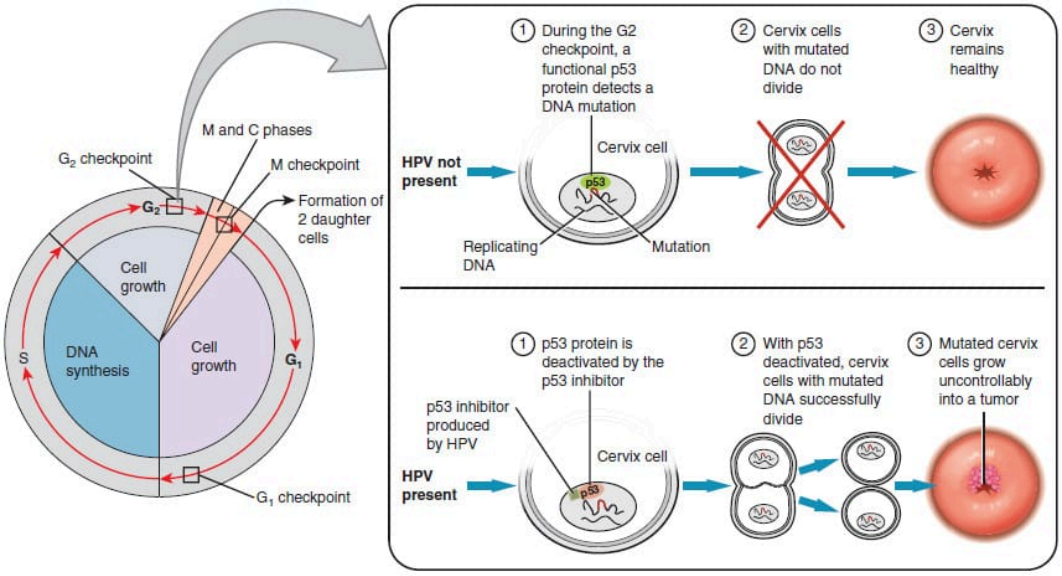


Figure 8. Development of Cervical Cancer. In most cases, cells infected with the HPV virus heal on their own. In some cases, however, the virus continues to spread and becomes an invasive cancer.

Screening and Prevention

The prevalence of cervical cancer in the United States is very low because of regular screening exams called **pap smears**. Pap smears sample cells of the cervix, allowing the detection of abnormal cells. If pre-cancerous cells are detected, there are several highly effective techniques that are currently in use to remove them before they pose a danger. However, women in developing countries often do not have access to regular pap smears. As a result, these women account for as many as 80 percent of the cases of cervical cancer worldwide.

In 2006, the first vaccine against the high-risk types of HPV was approved. There are now two HPV vaccines available: Gardasil® and Cervarix®. Whereas these vaccines were initially only targeted for women, because HPV is sexually transmitted, both men and women require vaccination for this approach to achieve its maximum efficacy. A recent study suggests that the HPV vaccine has cut the rates of HPV infection by the four targeted strains at least in half. Unfortunately, the high cost of manufacturing the vaccine is currently limiting access to many women worldwide.

Ovarian Cancer

Ovarian cancer affect the female ovaries. Unfortunately, this type of cancer often goes undetected until it has spread within the abdomen. Ovarian cancer often has no symptoms in the early stages and later stages may have non-specific symptoms such as weight loss or loss of apatite.

Ovarian Cancer

Check for Understanding

1. Identify the anatomical structures of the female breast.
2. What is the physiological function of the female breast and benefits of breastfeeding?
3. What is cancer and how does it impact the body?
4. What are the risk factors, symptoms, screening tests, and treatments for breast, ovarian and cervical cancers?

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7.9: Stress and Health

Chapter Objectives

- Describe the difference between a stressor and a stress response
- Describe the fight or flight reaction and the function of this in stress management
- Discuss the long and short term health impacts associated with a stress response
- Describe and/or demonstrate stress management techniques

"A ship in harbor is safe, but that is not what ships are built for?" ~ John Shedd
"There are some things you learn best in calm, an some in storm." ~ Willa Cather

Stress

In today's fast-paced society, most people complain about being stressed. However, when they use the term *stress*, they rarely know it's true meaning. The word carries many negative connotations and is associated with an unpleasant or traumatic event. As such, people mistakenly believe that stress is simply the nervousness and tension experienced prior to, during, or after a negative event. In fact, the effects of stress are physiological, emotional, *and* psychological.

Additionally, not all levels of stress are detrimental. The stress athletes experience right before a big game or college students feel right before an exam can enhance focus and increase their ability to concentrate. Stress is either good or bad depending on how long it persists and how it is perceived by the individual.

This chapter will provide a deeper understanding of what stress is and provide effective strategies for managing stress.

Stress is defined as the body's physical, mental, and emotional response to a particular stimulus, called a **stressor**. This adaption/coping-response helps the body prepare for challenging situations. It is the level of a person's response to a stressor that determines whether the experience is positive or negative. As a hardworking college student, you may feel as if you know the meaning of stress all too well. You may dream of a future where the demands on your time are diminished, so you can escape the high levels of stress you are feeling now. Unfortunately, regardless of their situation, everyone experiences stress on a regular basis. The good news is, not all stress is bad! Small levels of stress can enhance cognitive brain function. Stress may provide the motivation and concentration you need to write an essay, practice a speech, or prepare for a job interview. For most people, these types of stressors are manageable and not harmful. Stressors that have the potential for harm include the sudden loss of a loved one, the unexpected ending of a romantic relationship, or the unfair demands of an unreasonable boss.

Defining Stress

Stress, then, is more than simply the tension and apprehension generated by problems, obstacles, or traumatic events. Stress is the body's automatic response (physical, mental, and emotional) to any stressor. It is a natural and unavoidable part of life, and it can be empowering and motivating, or harmful and potentially dangerous.

For more information on stress click on the links below:

What is stress and what causes it?

The Effects of Stress on The Body

Not all stress is bad. All animals have a stress response, which can be lifesaving in some situations. The nerve chemicals and hormones released during such stressful times prepares the animal to face a threat or flee to safety (Fight or Flight Response). When you face a dangerous situation, your pulse quickens, you breathe faster, your muscles tense, your brain uses more oxygen and increases activity—all functions aimed at survival. In the short term, it can even boost the immune system.

However, long-term stress can increase the risk of diseases like depression, heart disease and a variety of other problems. With chronic stress, those same nerve chemicals that are normal, or even beneficial, in short bursts can suppress functions that aren't

needed for immediate survival. Your immunity is lowered and your digestive, excretory, and reproductive systems stop working normally.

Problems occur if the stress response goes on too long, such as when the source of stress is constant, or if the response continues after the danger has subsided. A stress-related illness called post-traumatic stress disorder (PTSD) develops after an event like war, physical or sexual assault, or a natural disaster. If you have chronic stress, the best way to deal with it is to take care of the underlying problem. Counseling can help you find ways to relax and calm down. Doctor prescribed medications may also help.

Your Bodies Response to Stress

When we experience excessive stress, either from internal worry or external circumstance, a bodily reaction called the **"fight-or-flight"response** will be triggered. The response system represents the genetic impulse to protect ourselves from bodily harm. During stress-response processes, the sympathetic nervous system increases heart rate and releases chemicals to prepare the body to either fight or flee. When the fight-or-flight response system get activated, it tends to perceive everything in the environment as a potential threat to survival.

In modern life, we do not get the option of "flight" very often. We have to deal with those stressors all the time and find a solution. When you need to take a final exam, there is no easy way for you to avoid it; sitting in the test room for hours feels like the only choice. Lacking the "flight" option in stress-response process leads to higher stress levels in modern society.

The body responds to stress by releasing stress hormones. These hormones make blood pressure, heart rate, and blood sugar levels go up. Long-term stress can help cause a variety of health problems, including:

- Mental health disorders, like depression and anxiety
- Obesity
- Heart disease
- High blood pressure
- Abnormal heart beats
- Menstrual problems
- Acne and other skin problems

General Adaptation Syndrome

Hans Selye (1907-1982) started the modern era of research into something called stress. He proposed a three-stage pattern of response to stress that he called the **General Adaptation Syndrome (GAS)**. The model represents that when the organism first encounters stress, in the form of novelty or threat, it responds with an **alarm reaction**. This is followed by a **recovery or resistance stage** during which the organism repairs itself and stores energy. If the stress-causing events continue, **exhaustion** sets in. This third stage is what has become known as "burn-out". Classic symptoms of burn-out include loss of drive, emotional flatness, and (in humans) dulling of responsiveness to the needs of others.

Three Stages of GAS

1. Alarm reaction stage

In this stage, your body experiences the "fight or flight" response. This natural reaction prepares you to either flee or protect yourself in dangerous situations. The **sympathetic branch** of the autonomic nervous system is activated and the adrenal glands secrete two hormones to stimulate your reactions to stress: epinephrine (also known as adrenalin) and norepinephrine (also known as noradrenalin).

Adrenalin mobilizes glucose and fatty acid release from fatty cells. The body is able to use both as energy to respond to stress. Adrenalin and noradrenalin also have powerful effects on the heart. Both the heart rate and stroke volume are increased, thereby increasing the body's cardiac output. They also help to shunt blood away from the other parts of the body and thereby push more blood to the heart, brain, and muscles as the body prepares to attack or flee. At the same time, the adrenal glands also release cortisol, to help meet the body's energy needs in times of stress.

2. Resistance stage

After the initial reaction to the stressor during the alarm reaction stage, the **parasympathetic branch** of the autonomic nervous system counteracts the changes that the stressful stimulus has produced, and attempts to restore a state of **homeostasis**, the default state in which the body functions normally.

During the resistance stage, the results of the hormonal changes which occurred in the previous stage are still apparent, including increased glucose levels in the blood and higher blood pressure, but stress hormone levels begin to return to normal, enabling the body's focus to shift from alertness to repair.

If the resistance stage continues for too long the body will stay in a state of alertness and continue to produce the stress hormones. Signs of the resistance stage include:

- Irritability
- Frustration
- Poor concentration

3. Exhaustion stage

After an extended period of stress, the body enters this final stage of GAS. At this stage, the body has depleted its physical, emotional, and mental resources and is unable to maintain normal function. Once the body is no longer equipped to fight stress and may experience these symptoms:

- Fatigue
- Depression
- Anxiety
- Feeling unable to cope

Eustress vs Distress

Negative stress, or **distress**, is often part of activities that we perceive we cannot escape. Our bodies and minds seem to have evolved to cope well with sudden and brief stressors, such as escaping attack by a predator. We do not seem to be designed to handle chronic stress even if it is mild, like driving in heavy traffic. Our society has created many conditions that produce chronic stress and are associated with stress related illnesses. We have time pressures, work pressures, relationship pressures, crowding, noise, crime, to many things to do in too little time, achievement pressures, and even education-related pressures in this course.

However, stress is not always bad. Sometimes a challenge is a good thing. Indeed, one could argue that nothing useful in life can be accomplished without some degree of stress. "Good stress," Selye pointed out, is "the spice of life." To combat the notion that all stress was bad, Selye developed the idea of **eustress**, which is a person's ideal stress level. Selye proposed that different people needed different levels of challenge or stimulation (stress) in their lives. Some people ("turtles") need low levels of stress. Others ("racehorses") thrive on challenges. Challenges are not harmful in themselves. A person could be a busy executive or engage in strenuous exercise without experiencing negative stress-related symptoms, as long as the person enjoyed the challenge.

Common Causes of Stress

Stress happens when people feel like they don't have the tools to manage all of the demands in their lives. Stress can be short-term or long-term. Missing the bus or arguing with your spouse or partner can cause short-term stress. Money problems or trouble at work can cause long-term stress. Even happy events, like having a baby or getting married can cause stress. Some of the most common stressful life events include:

- Death of a spouse
- Death of a close family member divorce
- Losing your job
- Major personal illness or injury
- Marital separation
- Marriage

- Pregnancy
- Retirement

Common Signs and Symptoms of Stress

Everyone responds to stress a little differently. Symptoms may vary person to person. Here are some of the signs to look for:

- Not eating or eating too much
- Feeling like you have no control
- Needing to have too much control
- Forgetfulness
- Headaches
- Lack of energy
- Lack of focus
- Trouble getting things done
- Poor self-esteem
- Short temper
- Upset stomach
- Back pain
- General aches and pains

These symptoms may also be signs of depression or anxiety, which can be caused by long-term stress.

Women React to Stress Differently Than Men?

One recent survey found that women were more likely to experience physical symptoms of stress than men. However, it cannot be said that this applies to all women. We do know that women often cope with stress in different ways than men. Women "**tend and befriend,**" taking care of those closest to them, but also drawing support from friends and family. Men are more likely to have the "**fight or flight**" response. They cope by "escaping" into a relaxing activity or other distraction.

Stress is in the Eye of the Beholder

How to Make Stress Your Friend

The process by which we experience a situation is described by Lazarus's Theory of Cognitive Appraisal. This theory may be beneficial to our understanding of the differences between individual's stress levels. The theory's main points are:

1. When we experience a situation or event we first determine if it is a threat, a challenge, or is neutral.
2. We then assess our inventory of resources to cope with the event. If we do not perceive we are adequate to the task, we must be able to withdraw or we will feel trapped in a situation with aversive consequences coming. That induces distress and all the physiological processes that harm our health. If we perceive that we have the resources to successfully cope with the situation, we feel challenged and optimistic. Note that challenge and optimism are related to enhanced health and sense of well-being.

This second stage of appraisal impacts the first stage in a loop process. If we at first perceive a threat but then realize we can handle it, it reduces the distress and may even create a perception of challenge. If at first we perceive a challenge but then realize that we don't have what it takes to be successful, we may begin to experience distress as we see the aversive outcome of failure looming ahead. Depending on the meaning of the outcome to us, the distress may be mild or severe. If the situation is always hanging over us and we always feeling inadequate to it and anxious about negative outcomes, we are always under distress. Our health and well-being take a beating in that scenario.

Next, we must select from our repertoire of coping resources. There are two types of coping resources:

- Instrumental
- Palliative (emotion-focused)

Instrumental coping solves the problem and removes the stressor from our experience as in working out a conflict with someone

to reduce the distress or by getting a better job to reduce financial pressures.

Palliative coping alters our physiological reactions to stress that will not go away and cannot be escaped. These include relaxation skills, reinterpretation of the meaning or effects of the stressor, acceptance of the situation, or optimism about future improvements in the situation. Palliative skills would include relaxing in the traffic jam even though you have an important appointment that is being missed. You realize you cannot do anything about it, so you may as well relax because anger and tension will not make the cars move any faster, but it will hurt you, so you choose to relax instead.

As we go to our repertoire of coping skills to select one or more, we may become more optimistic of success and reappraise the situation in the first step. It may become less threatening and hence less distressful. We could find that our coping resources will be less adequate than we initially thought and we would become more threatened now. Even a challenge might be converted into a threat as in traveling to a another country for the first time and finding your credit cards are missing and you have no money for anything and no way to get any.

This interactive appraisal and coping process is at the heart of the impact of stress on us. If we interpret a situation as stressful, it has the stress-related effects on us. If we have few coping sources, more situations will be perceived as distressing. If we have many coping resources, more situations will be perceived as challenging or at least neutral.

As I am driving down the road and have a flat tire, I could be annoyed at the trouble it causes or feel threatened by past negative experience associated with changing a tire. If I don't know how to change a tire and it is dark out, I may feel very threatened as I perceive helplessness and vulnerability to someone's attacking me. If I assure myself that this is unlikely, and I do know how to change a tire, I may decide that I will get this done in ten minutes and be on the road safely. Or may not have the skills to change a tire but have a cell phone and a close friend who will quickly lend a hand (social support) which decreases distress.

These factual situations are part of the appraisal and coping process. Perception is also critically important. If I have little confidence in myself to handle a flat tire even though I have been taught how to do it and have the tire, I may feel more threatened. If I have the cell phone but don't believe I should bother anybody to come here, or don't believe they would want to help me, the facts do not determine my reaction as much as my perception of the facts determines it.

A second example of the role of coping skills and perception could involve getting started in an online course. If you are a computer whiz and have taken several college courses including online courses before, you were able to start with little problem. Learning to use online resources did not cause much distress. But if you were new to using the Internet, had never taken an online course, and had low self-confidence, you may have been quite distressed. Same situation, different coping resources.

Now add perception. If you perceive college as a supportive environment, and instructors as willing to be flexible when circumstances are beyond all of our control, you may be hassled but not threatened about failing the course because of these factors. But if you see colleges and instructors as money-hungry and deliberately placing obstacles in your path to cause you to fail and drop out, you have may been very distressed when you had difficulties as you would see no support or flexibility to allow you to adapt to the new situation. The reality of the college and instructor's intent make no difference in your initial perception and resultant choices. It is your perception of reality that determines what you will do.

The appraisal and coping process underlies the statement that "stress is in the eye of the beholder." Any event or situation may be perceived differently by different individuals due to past experience with it, learned skills, personality traits like Type A and optimism, and the amount of distress being experienced already. Social support may be instrumental in helping cope with problem as in coming to help with the flat tire, or being eager to listen and be supportive with your sharing your experiences. Both reduce the distress levels.

Managing Stress

Everyone must deal with stress. There are steps that can be taken help manage stress in a positive way and keep it from increasing risk of illness. Try these tips to keep stress in check:

Develop a new attitude

- Become a problem solver. Make a list of the things that cause stress. From your list, figure out which problems you can solve now and which are beyond your control for the moment. From your list of problems that you can solve now, start with the little ones. Learn how to calmly look at a problem, think of possible solutions, and take action to solve the problem. Being able to solve small problems will give you confidence to tackle the big ones. And feeling confident that you can solve problems will

go a long way to helping you feel less stressed.
- Be flexible. Sometimes, it's not worth the stress to argue. Give in once in a while or meet people halfway.
- Get organized. Think ahead about how you're going to spend your time. Write a to-do list. Figure out what's most important to do and do those things first.
- Set limits. When it comes to things like work and family, figure out what you can really do. There are only so many hours in the day. Set limits for yourself and others. Don't be afraid to say NO to requests for your time and energy.

Relax

- Take deep breaths. If you're feeling stressed, taking a few deep breaths makes you breathe slower and helps your muscles relax.
- Stretch. Stretching can also help relax your muscles and make you feel less tense.
  Massage tense muscles. Having someone massage the muscles in the back of your neck and upper back can help you feel less tense.
- Take time for yourself. We all have lots of things that we have to do. But often we don't take the time to do the things that we really want to do. It could be listening to music, reading a good book, or going to a movie. Think of this as an order from your doctor, so you won't feel guilty!

Take care of your body

- Get enough sleep. Getting enough sleep helps you recover from the stresses of the day. Also, being well-rested helps you think better so that you are prepared to handle problems as they come up. Most adults need 7 to 9 hours of sleep a night to feel rested.
- Eat right. Try to fuel up with fruits, vegetables, beans, and whole grains. Don't be fooled by the jolt you get from caffeine or high-sugar snack foods. Your energy will wear off, and you could wind up feeling more tired than you did before.
- Get moving. Getting physical activity can not only help relax your tense muscles but improve your mood. Research shows that physical activity can help relieve symptoms of depression and anxiety.
- Don't deal with stress in unhealthy ways. This includes drinking too much alcohol, using drugs, smoking, or overeating.

Connect with others

- Share your stress. Talking about your problems with friends or family members can sometimes help you feel better. They might also help you see your problems in a new way and suggest solutions that you hadn't thought of.
- Get help from a professional if you need it. If you feel that you can no longer cope, talk to your doctor. She or he may suggest counseling to help you learn better ways to deal with stress. Your doctor may also prescribe medicines, such as antidepressants or sleep aids.
- Help others. Volunteering in your community can help you make new friends and feel better about yourself.

Coping with Stress

The effects of stress tend to build up over time. Taking practical steps to maintain your health and outlook can reduce or prevent these effects. The following are some tips that may help you to cope with stress:

- Seek help from a qualified mental health care provider if you are overwhelmed, feel you cannot cope, have suicidal thoughts, or are using drugs or alcohol to cope.
- Get proper health care for existing or new health problems.
- Stay in touch with people who can provide emotional and other support. Ask for help from friends, family, and community or religious organizations to reduce stress due to work burdens or family issues, such as caring for a loved one.
- Recognize signs of your body's response to stress, such as difficulty sleeping, increased alcohol and other substance use, being easily angered, feeling depressed, and having low energy.
- Set priorities-decide what must get done and what can wait, and learn to say no to new tasks if they are putting you into overload.
- Note what you have accomplished at the end of the day, not what you have been unable to do.
- Avoid dwelling on problems. If you can't do this on your own, seek help from a qualified mental health professional who can guide you.
- Schedule regular times for healthy and relaxing activities.
- Explore stress coping programs, which may incorporate meditation, yoga, tai chi, or other gentle exercises.

- Exercise regularly – just 30 minutes per day of gentle walking can help boost mood and reduce stress.

Exercise and Stress

Exercise builds stronger bodies only if we push ourselves beyond our regular level of strength and endurance. Progressing in your intellectual skills occurs only by going beyond your adaptation level for the complexity and amount of knowledge you must acquire. Stress as "challenge" enhances physical and emotional well-being. Mountain climbers want risk and challenge, but they want the type that they feel they can master and mostly control. They don't want to be perfectly in control because then the challenge would not be so great. They want to be on the edge between in-control and having to use every degree of skill, concentration, and problem solving to succeed. The same is true of race car drivers, downhill skiers, chess players, musicians, and artists.

These activities have been described by Csikszentmihalyi as inducing the experience of "flow" that totally captures the attention, makes it very easy to continue, and very hard to stop. There are many other activities and professions that produce "flow", but the essence of the experience is to be on the edge of challenge and failure with the perception that your own efforts will make the difference between good and bad outcomes. In these conditions stress builds healthier bodies and higher well-being. People who experience "flow" frequently report high degrees of satisfaction in life.

Physiological Toughness Model

There is also a psychophysiological framework for explaining how exercise cannot only reduce the immediate effects of stress but also can enhance the recovery from stressors. This framework is called the Physiological Toughness Model and it theorizes that intermittent but regular exposure to stressors, like exercise, can lead to psychological coping, emotional stability, and physiological changes. These physiological changes include increases in endorphins and reductions in stress hormones and lead to improvements in performance during challenging/threatening situations, strengthening of immune system functioning, and improvements in stress tolerance.

Meditation and Health

Many people practice meditation for a number of health-related purposes. A 2007 national government survey found that 9.4% of respondents had used meditation in the past 12 months.

What is meditation?

The term meditation refers to a group of techniques which may be practiced for many reasons, such as to increase calmness and physical relaxation, to improve psychological balance, to cope with illness, or to enhance overall wellness. Most types of meditation have four elements in common:

- A quiet location. Meditation is usually practiced in a quiet place with as few distractions as possible. This can be particularly helpful for beginners.
- A specific, comfortable posture. Depending on the type being practiced, meditation can be done while sitting, lying down, standing, walking, or in other positions.
- A focus of attention. Focusing one's attention is usually a part of meditation. For example, the meditator may focus on a mantra (a specially chosen word or set of words), an object, or the sensations of the breath.
- Having an open attitude. During meditation this means letting distractions come and go naturally without judging them.

How can meditation affect my health?

It is not fully known what changes occur in the body during meditation; whether they influence health; and, if so, how. Research is under way to find out more about meditation's effects, how it works, and diseases and conditions for which it may be most helpful. The National Center for Complementary and Alternative Medicine (NCCAM) is the federal government's lead agency for scientific research on complementary and alternative medicine (CAM). Some recent NCCAM-supported studies have been investigating meditation for relieving stress in caregivers for elderly patients with dementia and for relieving asthma symptoms.

Is meditation right for me?

Meditation is considered to be safe for healthy people, but if you are thinking about using meditation practices to prevent asthma

attacks, to control high blood pressure, to reduce arthritis pain, or for any other medical reason, be smart.

Relaxation Techniques

Relaxation techniques include a number of practices such as progressive relaxation, guided imagery, biofeedback, self-hypnosis, and deep breathing exercises. The goal is similar in all: to consciously produce the body's natural relaxation response, characterized by slower breathing, lower blood pressure, and a feeling of calm and well-being.
Relaxation techniques (also called relaxation response techniques) may be used by some to release tension and to counteract the ill effects of stress. Relaxation techniques are also used to induce sleep, reduce pain, and calm emotions. This fact sheet provides a general overview of relaxation techniques and suggests sources for additional information.

Key Points

- Relaxation techniques are used for a variety of health-related purposes, such as counteracting the effects of stress on the body.
- Most relaxation techniques can be self-taught and self-administered.
- Relaxation techniques are generally safe, but there is limited evidence of usefulness for specific health conditions. Research is under way to find out more about relaxation and health outcomes.
- Do not use relaxation techniques as a replacement for conventional care or to postpone seeing a doctor about a medical problem.
- Tell your health care providers about any complementary and alternative practices you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

About Relaxation Techniques

Relaxation is more than a state of mind; it physically changes the way your body functions. When your body is relaxed breathing slows, blood pressure and oxygen consumption decrease, and some people report an increased sense of well-being. This is called the "relaxation response." Being able to produce the relaxation response using relaxation techniques may counteract the effects of long-term stress, which may contribute to or worsen a range of health problems including depression, digestive disorders, headaches, high blood pressure, and insomnia.

Relaxation techniques often combine breathing and focused attention on pleasing thoughts and images to calm the mind and the body. Most methods require only brief instruction from a book or experienced practitioner before they can be done without assistance. These techniques may be most effective when practiced regularly and combined with good nutrition, regular exercise, and a strong social support system.

Some relaxation response techniques include:

- **Autogenic training:** When using this method, you focus on the physical sensation of your own breathing or heartbeat and picture your body as warm, heavy, and/or relaxed.
- **Biofeedback:** Biofeedback-assisted relaxation uses electronic devices to teach you how to consciously produce the relaxation response. Biofeedback is sometimes used to relieve conditions that are caused or worsened by stress.
- **Deep breathing or breathing exercises:** To relax using this method, you consciously slow your breathing and focus on taking regular and deep breaths.
- **Guided imagery:** For this technique, you focus on pleasant images to replace negative or stressful feelings and relax. Guided imagery may be directed by you or a practitioner through storytelling or descriptions designed to suggest mental images (also called visualization).
- **Progressive relaxation:** (also called Jacobson's progressive relaxation or progressive muscle relaxation). For this relaxation method, you focus on tightening and relaxing each muscle group. Progressive relaxation is often combined with guided imagery and breathing exercises.
- **Self-Hypnosis:** In self-hypnosis you produce the relaxation response with a phrase or nonverbal cue (called a "suggestion"). Self-hypnosis may be used to relieve pain (tension headaches, labor, or minor surgery) as well as to treat anxiety and irritable bowel syndrome.

If You Are Thinking About Using Relaxation Techniques for Health

- Do not use relaxation techniques as a replacement for conventional care or to postpone seeing a doctor about a medical

problem.
- Ask about the training and experience of the practitioner or instructor you are considering for any complementary alternative medicine practice.
- Look for published research studies on relaxation for the health condition in which you are interested. Remember that some claims for using relaxation therapies may exceed the available scientific evidence.
- Tell all your health care providers about any complementary and alternative practices you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

Resilience

Resilience is the ability to:

- Bounce back
- Take on difficult challenges and still find meaning in life
- Respond positively to difficult situations
- Rise above adversity
- Cope when things look bleak
- Tap into hope
- Transform unfavorable situations into wisdom, insight, and compassion
- Endure

Resilience refers to the ability of an individual, family, organization, or community to cope with adversity and adapt to challenges or change. It is an ongoing process that requires time and effort and engages people in taking a number of steps to enhance their response to adverse circumstances. Resilience implies that after an event, a person or community may not only be able to cope and recover, but also change to reflect different priorities arising from the experience and prepare for the next stressful situation.

Resilience is the most important defense people have against stress.
It is important to build and foster resilience to be ready for future challenges.
Resilience will enable the development of a reservoir of internal resources to draw upon during stressful situations.

Research (Aguirre, 2007; American Psychological Association, 2006; Bonanno, 2004) has shown that resilience is ordinary, not extraordinary, and that people regularly demonstrate being resilient.

Resilience is not a trait that people either have or do not have.
Resilience involves behaviors, thoughts, and actions that can be learned and developed in anyone. Resilience is tremendously influenced by a person's environment.

Resilience changes over time. It fluctuates depending on how much a person nurtures internal resources or coping strategies. Some people are more resilient in work life, while others exhibit more resilience in their personal relationships. People can build resilience and promote the foundations of resilience in any aspect of life they choose.

Building Resilience

Developing resilience is a personal journey. People do not react the same way to traumatic events. Some ways to build resilience include the following actions:

- Making connections with others
- Looking for opportunities for self-discovery
- Nurturing a positive view of self
- Accepting that change is a part of living
- Taking decisive actions
- Learning from the past

The ability to be flexible is a great skill to obtain and facilitates resilience growth. Getting help when it is needed is crucial to building resilience. An approach to building resilience that works for one person might not work for another. People use varying strategies. Resilience involves maintaining flexibility and balance in life during stressful circumstances and traumatic events. Being resilient does not mean that a person does not experience difficulty or distress. Emotional pain and sadness are common

in people who have suffered major adversity or trauma in their lives. Stress can be dealt with proactively by building resilience to prepare for stressful circumstances, while learning how to recognize symptoms of stress. Fostering resilience or the ability to bounce back from a stressful situation is a proactive mechanism to managing stress.

Check for Understanding

1. What is the difference between a stressor and a stress response?
2. What is the fight or flight reaction and how is it used by the body?
3. What is the GAS syndrome and what does this mean for long term stress?
4. How does long term and short term stress affect health or wellness?
5. How does perception impact the stress response?
6. What are some stress management techniques that you feel would be useful to you in managing short and long term stress?

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7.10: Growing Older

Chapter Objectives

- Describe the physical, emotional and social changes associated with ageing
- Discuss the positive and negative outcomes of the ageing process
- Develop a personalized goal for healthy aging

Growing Older

“Beautiful young people are accidents of nature, but beautiful old people are works of art.” ~Eleanor Roosevelt.

“We don’t stop playing because we grow old; we grow old because we stop playing.” ~George Bernard Shaw.

Signs and Symptoms of Ageing

We can all describe physical attributes that may signal to us that someone is “old”. Maybe these include gray hair, wrinkled skin or a strange obsession with music from the 1970’s. These ageing individuals may also seem to have more time to devote to hobbies and better financial security. Changes associated with ageing can be broken into 3 categories: Physical, Emotional, and Social.

Physical Changes Associated with Ageing

Menopause is commonly associated with the female ageing process. This is the point that the female body is depleted of viable eggs to the point that follicular changes to the ovaries affect the hormonal regulation of the mensural cycle.

Perimenopause

The earliest changes occur during the menopausal transition, referred to as **perimenopause**, when a women’s cycle becomes irregular but does not stop entirely. Although the levels of estrogen are still nearly the same as before the transition, the level of progesterone is reduced. This decline in progesterone can lead to abnormal growth, or hyperplasia, of the endometrium. This condition is a concern because it increases the risk of developing endometrial cancer. Two harmless conditions that can develop during the transition are uterine fibroids, which are benign masses of cells, and irregular bleeding. As estrogen levels change, other symptoms that occur are hot flashes and night sweats, trouble sleeping, vaginal dryness, mood swings, difficulty focusing, and thinning of hair on the head along with the growth of more hair on the face. Depending on the individual, these symptoms can be entirely absent, moderate, or severe.

Menopause

Female fertility (the ability to conceive) peaks when women are in their twenties, and is slowly reduced until a women reaches 35 years of age. After that time, fertility declines more rapidly, until it ends completely at menopause. Menopause is the cessation of the menstrual cycle that occurs as a result of the loss of ovarian follicles and the hormones that they produce. A woman is considered to have completed menopause if she has not menstruated in a full year. After that point, she is considered postmenopausal. The average age for this change is consistent worldwide at between 50 and 52 years of age, but it can normally occur in a woman’s forties, or later in her fifties. Poor health, including smoking, can lead to earlier loss of fertility and earlier menopause.

Post Menopause

After menopause, lower amounts of estrogens can lead to other changes. Cardiovascular disease becomes as prevalent in women as in men, possibly because estrogens reduce the amount of cholesterol in the blood vessels. When estrogen is lacking, many women find that they suddenly have problems with high cholesterol and the cardiovascular issues that accompany it. Osteoporosis

is another problem because bone density decreases rapidly in the first years after menopause. The reduction in bone density leads to a higher incidence of fractures.

Hormone therapy (HT), which employs medication (synthetic estrogens and progestins) to increase estrogen and progestin levels, can alleviate some of the symptoms of menopause. In 2002, the Women's Health Initiative began a study to observe women for the long-term outcomes of hormone replacement therapy over 8.5 years. However, the study was prematurely terminated after 5.2 years because of evidence of a higher than normal risk of breast cancer in patients taking estrogen-only HT. The potential positive effects on cardiovascular disease were also not realized in the estrogen-only patients. The results of other hormone replacement studies over the last 50 years, including a 2012 study that followed over 1,000 menopausal women for 10 years, have shown cardiovascular benefits from estrogen and no increased risk for cancer. Some researchers believe that the age group tested in the 2002 trial may have been too old to benefit from the therapy, thus skewing the results. In the meantime, intense debate and study of the benefits and risks of replacement therapy is ongoing. Current guidelines approve HT for the reduction of hot flashes or flushes, but this treatment is generally only considered when women first start showing signs of menopausal changes, is used in the lowest dose possible for the shortest time possible (5 years or less), and it is suggested that women on HT have regular pelvic and breast exams.

Cognitive Changes Associated with Ageing

Cognitive changes can also be seen in the aging process and often begin around the age of 60 (though can be seen earlier.) Cognitive change as part of the natural ageing process has been well researched and documented. Some cognitive abilities, such as vocabulary, are resilient to aging and may even improve with age. Other abilities, such as conceptual reasoning, memory, and processing speed, decline gradually over time.

Age-Related Cognitive Decline: Women are More Resilient than Men

Emotional Changes Associated with Ageing

In addition to the hormonal and cognitive effects of perimenopause on a women's emotional balance, other factors associates with ageing may impact wellbeing in this area:

- fewer responsibilities associated with child rearing
- becoming a grandmother
- more time to dedicate to personal causes or hobbies
- changes in physical appearance

Social Changes Associated with Ageing

One could argue that social changes to the aging progress for women have had the most drematic changes in later generations. Women now (more than in generations past) have has long term careers which bring friendships and financial assests seperat from a partner. The following factors may bring about social changes as women age:

- financial security
- time to travel with or spend time with friends
- romantic relationship stability or stagnation
- friends passing on
- changes to independent living

Planning for Healthy Ageing

Lifestyle choices can have a significant impact on an individuals physical, mental and emotional health as they age. Actions can start well before middle age to improve quality of life in the "golden years" such as:

- Eating a balanced diet
- Maintain a healthy body weight
- Daily physical activity
- Exercise aimed to strengthen the heart and other muscles of the body

- Properly manage health conditions
- Stay mentally active
- Family history of age related illnesses
- Make and maintain healthy social connections
- Financial planning

An an individual approaches retirement age they may want to also consider the following:

- Health benefits and Medicare
- Senior assistance programs
- Retirement and financial resources
- Staying connected to the community
- Managing medications and treatments for chronic illness
- Driving challenges for older adults
- Age related hearing and vision changes
- Emotional and social support

Check for Understanding

1. What are some of the physical, cognitive, social and emotional changes associated with ageing?
2. What are some positive outcomes of the ageing process?
3. What are some challenges associated with ageing?
4. What behaviors can a person manage early in life to improve likelihood of a positive aging experience?
5. What is one goal you could se not to improve your health in 20-40 years?

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8: SEX, PREGNANCY, AND CHILDBIRTH

8.1: Sexuality

8.2: Public Health Approach to Sexual Health

8.3: Stigma

8.4: Sexual Dysfunction

8.5: Sexual Frequency

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8.11: Reproduction

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8.1: Sexuality

Sexuality is a major part of being human. Love, affection and sexual intimacy all play a role in healthy relationships. They also contribute to your sense of well-being. A number of disorders can affect the ability to have or enjoy sex in both men and women. Concerns about infertility or fear of unplanned pregnancy can also come into play. In addition, a number of diseases and disorders affect sexual health. These include sexually transmitted diseases and cancer. In men, treatment of prostate cancer can cause erectile dysfunction. In women, cervical, uterine, vaginal, vulvar or ovarian cancer may have sexual effects.

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8.2: Public Health Approach to Sexual Health

Sexuality affects individuals and society across a broad spectrum of activities: through health, but also through factors at multiple levels, such as gender relations, reproduction, and economics. Physiological, behavioral, and affective measurement of sexuality and sexual behavior is complicated by cultural values and norms, but is essential to individual health (including happiness) as well as public health.

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8.3: Stigma

Cultural or structural norms that stigmatize aspects of sexuality, such as sexual orientation, have adverse effects on individuals across their lifespan, with homophobia being a prominent example of such. In addition, survey data reveal several individual and relationship factors that are important to sexual health at all levels, with overall health noted as the greatest predictor of sexual satisfaction.

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8.4: Sexual Dysfunction

Sexual dysfunction can pose public health problems, as it is related to public health issues and affects people's happiness and general well-being.

According to the National Health and Social Life Survey:

- The prevalence of sexual dysfunction was found to be higher among women than men.
- Lack of sexual desire is the most common problem among women
- For men, the most common sexual problem is premature ejaculation, not erectile dysfunction.
- Sexual problems increase with age, but sex-related personal distress decreases.

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8.5: Sexual Frequency

Sexual frequency is important for sexual relationship satisfaction. Sexual intercourse frequency is noted as being the most important factor when predicting sexual satisfaction. Satisfaction declines with age but not as steeply as sexual frequency declines. However, although satisfaction is lower in women, satisfaction levels do not change over time among women, compared with men.

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8.6: Sex and Health

Duration and age matter, but health matters most of all. Health proves to be a critical predictor of sexual satisfaction. Among those indicating their health is at least “very good,” more than half say they are satisfied with their sex lives. The majority of older Americans do not practice safe sex, even if they have multiple partners. It was reported that only 1 in 5 sexually active, dating singles use condoms regularly. Many older Americans report dating more than one person at a time and being sexually active with more than one sex partner (6% of men and 1% of women).

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8.7: Sexual Happiness

The most important indicator of the sexual happiness of older Americans is having a steady sex partner. That indicator is less important than the frequency of sexual intercourse, good health, low levels of stress, and the absence of financial worries. There are still behavioral differences between older men and women, and older men and women continue to rank the importance of sex and the enjoyment of sex differently—even as they age. Older men continue to have more sex and think about sex more than older women; they see it as more important to their quality of life. Older men report having more frequent orgasms than women (2 out of 3 men, compared with 1 in 3 women), but their frequency of orgasm drops with age. Older men are twice as likely (21% compared with 11%) to admit sexual activity outside their relationship than women.

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8.8: Sexual Bias and Misconceptions

People who are lesbian, gay, bisexual, or transgender (LGBT) are members of every community. They are diverse, come from all walks of life, and include people of all races and ethnicities, all ages, all socioeconomic statuses, and from all parts of the country. The perspectives and needs of LGBT people should be routinely considered in public health efforts to improve the overall health of every person and eliminate health disparities.

In addition to considering the needs of LGBT people in programs designed to improve the health of entire communities, there is also a need for culturally competent medical care and prevention services that are specific to this population. Social inequality is often associated with poorer health status, and sexual orientation has been associated with multiple health threats. Members of the LGBT community are at increased risk for a number of health threats when compared to their heterosexual peers. Differences in sexual behavior account for some of these disparities, but others are associated with social and structural inequities, such as the stigma and discrimination that LGBT populations experience.

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8.9: Reproductive Health

Both the male and female reproductive systems play a role in pregnancy. Problems with these systems can affect fertility and the ability to have children. There are many such problems in men and women. Reproductive health problems can also be harmful to overall health and impair a person's ability to enjoy a sexual relationship.

Your reproductive health is influenced by many factors. These include your age, lifestyle, habits, genetics, use of medicines and exposure to chemicals in the environment. Many problems of the reproductive system can be corrected.

Reproductive health includes a variety of topics, such as:

- Menstruation and menopause
- Pregnancy and preconception care
- Fertility/Infertility
- Contraception

Menstruation

The menstrual cycle is the process by which a woman’s body gets ready for the chance of a pregnancy each month. The average menstrual cycle is 28 days from the start of one to the start of the next, but it can range from 21 days to 35 days.

Most menstrual periods last from three to five days. In the United States, most girls start menstruating at age 12, but girls can start menstruating between the ages of 8 and 16.

Menstruation is a woman's monthly bleeding. When you menstruate, your body sheds the lining of the uterus (womb). Menstrual blood flows from the uterus through the small opening in the cervix and passes out of the body through the vagina (see how the menstrual cycle works below). Most menstrual periods last from 3 to 5 days.

When periods (menstruations) come regularly, this is called the menstrual cycle. Having regular menstrual cycles is a sign that important parts of your body are working normally. The menstrual cycle provides important body chemicals, called hormones, to keep you healthy. It also prepares your body for pregnancy each month. A cycle is counted from the first day of 1 period to the first day of the next period. The average menstrual cycle is 28 days long. Cycles can range anywhere from 21 to 35 days in adults and from 21 to 45 days in young teens.

In the first half of the cycle, levels of estrogen (the female hormone) start to rise. Estrogen plays an important role in keeping you healthy, especially by helping you to build strong bones and to help keep them strong, as you get older. Estrogen also makes the lining of the uterus (womb) grow and thicken. This lining of the womb is a place that will nourish the embryo if a pregnancy occurs. At the same time the lining of the womb is growing, an egg, or ovum, in one of the ovaries starts to mature. At about day 14 of an average 28-day cycle, the egg leaves the ovary. This is called ovulation.

After the egg has left the ovary, it travels through the fallopian tube to the uterus. Hormone levels rise and help prepare the uterine lining for pregnancy. A woman is most likely to get pregnant during the 3 days before or on the day of ovulation. Keep in mind, women with cycles that are shorter or longer than average may ovulate before or after day 14.

A woman becomes pregnant if the egg is fertilized by a man’s sperm cell and attaches to the uterine wall. If the egg is not fertilized, it will break apart. Then, hormone levels drop, and the thickened lining of the uterus is shed during the menstrual period.

The Menstrual Cycle

- Day 1 starts with the first day of your period. This occurs after hormone levels drop at the end of the previous cycle, signaling blood and tissues lining the uterus (womb) to break down and shed from the body. Bleeding lasts about 5 days.
- Usually by Day 7, bleeding has stopped. Leading up to this time, hormones cause fluid filled pockets called follicles to develop on the ovaries. Each follicle contains an egg.
- Between Day 7 and 14, one follicle will continue to develop and reach maturity. The lining of the uterus starts to thicken, waiting for a fertilized egg to implant there. The lining is rich in blood and nutrients.
- Around Day 14 (in a 28-day cycle), hormones cause the mature follicle to burst and release an egg from the ovary, a process

called ovulation.
- Over the next few days, the egg travels down the fallopian tube towards the uterus. If a sperm unites with the egg here, the fertilized egg will continue down the fallopian tube and attach to the lining of the uterus.
- If the egg is not fertilized, hormone levels will drop around Day 25. This signals the next menstrual cycle to begin. The egg will break apart and be shed with the next period.

Pregnancy

Pregnancy is the term used to describe when a woman has a growing fetus inside of her. In most cases, the fetus grows in the uterus. Human pregnancy lasts about 40 weeks, or just more than 9 months, from the start of the last menstrual period to childbirth.

What are prenatal and preconception care and why are they important?

Prenatal care is the care woman gets during a pregnancy. Getting early and regular prenatal care is important for the health of both mother and the developing baby. In addition, health care providers are now recommending a woman see a health care provider for preconception care, even before she considers becoming pregnant or in between pregnancies.

Knowing if you are pregnant

A missed period is often the first clue that a woman might be pregnant. Sometimes, a woman might suspect she is pregnant even sooner. Symptoms such as headache, fatigue, and breast tenderness, can occur even before a missed period. The wait to know can be emotional. These days, many women first use home pregnancy tests (HPT) to find out. Your doctor also can test you.

All pregnancy tests work by detecting a special hormone in the urine or blood that is only there when a woman is pregnant. It is called human chorionic gonadotropin (kohr-ee-ONihk goh-NAD-uh-TROH-puhn), or hCG. hCG is made when a fertilized egg implants in the uterus. hCG rapidly builds up in your body with each passing day you are pregnant. Read on to learn when and how to test for pregnancy.

Home pregnancy tests

HPTs are inexpensive, private, and easy to use. Most drugstores sell HPTs over the counter. The cost depends on the brand and how many tests come in the box. They work by detecting hCG in your urine. HPTs are highly accurate. But their accuracy depends on many things. These include:

- **When you use them** – The amount of hCG in your urine increases with time. So, the earlier after a missed period you take the test the harder it is to spot the hCG. Some HPTs claim that they can tell if you are pregnant one day after a missed period or even earlier. But a recent study shows that most HPTs don't give accurate results this early in pregnancy. Positive results are more likely to be true than negative results. Waiting one week after a missed period will usually give a more accurate result. You can take the test sooner. But just know that a lot of pregnant women will get negative test results during the first few days after the missed period. It's a good idea to repeat the test again after a week has passed. If you get two negative results but still think you're pregnant, call your doctor.
- **How you use them** – Be sure to check the expiration date and follow the directions. Many involve holding a test stick in the urine stream. For some, you collect urine in a cup and then dip the test stick into it. Then, depending on the brand, you will wait a few minutes to get the results. Research suggests waiting 10 minutes will give the most accurate result. Also, testing your urine first thing in the morning may boost the accuracy. You will be looking for a plus sign, a change in color, or a line. A change, whether bold or faint, means the result is positive. New digital tests show the words "pregnant" or "not pregnant". Most tests also have a "control indicator" in the results window. This line or symbol shows whether or not the test is working. If the control indicator does not appear, the test is not working properly. You should not rely on any results from a HPT that may be faulty.
- **Who uses them** – The amount of hCG in the urine is different for every pregnant woman. So, some women will have accurate results on the day of the missed period while others will need to wait longer. Also, some medicines affect HPTs. Discuss the medicines you use with your doctor before trying to become pregnant.
- **The brand of test** – Some HPT tests are better than others at spotting hCG early on.

The most important part of using any HPT is to follow the directions exactly as written. Most tests also have toll-free phone numbers to call in case of questions about use or results.

If a HPT says you are pregnant, you should call your doctor right away. Your doctor can use a more sensitive test along with a pelvic exam to tell for sure if you're pregnant. Seeing your doctor early on in your pregnancy can help you and your baby stay healthy.

Unplanned Pregnancy

Unplanned pregnancy is common. About 1 in 2 pregnancies in America are unplanned. Ideally, a woman who is surprised by an unplanned pregnancy is in good preconception health and is ready and able to care for a new child. But this sometimes isn't the case.

If you have an unplanned pregnancy, you might not know what to do next. You might worry that the father (or mother) won't welcome the news. You might not be sure you can afford to care for a baby. You might worry if past choices you have made, such as drinking or drug use, will affect your unborn baby's health. You might be concerned that having a baby will keep you from finishing school or pursuing a career.

If you are pregnant after being raped, you might feel ashamed, numb, or afraid. Unplanned pregnancy is common among abused women. Research has found that some abusers force their partners to have sex without birth control and/or sabotage the birth control their partners are using, leading to unplanned pregnancy.

You might wonder what options you have. Here are some next steps to help you move forward:

- Start taking care of yourself right away. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) folic acid every. Stop alcohol, tobacco, and drug use.
- Make a doctor's visit to confirm your pregnancy. Discuss your health and issues that could affect your pregnancy. Ask for help quitting smoking. Find out what you can do to take care of yourself and your unborn baby.
- Ask your doctor to recommend a counselor who you can talk to about your situation.
- Seek support in someone you trust and respect.

Trying to Get Pregnant

How do you figure out when you're fertile and when you're not? Wondering if you or your partner is infertile? Read on to boost your chances of conception and get help for fertility problems.

Fertility awareness

The menstrual cycle

Being aware of your menstrual cycle and the changes in your body that happen during this time can help you know when you are most likely to get pregnant.

The average menstrual cycle lasts 28 days. But normal cycles can vary from 21 to 35 days. The amount of time before ovulation occurs is different in every woman and even can be different from month to month in the same woman, varying from 13 to 20 days long. Learning about this part of the cycle is important because it is when ovulation and pregnancy can occur. After ovulation, every woman (unless she has a health problem that affects her periods or becomes pregnant) will have a period within 14 to 16 days.

Charting your fertility pattern

Knowing when you're most fertile will help you plan pregnancy. There are three ways you can keep track of your fertile times. They are:

1. **Basal body temperature method** – Basal body temperature is your temperature at rest as soon as you awake in the morning. A woman's basal body temperature rises slightly with ovulation. So by recording this temperature daily for several months, you'll be able to predict your most fertile days.
2. Basal body temperature differs slightly from woman to woman. Anywhere from 96 to 98 degrees Fahrenheit orally is average before ovulation. After ovulation most women have an oral temperature between 97 and 99 degrees Fahrenheit. The rise in temperature can be a sudden jump or a gradual climb over a few days.
3. Usually a woman's basal body temperature rises by only 0.4 to 0.8 degrees Fahrenheit. To detect this tiny change, women must use a basal body thermometer. These thermometers are very sensitive. Most pharmacies sell them for about $10. You can then record your temperature on a basal body temperature chart.

4. The rise in temperature doesn't show exactly when the egg is released. But almost all women have ovulated within three days after their temperatures spike. Body temperature stays at the higher level until the woman's period starts.
5. A woman is most fertile and most likely to get pregnant:
    - Two to three days before your temperature hits the highest point (ovulation)
    - and 12 to 24 hours after ovulation
6. A man's sperm can live for up to three days in a woman's body. The sperm can fertilize an egg at any point during that time. So if you have unprotected sex a few days before ovulation, you could get pregnant.
7. Many things can affect basal body temperature. For your chart to be useful, make sure to take your temperature every morning at about the same time. Things that can alter your temperature include:
    - Drinking alcohol the night before
    - Smoking cigarettes the night before
    - Getting a poor night's sleep
    - Having a fever
    - Doing anything in the morning before you take your temperature — including going to the bathroom and talking on the phone
8. **Calendar method**– This involves recording your menstrual cycle on a calendar for eight to 12 months. The first day of your period is Day 1. Circle Day 1 on the calendar. The length of your cycle may vary from month to month. So write down the total number of days it lasts each time. Using this record, you can find the days you are most fertile in the months ahead:
    - To find out the first day when you are most fertile, subtract 18 from the total number of days in your shortest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The X marks the first day you're likely to be fertile.
    - To find out the last day when you are most fertile, subtract 11 from the total number of days in your longest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The time between the two Xs is your most fertile window.
9. This method always should be used along with other fertility awareness methods, especially if your cycles are not always the same length.

Optional: Use this Ovulation and due date calculator to find out when you (or a woman you know) are most likely to become pregnant and to estimate your due date should conception occur.

Did you know?

The cervical mucus method is less reliable for some women. Women who are breastfeeding, taking hormonal birth control (like the pill), using feminine hygiene products, have vaginitis or sexually transmitted infections (STIs), or have had surgery on the cervix should not rely on this method.

1. **Cervical mucus method** (also known as the ovulation method) – This involves being aware of the changes in your cervical mucus throughout the month. The hormones that control the menstrual cycle also change the kind and amount of mucus you have before and during ovulation. Right after your period, there are usually a few days when there is no mucus present or "dry days." As the egg starts to mature, mucus increases in the vagina, appears at the vaginal opening, and is white or yellow and cloudy and sticky. The greatest amount of mucus appears just before ovulation. During these "wet days" it becomes clear and slippery, like raw egg whites. Sometimes it can be stretched apart. This is when you are most fertile. About four days after the wet days begin the mucus changes again. There will be much less and it becomes sticky and cloudy. You might have a few more dry days before your period returns. Describe changes in your mucus on a calendar. Label the days, "Sticky," "Dry," or "Wet." You are most fertile at the first sign of wetness after your period or a day or two before wetness begins.
2. To most accurately track your fertility, use a combination of all three methods. This is called the symptothermal (SIMP-toh-thur-muhl) method. You can also purchase over-the-counter ovulation kits or fertility monitors to help find the best time to conceive. These kits work by detecting surges in a specific hormone called luteinizing hormone, which triggers ovulation.

Infertility

Some women want children but either cannot conceive or keep miscarrying. This is called infertility. Lots of couples have infertility problems. About one-third of the time, it is a female problem. In another one-third of cases, it is the man with the fertility problem. For the remaining one-third, both partners have fertility challenges or no cause is found.

Causes of infertility

Some common reasons for infertility in women include:

Age – Women generally have some decrease in fertility starting in their early 30s. And while many women in their 30s and 40s have no problems getting pregnant, fertility especially declines after age 35. As a woman ages, normal changes that occur in her ovaries and eggs make it harder to become pregnant. Even though menstrual cycles continue to be regular in a woman's 30s and 40s, the eggs that ovulate each month are of poorer quality than those from her 20s. It is harder to get pregnant when the eggs are poorer in quality. As a woman nears menopause, the ovaries may not release an egg each month, which also can make it harder to get pregnant. Also, as a woman and her eggs age, she is more likely to miscarry, as well as have a baby with genetic problems, such as Down syndrome.

Health problems – Some women have diseases or conditions that affect their hormone levels, which can cause infertility. Women with polycystic ovary syndrome (PCOS) rarely or never ovulate. Failure to ovulate is the most common cause of infertility in women.

- With primary ovarian insufficiency (POI), a woman's ovaries stop working normally before she is 40. It is not the same as early menopause. Some women with POI get a period now and then. But getting pregnant is hard for women with POI.
- A condition called luteal phase defect (LPD) is a failure of the uterine lining to be fully prepared for pregnancy. This can keep a fertilized egg from implanting or result in miscarriage.

Common problems with a woman's reproductive organs, like uterine fibroids, endometriosis, and pelvic inflammatory disease can worsen with age and also affect fertility. These conditions might cause the fallopian tubes to be blocked, so the egg can't travel through the tubes into the uterus.

Lifestyle factors – Certain lifestyle factors also can have a negative effect on a woman's fertility. Examples include smoking, alcohol use, weighing much more or much less than an ideal body weight, a lot of strenuous exercise, and having an eating disorder. Stress also can affect fertility.

Unlike women, some men remain fertile into their 60s and 70s. But as men age, they might begin to have problems with the shape and movement of their sperm. They also have a slightly higher risk of sperm gene defects. Or they might produce no sperm, or too few sperm. Lifestyle choices also can affect the number and quality of a man's sperm. Alcohol and drugs can temporarily reduce sperm quality. And researchers are looking at whether environmental toxins, such as pesticides and lead, also may be to blame for some cases of infertility. Men also can have health problems that affect their sexual and reproductive function. These can include sexually transmitted infections (STIs), diabetes, surgery on the prostate gland, or a severe testicle injury or problem.

When to see your doctor

You should talk to your doctor about your fertility if:

- You are younger than 35 and have not been able to conceive after one year of frequent sex without birth control.
- You are age 35 or older and have not been able to conceive after six months of frequent sex without birth control.
- You believe you or your partner might have fertility problems in the future (even before you begin trying to get pregnant).
- You or your partner has a problem with sexual function or libido.

Happily, doctors are able to help many infertile couples go on to have babies.

If you are having fertility issues, your doctor can refer you to a fertility specialist, a doctor who treats infertility. The doctor will need to test both you and your partner to find out what the problem is. Depending on the problem, your doctor might recommend treatment. About 9 in 10 cases of infertility are treated with drugs or surgery. *Don't delay seeing your doctor as age also affects the success rates of these treatments.* For some couples, adoption or foster care offers a way to share their love with a child and to build a family.

Infertility treatment

Some treatments include:

- **Drugs** – Various fertility drugs may be used for women with ovulation problems. It is important to talk with your doctor about the drug to be used. You should understand the drug's benefits and side effects. Depending on the type of fertility drug and the dosage of the drug used, multiple births (such as twins) can occur.
- **Surgery** – Surgery is done to repair damage to a woman's ovaries, fallopian tubes, or uterus. Sometimes a man has an infertility problem that can be corrected by surgery.
- **Intrauterine (in-truh-YOOT-uh-ruhn) insemination (IUI), also called artificial insemination** – Male sperm is injected into part of the woman's reproductive tract, such as into the uterus or fallopian tube. IUI often is used along with drugs that

cause a woman to ovulate.
- **Assisted reproductive technology (ART)** – ART involves stimulating a woman's ovaries; removing eggs from her body; mixing them with sperm in the laboratory; and putting the embryos back into a woman's body. Success rates of ART vary and depend on many factors.
- **Third party assistance** – Options include donor eggs (eggs from another woman are used), donor sperm (sperm from another man are used), or surrogacy (when another woman carries a baby for you).

Finding the cause of infertility is often a long, complex, and emotional process. And treatment can be expensive. Many health insurance companies do not provide coverage for infertility or provide only limited coverage. Check your health insurance contract carefully to learn about what is covered. Some states have laws that mandate health insurance policies to provide infertility coverage.

Preconception Care: Why Preconception Health Matters

Preconception health is a woman's health before she becomes pregnant. It means knowing how health conditions and risk factors could affect a woman or her unborn baby if she becomes pregnant. For example, some foods, habits, and medicines can harm your baby — even before he or she is conceived. Some health problems, such as diabetes, also can affect pregnancy.

Every woman should be thinking about her health whether or not she is planning pregnancy. One reason is that about half of all pregnancies are not planned. Unplanned pregnancies are at greater risk of preterm birth and low birth weight babies. Another reason is that, despite important advances in medicine and prenatal care, about 1 in 8 babies is born too early. Researchers are trying to find out why and how to prevent preterm birth. But experts agree that women need to be healthy before becoming pregnant. By taking action on health issues and risks before pregnancy, you can prevent problems that might affect you or your baby later.

Five most important things to boost your preconception health

Women and men should prepare for pregnancy before becoming sexually active — or at least three months before getting pregnant. Some actions, such as quitting smoking, reaching a healthy weight, or adjusting medicines you are using, should start even earlier. The five most important things a woman can do for preconception health are:

1. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) of folic acid every day if you are planning or capable of pregnancy to lower your risk of some birth defects of the brain and spine, including spina bifida. All women need folic acid every day. Talk to your doctor about your folic acid needs. Some doctors prescribe prenatal vitamins that contain higher amounts of folic acid.
2. Stop smoking and drinking alcohol.
3. If you have a medical condition, be sure it is under control. Some conditions that can affect pregnancy or be affected by it include asthma, diabetes, oral health, obesity, or epilepsy.
4. Talk to your doctor about any over-the-counter and prescription medicines you are using. Note: These include dietary or herbal supplements. Be sure your vaccinations are up to date.
5. Avoid contact with toxic substances or materials that could cause infection at work and at home. Stay away from chemicals and cat or rodent feces.

Contraception

According to the Guttmacher Institute: " In 2008, there were 6.4 million pregnancies to the 62 million women of reproductive age (15–44) in the United States. Sixty-six percent of these pregnancies resulted in live births and 19% in induced abortions. And, nearly half of pregnancies among American women—more than three million each year—are unintended."

An unintended pregnancy is a pregnancy that is either mistimed or unwanted at the time of conception. It is a core concept in understanding the fertility of populations and the unmet need for contraception. Unintended pregnancy is associated with an increased risk of morbidity for women, and with health behaviors during pregnancy that are associated with adverse effects. For example, women with an unintended pregnancy may delay prenatal care, which may affect the health of the infant. Women of all ages may have unintended pregnancies, but some groups, such as teens, are at a higher risk. Efforts to decrease unintended pregnancy include finding better forms of contraception, and increasing contraceptive use and adherence.

Contraception, also known as birth control, is designed to prevent pregnancy. Some types of birth control include (but are not

limited to):

- Barrier methods, such as condoms, the diaphragm, and the cervical cap, are designed to prevent the sperm from reaching the egg for fertilization. Intrauterine device, or IUD, is a small device that is inserted into the uterus by a health care provider. The IUD prevents a fertilized egg from implanting in the uterus. An IUD can stay in the uterus for up to 10 years until a health care provider removes it.
- Hormonal birth control, such as birth control pills, injections, skin patches, and vaginal rings, release hormones into a woman's body that interfere with fertility by preventing ovulation, fertilization, or implantation.
- Sterilization is a method that permanently prevents a woman from getting pregnant or a man from being able to get a woman pregnant. Sterilization involves surgical procedures that must be done by a health care provider and usually cannot be reversed.

The choice of birth control depends on factors such as a person's overall health, age, frequency of sexual activity, number of sexual partners, desire to have children in the future, and family history of certain diseases. A woman should talk to her health care provider about her choice of birth control method.

It is important to remember that even though birth control methods can prevent pregnancy, they do not all protect against sexually transmitted diseases or HIV.

Contraception Methods

There is no "best" method of birth control. Each method has its pros and cons. All women and men can have control over when, and if, they become parents. Making choices about birth control, or contraception, isn't easy. There are many things to think about. To get started, learn about birth control methods you or your partner can use to prevent pregnancy. You can also talk with your doctor about the choices.

Before choosing a birth control method, think about:

- Your overall health
- How often you have sex
- The number of sex partners you have
- If you want to have children someday
- How well each method works to prevent pregnancy
- Possible side effects
- Your comfort level with using the method

You can choose from many methods of birth control. They are grouped by how they work:

- Continuous abstinence: This means not having sex (vaginal, anal, or oral) at any time. It is the only sure way to prevent pregnancy and protect against sexually transmitted infections (STIs), including HIV.
- Natural family planning/rhythm method: This method is when you do not have sex or use a barrier method on the days you are most fertile (most likely to become pregnant). A woman who has a regular menstrual cycle has about 9 or more days each month when she is able to get pregnant. These fertile days are about 5 days before and 3 days after ovulation, as well as the day of ovulation.

To have success with this method, you need to learn about your menstrual cycle. Then you can learn to predict which days you are fertile or "unsafe." To learn about your cycle, keep a written record of:

- When you get your period
- What it is like (heavy or light blood flow)
- How you feel (sore breasts, cramps)

This method also involves checking your cervical mucus and recording your body temperature each day. Cervical mucus is the discharge from your vagina. You are most fertile when it is clear and slippery like raw egg whites. Use a basal thermometer to take your temperature and record it in a chart. Your temperature will rise 0.4 to 0.8° F on the first day of ovulation. You can talk with your doctor or a natural family planning instructor to learn how to record and understand this information.

Barrier Methods - Put up a block, or barrier, to keep sperm from reaching the egg

Before having sex, you wet the sponge and place it, loop side down, inside your vagina to cover the cervix. The sponge is effective

for more than one act of intercourse for up to 24 hours. It needs to be left in for at least 6 hours after having sex to prevent pregnancy. It must then be taken out within 30 hours after it is inserted.

Only one kind of contraceptive sponge is sold in the United States. It is called the Today Sponge. Women who are sensitive to the spermicide nonoxynol-9 should not use the sponge.

Diaphragm, cervical cap, and cervical shield

These barrier methods block the sperm from entering the cervix (the opening to your womb) and reaching the egg.

- The diaphragm is a shallow latex cup.
- The cervical cap is a thimble-shaped latex cup. It often is called by its brand name, FemCap.
- The cervical shield is a silicone cup that has a one-way valve that creates suction and helps it fit against the cervix. It often is called by its brand name, Lea's Shield.

The diaphragm and cervical cap come in different sizes, and you need a doctor to "fit" you for one. The cervical shield comes in one size, and you will not need a fitting. Before having sex, add spermicide (to block or kill sperm) to the devices. Then place them inside your vagina to cover your cervix. You can buy spermicide gel or foam at a drug store.

All three of these barrier methods must be left in place for 6 to 8 hours after having sex to prevent pregnancy. The diaphragm should be taken out within 24 hours. The cap and shield should be taken out within 48 hours.

Female condom

This condom is worn by the woman inside her vagina. It keeps sperm from getting into her body. It is made of thin, flexible, manmade rubber and is packaged with a lubricant. It can be inserted up to 8 hours before having sex. Use a new condom each time you have intercourse. And don't use it and a male condom at the same time.

Male condom

Male condoms are a thin sheath placed over an erect penis to keep sperm from entering a woman's body. Condoms can be made of latex, polyurethane, or "natural/lambskin". The natural kind do not protect against STIs. Condoms work best when used with a vaginal spermicide, which kills the sperm. A new condom needs to be used with each sex act.

Condoms are either:

- Lubricated, which can make sexual intercourse more comfortable
- Non-lubricated, which can also be used for oral sex. It is best to add lubrication to nonlubricated condoms if you use them for vaginal or anal sex. You can use a waterbased lubricant, such as K-Y jelly. You can buy them at the drug store. Oil-based lubricants like massage oils, baby oil, lotions, or petroleum jelly will weaken the condom, causing it to tear or break.

Keep condoms in a cool, dry place. If you keep them in a hot place (like a wallet or glove compartment), the latex breaks down. Then the condom can tear or break.

Hormonal methods - Prevent pregnancy by interfering with ovulation, fertilization, and/or implantation of the fertilized egg

Oral contraceptives - combined pill ("The pill")

The pill contains the hormones estrogen and progestin. It is taken daily to keep the ovaries from releasing an egg. The pill also causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining the egg.

Some women prefer the "extended cycle" pills. These have 12 weeks of pills that contain hormones (active) and 1 week of pills that don't contain hormones (inactive). While taking extended cycle pills, women only have their period three to four times a year.

Many types of oral contraceptives are available. Talk with your doctor about which is best for you.

Your doctor may advise you not to take the pill if you:

- Are older than 35 and smoke
- Have a history of blood clots

- Have a history of breast, liver, or endometrial cancer

Antibiotics may reduce how well the pill works in some women. Talk to your doctor about a backup method of birth control if you need to take antibiotics. Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

The patch

Also called by its brand name, Ortho Evra, this skin patch is worn on the lower abdomen, buttocks, outer arm, or upper body. It releases the hormones progestin and estrogen into the bloodstream to stop the ovaries from releasing eggs in most women. It also thickens the cervical mucus, which keeps the sperm from joining with the egg. You put on a new patch once a week for 3 weeks. You don't use a patch the fourth week in order to have a period.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Shot/injection

The birth control shot often is called by its brand name Depo-Provera. With this method you get injections, or shots, of the hormone progestin in the buttocks or arm every 3 months. A new type is injected under the skin. The birth control shot stops the ovaries from releasing an egg in most women. It also causes changes in the cervix that keep the sperm from joining with the egg.

Vaginal ring

This is a thin, flexible ring that releases the hormones progestin and estrogen. It works by stopping the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining the egg. It is commonly called *NuvaRing*, its brand name. You squeeze the ring between your thumb and index finger and insert it into your vagina. You wear the ring for 3 weeks, take it out for the week that you have your period, and then put in a new ring.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Implantable devices — Devices that are inserted into the body and left in place for a few years.

Implantable rod

This is a matchstick-size, flexible rod that is put under the skin of the upper arm. It is often called by its brand name, Implanon. The rod releases a progestin, which causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining an egg. Less often, it stops the ovaries from releasing eggs. It is effective for up to 3 years.

Intrauterine devices or IUDs

An IUD is a small device shaped like a "T" that goes in your uterus. There are two types:

- |Copper IUD The copper IUD goes by the brand name ParaGard. It releases a small amount of copper into the uterus, which prevents the sperm from reaching and fertilizing the egg. It fertilization does occur, the IUD keeps the fertilized egg from implanting in the lining of the uterus. A doctor needs to put in your copper IUD. It can stay in your uterus for 5 to 10 years.
- Hormonal IUD The hormonal IUD goes by the brand name Mirena. It is sometimes called an intrauterine system, or IUS. It releases progestin into the uterus, which keeps the ovaries from releasing an egg and causes the cervical mucus to thicken so sperm can't reach the egg. It also affects the ability of a fertilized egg to successfully implant in the uterus. A doctor needs to put in a hormonal IUD. It can stay in your uterus for up to 5 years.

Sterilization implant (essure)

Essure is the first non-surgical method of sterilizing women. A thin tube is used to thread a tiny spring-like device through the vagina and uterus into each fallopian tube. The device works by causing scar tissue to form around the coil. This blocks the

fallopian tubes and stops the egg and sperm from joining.

It can take about 3 months for the scar tissue to grow, so it's important to use another form of birth control during this time. Then you will have to return to your doctor for a test to see if scar tissue has fully blocked your tubes.

Surgical sterilization

For women, surgical sterilization closes the fallopian tubes by being cut, tied, or sealed. This stops the eggs from going down to the uterus where they can be fertilized. The surgery can be done a number of ways. Sometimes, a woman having cesarean birth has the procedure done at the same time, so as to avoid having additional surgery later.

For men, having a vasectomy (vuh-SEK-tuh-mee) keeps sperm from going to his penis, so his ejaculate never has any sperm in it. Sperm stays in the system after surgery for about 3 months. During that time, use a backup form of birth control to prevent pregnancy. A simple test can be done to check if all the sperm is gone; it is called a semen analysis.

Emergency contraception

Used if a woman's primary method of birth control fails. It should not be used as a regular method of birth control. Emergency contraception (Plan B One-Step or Next Step. It is also called the "morning after pill.") Emergency contraception keeps a woman from getting pregnant when she has had unprotected vaginal intercourse. "Unprotected" can mean that no method of birth control was used. It can also mean that a birth control method was used but it was used incorrectly, or did not work (like a condom breaking). Or, a woman may have forgotten to take her birth control pills. She also may have been abused or forced to have sex. These are just some of the reasons women may need emergency contraception.

Emergency contraception can be taken as a single pill treatment or in two doses. A single dose treatment works as well as two doses and does not have more side effects. It works by stopping the ovaries from releasing an egg or keeping the sperm from joining with the egg. For the best chances for it to work, take the pill as soon as possible after unprotected sex. It should be taken within 72 hours after having unprotected sex.

A single-pill dose or two-pill dose of emergency contraception is available over-the-counter (OTC) for women ages 17 and older.

Can all types of birth control prevent sexually transmitted infections (STIs)?

No. The male latex condom is the only birth control method proven to help protect you from STIs, including HIV. Research is being done to find out how effective the female condom is at preventing STIs and HIV. For more information, see Will birth control pills protect me from sexually transmitted infections (STIs), including HIV/AIDS?

How well do different kinds of birth control work? Do they have side effects?

All birth control methods work the best if used correctly and every time you have sex. Be sure you know the right way to use them. Sometimes doctors don't explain how to use a method because they assume you already know. Talk with your doctor if you have questions. They are used to talking about birth control. So don't feel embarrassed about talking to him or her. Some birth control methods can take time and practice to learn. For example, some people don't know you can put on a male condom "inside out." Also, not everyone knows you need to leave a little space at the tip of the condom for the sperm and fluid when a man ejaculates, or has an orgasm. The misuse of contraceptives is known as human error and is the main reason why effectiveness is determined by typical use and perfect use. Below is a table showing the percentage of woman experiencing an unintended pregnancy during the fist year of typical use and the first year of perfect use of different types of contraception.

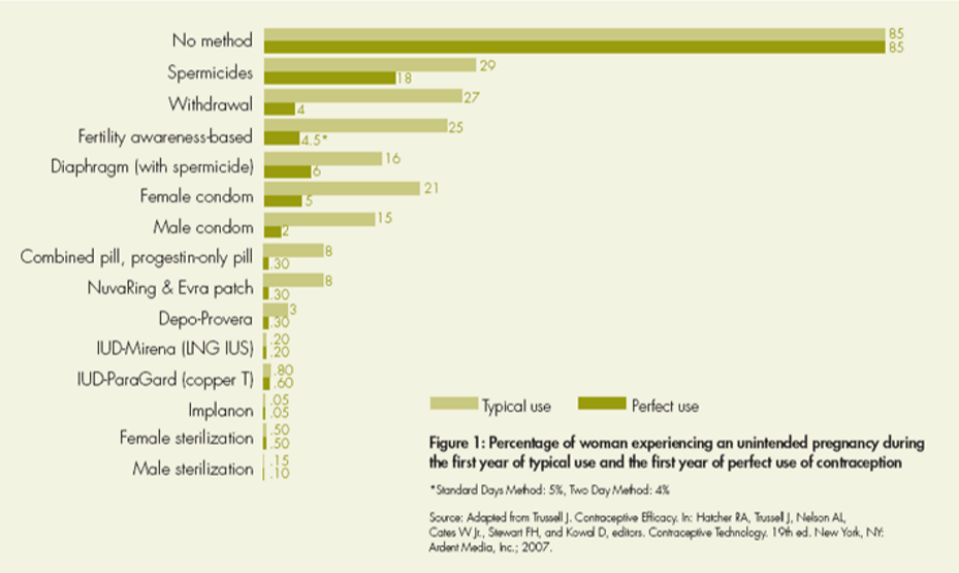


Figure 8.9.1. Success Rates of Common Contraception

Where to Get Birth Control

Where you get birth control depends on what method you choose.

You will need surgery or a medical procedure for:

- Sterilization, female and male

You need a prescription for these forms:

- Skin patch
- Diaphragm (your doctor needs to fit one to your shape)
- Cervical shield
- IUD (inserted by a doctor)
- Implantable rod (inserted by a doctor)

You can buy these forms over the counter:

- Male condoms
- Female condoms
- Sponges
- Spermicides
- Emergency contraception pills (girls younger than 17 need a prescription)
- Spermacides: They work by killing sperm. They come in many forms:
  - Foam
  - Gel
  - Cream
  - Film
  - Suppository
  - Tablet

Spermicides are put in the vagina no more than 1 hour before having sex. If you use a film, suppository, or tablet, wait at least 15 minutes before having sex so the spermicide can dissolve. Do not douche or rinse out your vagina for at least 6 to 8 hours after

having sex. You will need to use more spermicide each time you have sex.

Spermicides work best if used along with a barrier method, such as a condom, diaphragm, or cervical cap. Some spermicides are made just for use with the diaphragm and cervical cap. Check the package to make sure you are buying what you need.

All spermicides contain sperm-killing chemicals. Some contain nonoxynol-9, which may raise your risk of HIV if you use it a lot. It irritates the tissue in the vagina and anus, so it can cause the HIV virus to enter the body more freely. Some women are sensitive to nonoxynol-9 and need to use spermicides without it. Medications for vaginal yeast infections may lower the effectiveness of spermicides. Also, spermicides do not protect against sexually transmitted infections.

Withdrawal

Withdrawal is when a man takes his penis out of a woman's vagina (or "pulls out") before he ejaculates, or has an orgasm. This stops the sperm from going to the egg. "Pulling out" can be hard for a man to do. It takes a lot of self-control. Even if you use withdrawal, sperm can be released before the man pulls out. When a man's penis first becomes erect, preejaculate fluid may be on the tip of the penis. This fluid has sperm in it. So you could still get pregnant. Withdrawal does not protect you from STIs or HIV.

Dental Dams

The dental dam is a square piece of rubber that is used by dentists during oral surgery and other procedures. It is not a method of birth control. But it can be used to help protect people from STIs, including HIV, during oral-vaginal or oral-anal sex. It is placed over the opening to the vagina or the anus before having oral sex. You can buy dental dams at surgical supply stores.

Abortion

Abortion is the ending of pregnancy by removing a fetus or embryo before it can survive outside the uterus. An abortion that occurs spontaneously is also known as a miscarriage.

An abortion may be caused purposely and is then called an induced abortion, or less frequently, "induced miscarriage". The word abortion is often used to mean only induced abortions. A similar procedure after the fetus could potentially survive outside the womb is known as a "late termination of pregnancy".

When allowed by law, abortion in the developed world is one of the safest procedures in medicine. Modern methods use medication or surgery for abortions. The drug mifepristone in combination with prostaglandin appears to be as safe and effective as surgery during the first and second trimester of pregnancy. Birth control, such as the pill or intrauterine devices, can be used immediately following abortion. When performed legally and safely, induced abortions do not increase the risk of long-term mental or physical problems. In contrast, unsafe abortions (those performed by unskilled individuals, with hazardous equipment, or in unsanitary facilities) cause 47,000 deaths and 5 million hospital admissions each year. The World Health Organization recommends safe and legal abortions be available to all women.

Around 56 million abortions are performed each year in the world, with about 45% done unsafely. Abortion rates changed little between 2003 and 2008, before which they decreased for at least two decades as access to family planning and birth control increased. As of 2008, 40% of the world's women had access to legal abortions without limits as to reason. Countries that permit abortions have different limits on how late in pregnancy abortion is allowed.

Historically, abortions have been attempted using herbal medicines, sharp tools, with force, or through other traditional methods. Abortion laws and cultural or religious views of abortions are different around the world. In some areas abortion is legal only in specific cases such as rape, problems with the fetus, poverty, risk to a woman's health, or incest. In many places there is much debate over the moral, ethical, and legal issues of abortion. Those who oppose abortion often maintain that an embryo or fetus is a human with a right to life and may compare abortion to murder. Those who favor the legality of abortion often hold that a woman has a right to make decisions about her own body.

Methods of Abortion

How many weeks a woman is pregnant is usually the main factor in determining which abortion methods are practiced. Below are the two main methods for abortion.

Medical

Medical abortions are performed without entering the uterus. Instead, medical abortions terminate a pregnancy by abortifacient pharmaceuticals, which are drugs that cause abortion. These drugs induce abortion by blocking the action of progesterone, which results in the lining of the embryo being expelled from the uterus, thus terminating the pregnancy.

If medical abortion fails, surgical abortion must be used to complete the procedure. Early medical abortions account for the majority of abortions before 9 weeks gestation in Britain, France, Switzerland, and the Nordic countries. In the United States, the percentage of early medical abortions is far lower.

Medical abortion regimens using mifepristone in combination with a prostaglandin analog are the most common methods used for second-trimester abortions in Canada, most of Europe, China and India, in contrast to the United States where 96% of second-trimester abortions are performed surgically by dilation and evacuation.

Surgical

Up to 15 weeks' into a pregnancy, suction-aspiration or vacuum aspiration are the most common surgical methods of induced abortion. Manual vacuum aspiration (MVA) consists of removing the fetus or embryo, placenta, and membranes by suction using a manual syringe, while electric vacuum aspiration (EVA) uses an electric pump. These techniques differ in the mechanism used to apply suction, in how early in pregnancy they can be used, and in whether cervical dilation is necessary.

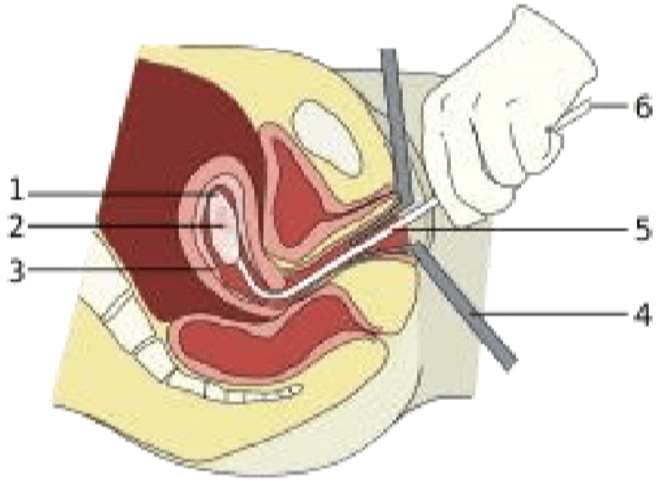


Figure 8.9.2. Vacuum Aspiration Abortion

1. Amniotic sac
2. Embryo
3. Uterine lining
4. Speculum
5. Vacurette
6. Attached to a suction pump

MVA, also known as "mini-suction" and "menstrual extraction", can be used in very early pregnancy, and does not require cervical dilation. Dilation and curettage (D&C), the second most common method of surgical abortion, is a standard gynecological procedure performed for a variety of reasons, including examination of the uterine lining for possible malignancy, investigation of abnormal bleeding, and abortion. Curettage refers to cleaning the walls of the uterus with a curette. The World Health Organization recommends this procedure, also called sharp curettage, only when MVA is unavailable.

From the 15th week of gestation until approximately the 26th, other techniques must be used. Dilation and evacuation (D&E) consists of opening the cervix of the uterus and emptying it using surgical instruments and suction. After the 16th week of gestation, abortions can also be induced by intact dilation and extraction (IDX) (also called intrauterine cranial decompression), which requires surgical decompression of the fetus's head before evacuation. IDX is sometimes called "partial-birth abortion", which has been federally banned in the United States.

In the third trimester of pregnancy, induced abortion may be performed surgically by intact dilation and extraction or by hysterotomy. Hysterotomy abortion is a procedure similar to a caesarean section and is performed under general anesthesia. It

requires a smaller incision than a caesarean section and is used during later stages of pregnancy. First-trimester procedures can generally be performed using local anesthesia, while second-trimester methods may require deep sedation or general anesthesia.

Abortion Debate

Induced abortion has long been the course of considerable debate.

Ethical, moral, philosophical, biological, religious and legal issues surrounding abortion are related to value systems. Opinions of abortion may be about fetal rights, governmental authority, and women's rights.

In both public and private debate, arguments presented in favor of or against abortion access focus on either the moral permissibility of an induced abortion, or justification of laws permitting or restricting abortion. The World Medical Association Declaration on Therapeutic Abortion notes, "circumstances bringing the interests of a mother into conflict with the interests of her unborn child create a dilemma and raise the question as to whether or not the pregnancy should be deliberately terminated." Abortion debates, especially pertaining to abortion laws, are often spearheaded by groups advocating one of these two positions. Anti-abortion groups who favor greater legal restrictions on abortion, including complete prohibition, most often describe themselves as "**pro-life**" while abortion rights groups who are against such legal restrictions describe themselves as "**pro-choice**". Generally, the former position argues that a human fetus is a human person with a right to live, making abortion morally the same as murder. The latter position argues that a woman has certain reproductive rights, especially the choice whether or not to carry a pregnancy to term.

Roe v. Wade

Roe v. Wade is a landmark decision issued in 1973 by the United States Supreme Court on the issue of the constitutionality of laws that criminalized or restricted access to abortions. The Court ruled 7–2 that a right to privacy under the Due Process Clause of the 14th Amendment extended to a woman's decision to have an abortion, but that this right must be balanced against the state's interests in regulating abortions: protecting women's health and protecting the potentiality of human life. Arguing that these state interests became stronger over the course of a pregnancy, the Court resolved this balancing test by tying state regulation of abortion to the third trimester of pregnancy.

Later, in *Planned Parenthood v. Casey* (1992), the Court rejected *Roe*'s trimester framework while affirming its central holding that a woman has a right to abortion until fetal viability. The *Roe* decision defined "viable" as "potentially able to live outside the mother's womb, albeit with artificial aid." Justices in *Casey* acknowledged that viability may occur at 23 or 24 weeks, or sometimes even earlier, in light of medical advances. In disallowing many state and federal restrictions on abortion in the United States, *Roe v. Wade* prompted a national debate that continues today about issues including whether, and to what extent, abortion should be legal, who should decide the legality of abortion, what methods the Supreme Court should use in constitutional adjudication, and what the role should be of religious and moral views in the political sphere. *Roe v. Wade* reshaped national politics, dividing much of the United States into pro-life and pro-choice camps, while activating grassroots movements on both sides.

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8.10: Behavioral Presentation of Human Sexuality

Sexual Health

Sexual health is a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination, and violence.

Sexuality

Sexuality is a big part of being human. Love, affection and sexual intimacy all play a role in healthy relationships. They also contribute to your sense of well-being. A number of disorders can affect the ability to have or enjoy sex in both men and women. Concerns about infertility or fear of unplanned pregnancy can also come into play. In addition, a number of diseases and disorders affect sexual health. These include sexually transmitted diseases and cancer. In men, treatment of prostate cancer can cause erectile dysfunction. In women, cervical, uterine, vaginal, vulvar, or ovarian cancer may have sexual effects.

Public Health Approach to Sexual Health

Sexuality affects individuals and society across a broad spectrum of activities: through health, but also through factors at multiple levels, such as gender relations, reproduction, and economics. Physiologic, behavioral, and affective measurement of sexuality and sexual behavior is complicated by cultural values and norms, but is essential to individual health (including happiness) as well as public health.

Stigma

Cultural or structural norms that stigmatize aspects of sexuality, such as sexual orientation, have adverse effects on individuals across their lifespan, with homophobia being a prominent example of such. In addition, survey data reveal several individual and relationship factors that are important to sexual health at all levels, with overall health noted as the greatest predictor of sexual satisfaction.

Infidelity

Sexuality is important to society not only because of health implications; it also affects gender and property relations, reproduction potential, and economics. Physical, mental, social, and cultural factors affect health, especially sexual health. For instance, infidelity between couples often leads to hurt and divorce, and in Western countries, between 25% and 50% of divorcees cite a spouse's infidelity as the primary cause of divorce.

Sexual Dysfunction

Sexual dysfunction can pose public health problems, as it is related to public health issues and affects people's happiness and general well-being.

According to the National Health and Social Life Survey,

- The prevalence of sexual dysfunction was found to be higher among women than men.
- Lack of sexual desire is the most common problem among women
- For men, the most common sexual problem is premature ejaculation, not erectile dysfunction.
- Sexual problems increase with age, but sex-related personal distress decreases.

Sexual Frequency

Sexual frequency is important for sexual relationship satisfaction. Sexual intercourse frequency is noted as being the most important factor when predicting sexual satisfaction. Satisfaction declines with age but not as steeply as sexual frequency declines. However, although satisfaction is lower in women, satisfaction levels do not change over time among women, compared with men.

Sex and Health

Duration and age matter, but health matters most of all. Health proves to be a critical predictor of sexual satisfaction. Among those indicating their health is at least “very good,” more than half say they are satisfied with their sex lives. The majority of older Americans do not practice safe sex, even if they have multiple partners. It was reported that only 1 in 5 sexually active, dating singles use condoms regularly. Many older Americans report dating more than one person at a time and being sexually active with more than one sex partner (6% of men and 1% of women).

There are cultural differences that affect sexual and romantic happiness. Despite having a lower overall reported health rating, Hispanics report being happier with their sex lives compared with the general population. Sexuality was found to be a higher priority for older Hispanics, who report higher levels of sexual activity and satisfaction. Having a partner matters.

Sexual Happiness

The most important indicator of the sexual happiness of older Americans is having a steady sex partner. That indicator is less important than the frequency of sexual intercourse, good health, low levels of stress, and the absence of financial worries. There are still behavioral differences between older men and women, and older men and women continue to rank the importance of sex and the enjoyment of sex differently—even as they age. Older men continue to have more sex and think about sex more than older women; they see it as more important to their quality of life. Older men report having more frequent orgasms than women (2 out of 3 men, compared with 1 in 3 women), but their frequency of orgasm drops with age. Older men are twice as likely (21% compared with 11%) to admit sexual activity outside their relationship than women.

Sex Trafficking

Sex trafficking is a modern-day form of slavery in which a commercial sex act is induced by force, fraud, or coercion, or in which the person induced to perform such an act is under the age of 18 years. Enactment of the Trafficking Victims Protection Act of 2000 (TVPA) made sex trafficking a serious violation of Federal law. The TVPA also recognizes labor trafficking, which is discussed in a separate fact sheet.

As defined by the TVPA, the term ‘commercial sex act’ means any sex act on account of which anything of value is given to or received by any person.

The TVPA recognizes that traffickers use psychological and well as physical coercion and bondage, and it defines coercion to include: threats of serious harm to or physical restraint against any person; any scheme, plan, or pattern intended to cause a person to believe that failure to perform an act would result in serious harm to or physical restraint against any person; or the abuse or threatened abuse of the legal process.

Victims of Sex Trafficking and What They Face

Victims of sex trafficking can be women or men, girls or boys, but the majority are women and girls. There are a number of common patterns for luring victims into situations of sex trafficking, including:

- A promise of a good job in another country
- A false marriage proposal turned into a bondage situation
- Being sold into the sex trade by parents, husbands, boyfriends
- Being kidnapped by traffickers

Sex traffickers frequently subject their victims to debt-bondage, an illegal practice in which the traffickers tell their victims that they owe money (often relating to the victims’ living expenses and transport into the country) and that they must pledge their

personal services to repay the debt.

Sex traffickers use a variety of methods to “condition” their victims including starvation, confinement, beatings, physical abuse, rape, gang rape, threats of violence to the victims and the victims’ families, forced drug use and the threat of shaming their victims by revealing their activities to their family and their families’ friends.

Victims face numerous health risks. Physical risks include drug and alcohol addiction; physical injuries (broken bones, concussions, burns, vaginal/anal tearings); traumatic brain injury (TBI) resulting in memory loss, dizziness, headaches, numbness; sexually transmitted diseases (e.g., HIV/AIDS, gonorrhea, syphilis, UTIs, pubic lice); sterility, miscarriages, menstrual problems; other diseases (e.g., TB, hepatitis, malaria, pneumonia); and forced or coerced abortions.

Psychological harms include mind/body separation/disassociated ego states, shame, grief, fear, distrust, hatred of men, self-hatred, suicide, and suicidal thoughts. Victims are at risk for Posttraumatic Stress Disorder (PTSD)—acute anxiety, depression, insomnia, physical hyper-alertness, self-loathing that is long-lasting and resistant to change (complex-PTSD).

Victims may also suffer from traumatic bonding—a form of coercive control in which the perpetrator instills in the victim fear as well as gratitude for being allowed to live.

Types of Sex Trafficking

Victims of trafficking are forced into various forms of commercial sexual exploitation including prostitution, pornography, stripping, live-sex shows, mail-order brides, military prostitution and sex tourism.Victims trafficked into prostitution and pornography are usually involved in the most exploitive forms of commercial sex operations. Sex trafficking operations can be found in highly-visible venues such as street prostitution, as well as more underground systems such as closed-brothels that operate out of residential homes. Sex trafficking also takes place in a variety of public and private locations such as massage parlors, spas, strip clubs and other fronts for prostitution. Victims may start off dancing or stripping in clubs and then be coerced into situations of prostitution and pornography.

Learning Activity: Identifying and Interacting With Victims of Human Trafficking

Find out about how to identify and interact with victims of human trafficking.

- What would you do if you think you identified someone who might be a victim of human trafficking?

Sources

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8.11: Reproduction

Reproductive Health

Both the male and female reproductive systems play a role in pregnancy. Problems with these systems can affect fertility and the ability to have children. There are many such problems in men and women.

Reproductive health problems can also be harmful to overall health and impair a person's ability to enjoy a sexual relationship.

Your reproductive health is influenced by many factors. These include your age, lifestyle, habits, genetics, use of medicines and exposure to chemicals in the environment. Many problems of the reproductive system can be corrected.

What is reproductive health?

Reproductive health includes a variety of topics, such as:

- Menstruation and menopause
- Pregnancy and preconception care
- Fertility/Infertility
- Contraception

More information on some of these issues is provided below.

Menstrual Cycle

The menstrual cycle is the process by which a woman's body gets ready for the chance of a pregnancy each month. The average menstrual cycle is 28 days from the start of one to the start of the next, but it can range from 21 days to 35 days.

Most menstrual periods last from three to five days. In the United States, most girls start menstruating at age 12, but girls can start menstruating between the ages of 8 and 16.

Menstruation and the menstrual cycle fact sheet

Menstruation is a woman's monthly bleeding. When you menstruate, your body sheds the lining of the uterus (womb). Menstrual blood flows from the uterus through the small opening in the cervix and passes out of the body through the vagina (see how the menstrual cycle works below). Most menstrual periods last from 3 to 5 days.

What is the menstrual cycle?

When periods (menstruations) come regularly, this is called the menstrual cycle. Having regular menstrual cycles is a sign that important parts of your body are working normally. The menstrual cycle provides important body chemicals, called hormones, to keep you healthy. It also prepares your body for pregnancy each month. A cycle is counted from the first day of 1 period to the first day of the next period. The average menstrual cycle is 28 days long. Cycles can range anywhere from 21 to 35 days in adults and from 21 to 45 days in young teens.

What happens during the menstrual cycle?

In the first half of the cycle, levels of estrogen (the female hormone) start to rise. Estrogen plays an important role in keeping you healthy, especially by helping you to build strong bones and to help keep them strong as you get older. Estrogen also makes the lining of the uterus (womb) grow and thicken. This lining of the womb is a place that will nourish the embryo if a pregnancy occurs. At the same time the lining of the womb is growing, an egg, or ovum, in one of the ovaries starts to mature. At about day 14 of an average 28-day cycle, the egg leaves the ovary. This is called ovulation.

After the egg has left the ovary, it travels through the fallopian tube to the uterus. Hormone levels rise and help prepare the uterine lining for pregnancy. A woman is most likely to get pregnant during the 3 days before or on the day of ovulation. Keep in mind, women with cycles that are shorter or longer than average may ovulate before or after day 14.

A woman becomes pregnant if the egg is fertilized by a man's sperm cell and attaches to the uterine wall. If the egg is not fertilized, it will break apart. Then, hormone levels drop, and the thickened lining of the uterus is shed during the menstrual period.

The Menstrual Cycle

- **Day 1** starts with the first day of your period. This occurs after hormone levels drop at the end of the previous cycle, signaling blood and tissues lining the uterus (womb) to break down and shed from the body. Bleeding lasts about 5 days.
- Usually by **Day 7**, bleeding has stopped. Leading up to this time, hormones cause fluid-filled pockets called follicles to develop on the ovaries. Each follicle contains an egg.
- Between **Day 7 and 14**, one follicle will continue to develop and reach maturity. The lining of the uterus starts to thicken, waiting for a fertilized egg to implant there. The lining is rich in blood and nutrients.
- Around **Day 14** (in a 28-day cycle), hormones cause the mature follicle to burst and release an egg from the ovary, a process called ovulation.
- Over the next few days, the egg travels down the fallopian tube towards the uterus. If a sperm unites with the egg here, the fertilized egg will continue down the fallopian tube and attach to the lining of the uterus.
- If the egg is not fertilized, hormone levels will drop around **Day 25**. This signals the next menstrual cycle to begin. The egg will break apart and be shed with the next period.

What is a typical menstrual period like?

During your period, you shed the thickened uterine lining and extra blood through the vagina. Your period may not be the same every month. It may also be different than other women's periods. Periods can be light, moderate, or heavy in terms of how much blood comes out of the vagina. This is called menstrual flow. The length of the period also varies. Most periods last from 3 to 5 days. But, anywhere from 2 to 7 days is normal.

For the first few years after menstruation begins, longer cycles are common. A woman's cycle tends to shorten and become more regular with age. Most of the time, periods will be in the range of 21 to 35 days apart.

What kinds of problems do women have with their periods?

Women can have a range of problems with their periods, including pain, heavy bleeding, and skipped periods.
Amenorrhea—the lack of a menstrual period. This term is used to describe the absence of a period in:

- Young women who haven't started menstruating by age 15
- Women and girls who haven't had a period for 90 days, even if they haven't been menstruating for long

Causes can include:

- Pregnancy
- Breastfeeding
- Extreme weight loss
- Eating disorders
- Excessive exercising
- Stress
- Serious medical conditions in need of treatment

As above, when your menstrual cycles come regularly, this means that important parts of your body are working normally. In some cases, not having menstrual periods can mean that your ovaries have stopped producing normal amounts of estrogen. Missing these hormones can have important effects on your overall health. Hormonal problems, such as those caused by polycystic ovary syndrome (PCOS) or serious problems with the reproductive organs, may be involved. It's important to talk to a doctor if you have this problem.

Dysmenorrhea (dis-men-uh-REE-uh)—painful periods, including severe cramps. Menstrual cramps in teens are caused by too much of a chemical called prostaglandin (pros-tuh-GLAN-duhn). Most teens with dysmenorrhea do not have a serious disease, even though the cramps can be severe. In older women, the pain is sometimes caused by a disease or condition such as uterine fibroids or endometriosis.

For some women, using a heating pad or taking a warm bath helps ease their cramps. Some over-the-counter pain medicines can also help with these symptoms. They include:

- Ibuprofen (for instance, Advil, Motrin, Midol Cramp>
- Ketoprofen (for instance, Orudis KT)
- Naproxen (for instance, Aleve)

If these medicines don't relieve your pain or the pain interferes with work or school, you should see a doctor. Treatment depends on what's causing the problem and how severe it is. Report vaginal bleeding that's different from normal menstrual periods. It includes:

- Bleeding between periods
- Bleeding after sex
- Spotting anytime in the menstrual cycle
- Bleeding heavier or for more days than normal
- Bleeding after menopause

Abnormal bleeding can have many causes. Your doctor may start by checking for problems that are most common in your age group. Some of them are not serious and are easy to treat. Others can be more serious. Treatment for abnormal bleeding depends on the cause.

In both teens and women nearing menopause, hormonal changes can cause long periods along with irregular cycles. Even if the cause is hormonal changes, you may be able to get treatment. You should keep in mind that these changes can occur with other serious health problems, such as uterine fibroids, polyps, or even cancer. See your doctor if you have any abnormal bleeding.

When does a girl usually get her first period?

In the United States, the average age for a girl to get her first period is 12. This does not mean that all girls start at the same age. A girl can start her period anytime between the ages of 8 and 15. Most of the time, the first period starts about 2 years after breasts first start to develop. If a girl has not had her first period by age 15, or if it has been more than 2 to 3 years since breast growth started, she should see a doctor.

Menopause

Women usually have periods until menopause. Menopause occurs between the ages of 45 and 55, usually around age 50. Menopause means that a woman is no longer ovulating (producing eggs) or having periods and can no longer get pregnant. Like menstruation, menopause can vary from woman to woman and these changes may occur over several years.

The time when your body begins its move into menopause is called the menopausal transition. This can last anywhere from 2 to 8 years. Some women have early menopause because of surgery or other treatment, illness, or other reasons. If you don't have a period for 90 days, you should see your doctor. He or she will check for pregnancy, early menopause, or other health problems that can cause periods to stop or become irregular.

When to Consult a Doctor about Your Period

See your doctor about your period if:

- You have not started menstruating by the age of 15.
- You have not started menstruating within 3 years after breast growth began, or if breasts haven't started to grow by age 13.
- Your period suddenly stops for more than 90 days.
- Your periods become very irregular after having had regular, monthly cycles.
- Your period occurs more often than every 21 days or less often than every 35 days.

- You are bleeding for more than 7 days.
- You are bleeding more heavily than usual or using more than 1 pad or tampon every 1 to 2 hours.
- You bleed between periods.
- You have severe pain during your period.
- You suddenly get a fever and feel sick after using tampons.

You should change a pad before it becomes soaked with blood. Each woman decides for herself what works best. You should change a tampon at least every 4 to 8 hours. Make sure to use the lowest absorbency tampon needed for your flow. For example, use junior or regular tampons on the lightest day of your period. Using a super absorbency tampon on your lightest days increases your risk for toxic shock syndrome (TSS). TSS is a rare but sometimes deadly disease. TSS is caused by bacteria that can produce toxins. If your body can't fight the toxins, your immune (body defense) system reacts and causes the symptoms of TSS (see below).

Young women may be more likely to get TSS. Using any kind of tampon puts you at greater risk for TSS than using pads. The Food and Drug Administration (FDA) recommends the following tips to help avoid tampon problems:

- Follow package directions for insertion.
- Choose the lowest absorbency for your flow.
- Change your tampon at least every 4 to 8 hours.
- Consider switching between pads and tampons.
- Know the warning signs of TSS (see below).
- Don't use tampons between periods.

If you have any of these symptoms of TSS while using tampons, take the tampon out, and contact your doctor right away:

- Sudden high fever (over 102 degrees)
- Muscle aches
- Diarrhea
- Vomiting
- Dizziness and/or fainting
- Sunburn-like rash
- Sore throat
- Bloodshot eyes

Preconception Care

Why preconception health matters

Preconception health is a woman's health before she becomes pregnant. It means knowing how health conditions and risk factors could affect a woman or her unborn baby if she becomes pregnant. For example, some foods, habits, and medicines can harm your baby—even before he or she is conceived. Some health problems, such as diabetes, also can affect pregnancy.

Every woman should be thinking about her health whether or not she is planning pregnancy. One reason is that about half of all pregnancies are not planned. Unplanned pregnancies are at greater risk of preterm birth and low birth weight babies. Another reason is that, despite important advances in medicine and prenatal care, about 1 in 8 babies is born too early. Researchers are trying to find out why and how to prevent preterm birth. But experts agree that women need to be healthier before becoming pregnant. By taking action on health issues and risks before pregnancy, you can prevent problems that might affect you or your baby later.

Five most important things to boost your preconception health

Women and men should prepare for pregnancy before becoming sexually active—or at least three months before getting pregnant. Some actions, such as quitting smoking, reaching a healthy weight, or adjusting medicines you are using, should start even earlier.

The five most important things a woman can do for preconception health are:

1. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) of folic acid every day if you are planning or capable of pregnancy to lower your risk of some birth defects of the brain and spine, including spina bifida. All women need folic

acid every day. Talk to your doctor about your folic acid needs. Some doctors prescribe prenatal vitamins that contain higher amounts of folic acid.
2. Stop smoking and drinking alcohol.
3. If you have a medical condition, be sure it is under control. Some conditions that can affect pregnancy or be affected by it include asthma, diabetes, oral health, obesity, or epilepsy.
4. Talk to your doctor about any over-the-counter and prescription medicines you are using. These include dietary or herbal supplements. Be sure your vaccinations are up to date.
5. Avoid contact with toxic substances or materials that could cause infection at work and at home. Stay away from chemicals and cat or rodent feces.

Talk to your doctor before you become pregnant

Did you know?

It's best to be at a healthy weight when you become pregnant. Being overweight or underweight puts you at increased risk for problems during pregnancy. Learn how healthy food choices and physical fitness, together, can help you reach or maintain a healthy weight.

Preconception care can improve your chances of getting pregnant, having a healthy pregnancy, and having a healthy baby. If you are sexually active, talk to your doctor about your preconception health now.

Preconception care should begin at least three months before you get pregnant. But some women need more time to get their bodies ready for pregnancy. Be sure to discuss your partner's health too. Ask your doctor about:

- Family planning and birth control.
- Taking folic acid.
- Vaccines and screenings you may need, such as a Pap test and screenings for sexually transmitted infections (STIs), including HIV.
- Managing health problems, such as diabetes, high blood pressure, thyroid disease, obesity, depression, eating disorders, and asthma. Find out how pregnancy may affect, or be affected by, health problems you have.
- Medicines you use, including over-the-counter, herbal, and prescription drugs and supplements.
- Ways to improve your overall health, such as reaching a healthy weight, making healthy food choices, being physically active, caring for your teeth and gums, reducing stress, quitting smoking, and avoiding alcohol.
- How to avoid illness.
- Hazards in your workplace or home that could harm you or your baby.
- Health problems that run in your or your partner's family.
- Problems you have had with prior pregnancies, including preterm birth.
- Family concerns that could affect your health, such as domestic violence or lack of support.

Bring a list of talking points to be sure you don't forget anything. If you run out of time at your visit, schedule a follow-up visit to make sure everything is covered.

Your partner's role in preparing for pregnancy

Your partner can do a lot to support and encourage you in every aspect of preparing for pregnancy. Here are some ways:

- Make the decision about pregnancy together. When both partners intend for pregnancy, a woman is more likely to get early prenatal care and avoid risky behaviors such as smoking and drinking alcohol.
- Screening for and treating sexually transmitted infections (STIs) can help make sure infections are not passed to female partners.
- Male partners can improve their own reproductive health and overall health by limiting alcohol, quitting smoking or illegal drug use, making healthy food choices, and reducing stress. Studies show that men who drink a lot, smoke, or use drugs can have problems with their sperm. These might cause you to have problems getting pregnant. If your partner won't quit smoking, ask that he not smoke around you, to avoid harmful effects of secondhand smoke.
- Your partner should also talk to his doctor about his own health, his family health history, and any medicines he uses.
- People who work with chemicals or other toxins can be careful not to expose women to them. For example, people who work with fertilizers or pesticides should change out of dirty clothes before coming near women. They should handle and wash soiled clothes separately.

Genetic counseling

Did you know?

Some companies offer genetic tests that you can do yourself through the mail. These tests may not provide true or meaningful information. These tests might provide harmful information. Talk to your doctor before using this type of test.

The genes your baby is born with can affect your baby's health in these ways:

- Single gene disorders are caused by a problem in a single gene. Genes contain the information your body's cells need to function. Single gene disorders run in families. Examples of single gene disorders are cystic fibrosis and sickle cell anemia.
- Chromosome disorders occur when all or part of a chromosome is missing or extra, or if the structure of one or more chromosomes is not normal. Chromosomes are structures where genes are located. Most chromosome disorders that involve whole chromosomes do not run in families.

Talk to your doctor about your and your partner's family health histories before becoming pregnant. This information can help your doctor find out any genetic risks you might have.

Depending on your genetic risk factors, your doctor might suggest you meet with a genetic professional. Some reasons a person or couple might seek genetic counseling are:

- A family history of a genetic condition, birth defect, chromosomal disorder, or cancer
- Two or more pregnancy losses, a stillbirth, or a baby who died
- A child with a known inherited disorder, birth defect, or intellectual disability
- A woman who is pregnant or plans to become pregnant at 35 years or older
- Test results that suggest a genetic condition is present
- Increased risk of getting or passing on a genetic disorder because of one's ethnic background
- People related by blood who want to have children together

During a consultation, the genetics professional meets with a person or couple to discuss genetic risks or to diagnose, confirm, or rule out a genetic condition. Sometimes, a couple chooses to have genetic testing. Some tests can help couples to know the chances that a person will get or pass on a genetic disorder. The genetics professional can help couples decide if genetic testing is the right choice for them.

Learning Activity

Find out about direct-to-consumer genetic testing kits.

- Would you use a genetic test that you can do yourself through the mail? Why or why not?

What is pregnancy?

Pregnancy is the term used to describe when a woman has a growing fetus inside of her. In most cases, the fetus grows in the uterus.

Human pregnancy lasts about 40 weeks, or just more than 9 months, from the start of the last menstrual period to childbirth.

What are prenatal and preconception care and why are they important?

Prenatal care is the care woman gets during a pregnancy. Getting early and regular prenatal care is important for the health of both mother and the developing baby.

In addition, health care providers are now recommending a woman see a health care provider for preconception care, even before she considers becoming pregnant or in between pregnancies.

Knowing if you are pregnant

A missed period is often the first clue that a woman might be pregnant. Sometimes, a woman might suspect she is pregnant even sooner. Symptoms such as headache, fatigue, and breast tenderness, can occur even before a missed period. The wait to know can be emotional. These days, many women first use home pregnancy tests (HPT) to find out. Your doctor also can test you.

All pregnancy tests work by detecting a special hormone in the urine or blood that is only there when a woman is pregnant. It is called human chorionic gonadotropin (kohr-ee-ON-ihk goh-NAD-uh-TROH-puhn), or hCG. hCG is made when a fertilized egg implants in the uterus. hCG rapidly builds up in your body with each passing day you are pregnant. Read on to learn when and how to test for pregnancy.

Home pregnancy tests

Reading a home pregnancy test

HPTs are inexpensive, private, and easy to use. Most drugstores sell HPTs over the counter. The cost depends on the brand and how many tests come in the box. They work by detecting hCG in your urine. HPTs are highly accurate. But their accuracy depends on many things. These include:

- **When you use them—**The amount of hCG in your urine increases with time. So, the earlier after a missed period you take the test the harder it is to spot the hCG. Some HPTs claim that they can tell if you are pregnant one day after a missed period or even earlier. But a recent study shows that most HPTs don't give accurate results this early in pregnancy. Positive results are more likely to be true than negative results. Waiting one week after a missed period will usually give a more accurate result. You can take the test sooner. But just know that a lot of pregnant women will get negative test results during the first few days after the missed period. It's a good idea to repeat the test again after a week has passed. If you get two negative results but still think you're pregnant, call your doctor.
- **How you use them—**Be sure to check the expiration date and follow the directions. Many involve holding a test stick in the urine stream. For some, you collect urine in a cup and then dip the test stick into it. Then, depending on the brand, you will wait a few minutes to get the results. Research suggests waiting 10 minutes will give the most accurate result. Also, testing your urine first thing in the morning may boost the accuracy. You will be looking for a plus sign, a change in color, or a line. A change, whether bold or faint, means the result is positive. New digital tests show the words "pregnant" or "not pregnant." Most tests also have a "control indicator" in the results window. This line or symbol shows whether or not the test is working. If the control indicator does not appear, the test is not working properly. You should not rely on any results from a HPT that may be faulty.
- **Who uses them—**The amount of hCG in the urine is different for every pregnant woman. So, some women will have accurate results on the day of the missed period while others will need to wait longer. Also, some medicines affect HPTs. Discuss the medicines you use with your doctor before trying to become pregnant.
- **The brand of test—**Some HPT tests are better than others at spotting hCG early on.

The most important part of using any HPT is to follow the directions exactly as written. Most tests also have toll-free phone numbers to call in case of questions about use or results.

If a HPT says you are pregnant, you should call your doctor right away. Your doctor can use a more sensitive test along with a pelvic exam to tell for sure if you're pregnant. Seeing your doctor early on in your pregnancy can help you and your baby stay healthy.

Unplanned Pregnancy

Unplanned pregnancy is common. About 1 in 2 pregnancies in America are unplanned. Ideally, a woman who is surprised by an unplanned pregnancy is in good preconception health and is ready and able to care for a new child. But this sometimes isn't the case.

If you have an unplanned pregnancy, you might not know what to do next. You might worry that the father won't welcome the news. You might not be sure you can afford to care for a baby. You might worry if past choices you have made, such as drinking or drug use, will affect your unborn baby's health. You might be concerned that having a baby will keep you from finishing school or pursuing a career.

If you are pregnant after being raped, you might feel ashamed, numb, or afraid. Unplanned pregnancy is common among abused women. Research has found that some abusers force their partners to have sex without birth control and/or sabotage the birth control their partners are using, leading to unplanned pregnancy.

You might wonder what options you have. Here are some next steps to help you move forward:

- Start taking care of yourself right away. Take 400 to 800 micrograms (400 to 800 mcg or 0.4 to 0.8 mg) folic acid every. Stop alcohol, tobacco, and drug use.
- Make a doctor's visit to confirm your pregnancy. Discuss your health and issues that could affect your pregnancy. Ask for help quitting smoking. Find out what you can do to take care of yourself and your unborn baby.
- Ask your doctor to recommend a counselor who you can talk to about your situation.
- Seek support in someone you trust and respect.

Trying to Get Pregnant

How do you figure out when you're fertile and when you're not? Wondering if you or your partner is infertile? Read on to boost your chances of conception and get help for fertility problems.

Fertility awareness

The menstrual cycle

Being aware of your menstrual cycle and the changes in your body that happen during this time can help you know when you are most likely to get pregnant.

The average menstrual cycle lasts 28 days. But normal cycles can vary from 21 to 35 days. The amount of time before ovulation occurs is different in every woman and even can be different from month to month in the same woman, varying from 13 to 20 days long. Learning about this part of the cycle is important because it is when ovulation and pregnancy can occur. After ovulation, every woman (unless she has a health problem that affects her periods or becomes pregnant) will have a period within 14 to 16 days.

Charting your fertility pattern

Knowing when you're most fertile will help you plan pregnancy. There are three ways you can keep track of your fertile times. They are:

1. **Basal body temperature method**—Basal body temperature is your temperature at rest as soon as you awake in the morning. A woman's basal body temperature rises slightly with ovulation. So by recording this temperature daily for several months, you'll be able to predict your most fertile days.

Basal body temperature differs slightly from woman to woman. Anywhere from 96 to 98 degrees Fahrenheit orally is average before ovulation. After ovulation most women have an oral temperature between 97 and 99 degrees Fahrenheit. The rise in temperature can be a sudden jump or a gradual climb over a few days.

Usually a woman's basal body temperature rises by only 0.4 to 0.8 degrees Fahrenheit. To detect this tiny change, women must use a basal body thermometer. These thermometers are very sensitive. Most pharmacies sell them for about $10. You can then record your temperature on our special Basal Body Temperature Chart.

The rise in temperature doesn't show exactly when the egg is released. But almost all women have ovulated within three days after their temperatures spike. Body temperature stays at the higher level until the woman's period starts.

A woman is most fertile and most likely to get pregnant:

- Two to three days before your temperature hits the highest point (ovulation)
- 12 to 24 hours after ovulation

A man's sperm can live for up to three days in a woman's body. The sperm can fertilize an egg at any point during that time. So if you have unprotected sex a few days before ovulation, you could get pregnant.

Many things can affect basal body temperature. For your chart to be useful, make sure to take your temperature every morning at about the same time. Things that can alter your temperature include:

- Drinking alcohol the night before
- Smoking cigarettes the night before
- Getting a poor night's sleep
- Having a fever
- Doing anything in the morning before you take your temperature—including going to the bathroom and talking on the phone

2. **Calendar method**—This involves recording your menstrual cycle on a calendar for eight to 12 months. The first day of your period is Day 1. Circle Day 1 on the calendar. The length of your cycle may vary from month to month. So write down the total number of days it lasts each time. Using this record, you can find the days you are most fertile in the months ahead:
    - To find out the first day when you are most fertile, subtract 18 from the total number of days in your shortest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The X marks the first day you're likely to be fertile.
    - To find out the last day when you are most fertile, subtract 11 from the total number of days in your longest cycle. Take this new number and count ahead that many days from the first day of your next period. Draw an X through this date on your calendar. The time between the two Xs is your most fertile window.

    This method always should be used along with other fertility awareness methods, especially if your cycles are not always the same length.

Optional Learning Activity

Use this Ovulation and due date calculator to find out when you (or a woman you know) are most likely to become pregnant and to estimate your due date should conception occur.

Did you know?

The cervical mucus method is less reliable for some women. Women who are breastfeeding, taking hormonal birth control (like the pill), using feminine hygiene products, have vaginitis or sexually transmitted infections (STIs), or have had surgery on the cervix should not rely on this method.

3. **Cervical mucus method** (also known as the ovulation method)—This involves being aware of the changes in your cervical mucus throughout the month. The hormones that control the menstrual cycle also change the kind and amount of mucus you have before and during ovulation. Right after your period, there are usually a few days when there is no mucus present or "dry days." As the egg starts to mature, mucus increases in the vagina, appears at the vaginal opening, and is white or yellow and cloudy and sticky. The greatest amount of mucus appears just before ovulation. During these "wet days" it becomes clear and slippery, like raw egg whites. Sometimes it can be stretched apart. This is when you are most fertile. About four days after the wet days begin the mucus changes again. There will be much less and it becomes sticky and cloudy. You might have a few more dry days before your period returns. Describe changes in your mucus on a calendar. Label the days, "Sticky," "Dry," or "Wet." You are most fertile at the first sign of wetness after your period or a day or two before wetness begins.To most accurately track your fertility, use a combination of all three methods. This is called the symptothermal method. You can also purchase over-the-counter ovulation kits or fertility monitors to help find the best time to conceive. These kits work by detecting surges in a specific hormone called luteinizing hormone, which triggers ovulation.

Infertility

Some women want children but either cannot conceive or keep miscarrying. This is called *infertility*. Lots of couples have infertility problems. About one-third of the time, it is a female problem. In another one-third of cases, it is the man with the fertility problem. For the remaining one-third, both partners have fertility challenges or no cause is found.

Causes of infertility

Some common reasons for infertility in women include:

Age—Women generally have some decrease in fertility starting in their early 30s. And while many women in their 30s and 40s have no problems getting pregnant, fertility especially declines after age 35. As a woman ages, normal changes that occur in her ovaries and eggs make it harder to become pregnant. Even though menstrual cycles continue to be regular in a woman's 30s and 40s, the eggs that ovulate each month are of poorer quality than those from her 20s. It is harder to get pregnant when the eggs are poorer in quality. As a woman nears menopause, the ovaries may not release an egg each month, which also can make it harder to get pregnant. Also, as a woman and her eggs age, she is more likely to miscarry, as well as have a baby with genetic problems, such as Down syndrome.

Health problems—Some women have diseases or conditions that affect their hormone levels, which can cause infertility. Women with polycystic ovary syndrome (PCOS) rarely or never ovulate. Failure to ovulate is the most common cause of infertility in women.

- With primary ovarian insufficiency (POI), a woman's ovaries stop working normally before she is 40. It is not the same as early menopause. Some women with POI get a period now and then. But getting pregnant is hard for women with POI.
- A condition called luteal phase defect (LPD) is a failure of the uterine lining to be fully prepared for pregnancy. This can keep a fertilized egg from implanting or result in miscarriage.

Common problems with a woman's reproductive organs, like uterine fibroids, endometriosis, and pelvic inflammatory disease can worsen with age and also affect fertility. These conditions might cause the fallopian tubes to be blocked, so the egg can't travel through the tubes into the uterus.

Lifestyle factors—Certain lifestyle factors also can have a negative effect on a woman's fertility. Examples include smoking, alcohol use, weighing much more or much less than an ideal body weight, a lot of strenuous exercise, and having an eating disorder. Stress also can affect fertility.

Unlike women, some men remain fertile into their 60s and 70s. But as men age, they might begin to have problems with the shape and movement of their sperm. They also have a slightly higher risk of sperm gene defects. Or they might produce no sperm, or too few sperm. Lifestyle choices also can affect the number and quality of a man's sperm. Alcohol and drugs can temporarily reduce sperm quality. And researchers are looking at whether environmental toxins, such as pesticides and lead, also may be to blame for some cases of infertility. Men also can have health problems that affect their sexual and reproductive function. These can include sexually transmitted infections (STIs), diabetes, surgery on the prostate gland, or a severe testicle injury or problem.

When to see your doctor

You should talk to your doctor about your fertility if:

- You are younger than 35 and have not been able to conceive after one year of frequent sex without birth control.
- You are age 35 or older and have not been able to conceive after six months of frequent sex without birth control.
- You believe you or your partner might have fertility problems in the future (even before you begin trying to get pregnant).
- You or your partner has a problem with sexual function or libido.

Happily, doctors are able to help many infertile couples go on to have babies.

If you are having fertility issues, your doctor can refer you to a fertility specialist, a doctor who treats infertility. The doctor will need to test both you and your partner to find out what the problem is. Depending on the problem, your doctor might recommend treatment. About 9 in 10 cases of infertility are treated with drugs or surgery. *Don't delay seeing your doctor as age also affects the success rates of these treatments.* For some couples, adoption or foster care offers a way to share their love with a child and to build a family.

Infertility treatment

Some treatments include:

- **Drugs**—Various fertility drugs may be used for women with ovulation problems. It is important to talk with your doctor about the drug to be used. You should understand the drug's benefits and side effects. Depending on the type of fertility drug and

the dosage of the drug used, multiple births (such as twins) can occur.
- **Surgery**—Surgery is done to repair damage to a woman's ovaries, fallopian tubes, or uterus. Sometimes a man has an infertility problem that can be corrected by surgery.
- **Intrauterine insemination (IUI), also called artificial insemination**—Male sperm is injected into part of the woman's reproductive tract, such as into the uterus or fallopian tube. IUI often is used along with drugs that cause a woman to ovulate.
- **Assisted reproductive technology (ART)**—ART involves stimulating a woman's ovaries; removing eggs from her body; mixing them with sperm in the laboratory; and putting the embryos back into a woman's body. Success rates of ART vary and depend on many factors.
- **Third party assistance**—Options include donor eggs (eggs from another woman are used), donor sperm (sperm from another man are used), or surrogacy (when another woman carries a baby for you).

Finding the cause of infertility is often a long, complex, and emotional process. And treatment can be expensive. Many health insurance companies do not provide coverage for infertility or provide only limited coverage. Check your health insurance contract carefully to learn about what is covered. Some states have laws that mandate health insurance policies to provide infertility coverage.

Birth Control Methods

Birth Control Methods: Reversible and Permanent

In the United States, **almost half of all pregnancies are unintended**. Yet, several safe and highly effective methods of contraception (birth control) are available to prevent unintended pregnancy. Since 2000, several new methods of birth control have become available in the United States, including

- the levonorgestrel-releasing intrauterine system,
- the hormonal contraceptive patch,
- the hormonal contraceptive ring,
- the hormonal implant, a 91-day regimen of oral contraceptives, two new barrier methods, and
- a new form of female sterilization.

Most women of reproductive age in the United States use birth control. Between 2006–2008, 99% of women who had ever had sexual intercourse had used at least one method of birth control; however, 7.3% of women who were currently at risk of unintended pregnancy were not using a contraceptive method. The **most popular method of birth control was the oral contraceptive pill**, used by 10.7 million women in the United States, followed by female sterilization, condoms, male sterilization, and other methods of birth control. Approximately **10% of women had ever used emergency contraception**.

Types of Birth Control

The effectiveness of birth control methods is critically important for reducing the risk of unintended pregnancy. Intrauterine contraception and the contraceptive implant remain effective for years once correctly in place. The effectiveness of hormonal, barrier, and fertility awareness-based methods depends on correct and consistent use. For each of these methods, a range of effectiveness estimates is provided; lower estimates are based on typical use and higher estimates are based on perfect use.

Reversible Methods of Birth Control

Intrauterine Contraception* Copper T intrauterine device (IUD) —An IUD is a small device that is shaped in the form of a "T." Your doctor places it inside the uterus to prevent pregnancy. It can stay in your uterus for up to 10 years. This IUD is more than 99% effective at preventing pregnancy.

- **Levonorgestrel intrauterine system (IUS)**—The IUS is a small T-shaped device like the IUD. It is placed inside the uterus by a doctor. It releases a small amount of progestin each day to keep you from getting pregnant. The IUS stays in your uterus for up to 5 years. The IUS is more than 99% effective at preventing pregnancy.

Hormonal Methods

- **Implant**—The implant is a single, thin rod that is inserted under the skin of a women's upper arm. The rod contains a progestin that is released into the body over 3 years. It is 99% effective at preventing pregnancy.
- **Injection or "shot"**—Women get shots of the hormone progestin in the buttocks or arm every three months from their doctor. It is 94–99% effective at preventing pregnancy.**Combined oral contraceptives**—Also called "the pill,"combined oral contraceptives contain the hormones estrogen and progestin. It is prescribed by a doctor. A pill is taken at the same time each day. If you are older than 35 years and smoke, have a history of blood clots or breast cancer, your doctor may advise you not to take the pill. The pill is 91–99% effective at preventing pregnancy.
- **Progestin only pill**—Unlike the combined pill, the progestin-only pill (sometimes called the mini-pill) only has one hormone, progestin, instead of both estrogen and progestin. It is prescribed by a doctor. It is taken at the same time each day. It is a good option for women who can't take estrogen. They are 91–99% effective at preventing pregnancy.**Patch**—This skin patch is worn on the lower abdomen, buttocks, or upper body (but not on the breasts). This method is prescribed by a doctor. It releases hormones progestin and estrogen into the bloodstream. You put on a new patch once a week for three weeks. During the fourth week, you do not wear a patch, so you can have a menstrual period. The patch is 91–99% effective at preventing pregnancy, but it appears to be less effective in women who weigh more than 198 pounds.
- **Hormonal vaginal contraceptive ring**—The ring releases the hormones progestin and estrogen. You place the ring inside your vagina. You wear the ring for three weeks, take it out for the week you have your period, and then put in a new ring. It is 91–99% effective at preventing pregnancy.
- **Emergency contraception**—Emergency contraception is NOT a regular method of birth control. Emergency contraception can be used after no birth control was used during sex, or if the birth control method failed, such as if a condom broke.
    - Women can take emergency contraceptive pills up to 5 days after unprotected sex, but the sooner the pills are taken, the better they will work. There are three different types of emergency contraceptive pills available in the United States. Some emergency contraceptive pills are available over the counter for women 17 years of age or older. If younger than 17 years, emergency contraceptive pills are available by prescription.
    - Another type of emergency contraception is having your doctor insert the Copper T IUD into your uterus within seven days of unprotected sex. This method is 99% effective at preventing pregnancy.

Barrier Methods

- **Male condom**—Worn by the man, a male condom keeps sperm from getting into a woman's body. Latex condoms, the most common type, help prevent pregnancy and HIV and other STDs as do the newer synthetic condoms. "Natural" or "lambskin" condoms also help prevent pregnancy, but may not provide protection against STDs, including HIV. Male condoms are 82–98% effective at preventing pregnancy. Condoms can only be used once. You can buy condoms, KY jelly, or water-based lubricants at a drug store. Do not use oil-based lubricants such as massage oils, baby oil, lotions, or petroleum jelly with latex condoms. They will weaken the condom, causing it to tear or break.
- **Female condom**—Worn by the woman, the female condom helps keeps sperm from getting into her body. It is packaged with a lubricant and is available at drug stores. It can be inserted up to eight hours before sexual intercourse. Female condoms are 79–95% effective at preventing pregnancy, and also may help prevent STDs.
- **Diaphragm or cervical cap**—Each of these barrier methods are placed inside the vagina to cover the cervix to block sperm. The diaphragm is shaped like a shallow cup. The cervical cap is a thimble-shaped cup.Before sexual intercourse, you insert them with spermicide to block or kill sperm. The diaphragm is 84–94% effective at preventing pregnancy. Visit your doctor for a proper fitting because diaphragms and cervical caps come in different sizes
- **Spermicides**—These products work by killing sperm and come in several forms—foam, gel, cream, film, suppository, or tablet. They are placed in the vagina no more than one hour before intercourse. You leave them in place at least six to eight hours after intercourse. You can use a spermicide in addition to a male condom, diaphragm, or cervical cap. Spermicides alone are about 72–82% effective at preventing pregnancy. They can be purchased at drug stores.

Fertility Awareness-Based Methods

- **Natural family planning or fertility awareness**—Understanding your monthly fertility pattern can help you plan to get pregnant or avoid getting pregnant. Your fertility pattern is the number of days in the month when you are fertile (able to get pregnant), days when you are infertile, and days when fertility is unlikely, but possible. If you have a regular menstrual cycle, you have about nine or more fertile days each month. If you do not want to get pregnant, you do not have sex on the days you are fertile, or you use a barrier method of birth control on those days. These fertility awareness-based methods are 75–96% effective at preventing pregnancy.

Permanent Methods of Birth Control

Contraceptive sterilization is a permanent, safe, and highly effective approach for birth control. These methods are meant for people who are sure that they do not desire a pregnancy in the future.

The following methods are more than 99% effective at preventing pregnancy.

- **Female Sterilization—Tubal ligation or "tying tubes"**—A woman can have her fallopian tubes tied (or closed) so that sperm and eggs cannot meet for fertilization. The procedure can be done in a hospital or in an outpatient surgical center. You can go home the same day of the surgery and resume your normal activities within a few days. This method is effective immediately.
- **Transcervical Sterilization**— A thin tube is used to thread a tiny device into each fallopian tube. It irritates the fallopian tubes and causes scar tissue to grow and permanently plug the tubes. It can take about three months for the scar tissue to grow, so use another form of birth control during this time. Return to your doctor for a test to see if scar tissue has fully blocked your fallopian tubes.
- **Male Sterilization–Vasectomy**—This operation is done to keep a man's sperm from going to his penis, so his ejaculate never has any sperm in it that can fertilize an egg. The procedure is done at an outpatient surgical center. The man can go home the same day. Recovery time is less than one week. After the operation, a man visits his doctor for tests to count his sperm and to make sure the sperm count has dropped to zero; this takes about 12 weeks. Another form of birth control should be used until the man's sperm count has dropped to zero.

Although most women and men who undergo contraceptive sterilization do not regret having had the procedure, the permanence of the method is an important consideration, as regret has been documented in studies. For example, the U.S. Collaborative Review of Sterilization (CREST) study found that women who were younger at the time of the procedure were more likely to experience regret.

An additional issue addressed by the CREST study was the question of whether women who underwent contraceptive sterilization developed a "post-tubal ligation syndrome" of menstrual abnormalities, something that had been debated for years. Results indicated that menstrual abnormalities were no more common among women who had undergone tubal sterilization than among women who had not.

When considering a vasectomy, it's important to understand that failures can occur. CDC research has estimated there is a probability of 11 failures per 1,000 procedures over 2 years; half of the failures occurred in the first three months after the vasectomy, and no failures occurred after 72 weeks. CDC research also examined regret among women whose partner underwent a vasectomy. In interviews with female partners of men who received vasectomies, CDC found that while most women did not regret their husband's vasectomies, the probability of regret over 5 years was about 6%. This is why it is important to know facts about this and other permanent forms of birth control before making a decision.

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9: CONTRACEPTION AND ABORTION

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9.1: Contraception and Abortion

As you have learned, passion is one of the three components of love, as defined by Sternberg, and relates to physical attraction and sexual desire. When entering into a sexual relationship, it is important to understand the various ways you can protect yourself from unwanted pregnancy and sexually transmitted diseases (STD's); although all contraceptive methods are intended to reduce unwanted pregnancy, not all of them also protect against STD's. There are many forms of contraception to choose from whether it is meant to be permanent or temporary (reversible) and whether it prevents pregnancy by either adjusting hormones, placing a barrier between the sperm and egg, or abstaining during ovulation. How effective each method is at preventing pregnancy is impacted by how the couple uses the method. If a person uses the method perfectly, called **Perfect Use Effectiveness**, it will have a higher effectiveness than those who are considered typical users, called **Typical Use Effectiveness**. The only contraceptive method that is 100% effective is abstinence. Pregnancy is a possibility even if you are perfectly using contraceptive methods with high effectiveness. Unwanted pregnancies can be terminated through abortion.

Contraceptive Methods

It is important for sexual partners to discuss contraceptive options, asking question such as:

- Does either partner have allergies, such as a latex allergy?
- Are the partners concerned about transmission of sexually transmitted diseases?
- Can the female take hormonal birth control or are they contraindicated for them?
- Will it be challenging for the female to take a pill every day at the same time?
- Does either partner have religious beliefs that impact the use of contraception?

The answers to your questions may help in deciding which option to choose.

For example, couples who are concerned about STD's need to choose contraceptive options that reduce the transmission of STD's which means choosing to use either a male condom or female condom. Male condoms are much cheaper and easier to find than female condoms. It is important to understand that surgical, hormonal, or natural birth control options do not protect against STD's. Couples who are in a long term committed relationship and are not concerned about STD's and would like a long term contraceptive might choose a permanent surgical option or a long term option like an Intrauterine Device (IUD). Couples who have a latex allergy and still want to use condoms can choose lambskin or polyurethane condoms instead of the more commonly used latex condoms. Couples who are very concerned about unwanted pregnancies will want to choose a method with the highest effectiveness rate and ensure they use the method as perfectly as possible, they may also want to combine methods such as using birth control pills and condoms.

When choosing a contraceptive method it is important to understand the difference between surgical, hormonal, barrier, or fertility awareness methods.

- Surgical method (permanent option)
  - Permanent methods of birth control that are also referred to as sterilization. These methods are for those who are sure that they do not want to conceive a child. Women choosing a permanent method can have their fallopian tubes tied or closed off, called a tubal ligation, or they can choose to have a small tube inserted into the fallopian tubes, called transcervical sterilization, which irritates the fallopian tubes causing scar tissue to form and close off the tubes. Men commonly get a vasectomy which is an outpatient procedure in which the tube that carries sperm is cut.
- Hormonal method (reversible)
  - When a woman is pregnant they no longer release an egg each month and if there is no egg released, they cannot become pregnant. Hormonal methods reduce the chance of pregnancy by providing hormones to the woman that tricks the woman's body into thinking they are pregnant, thus the egg is not released each month.
- Barrier method (reversible)
  - In order for pregnancy to occur the egg from a woman and the sperm from a man must meet. If the sperm fertilizes the egg then conception, or pregnancy, occurs. Barrier methods of birth control work by creating a barrier in which the egg and sperm cannot meet.
- FAM: Fertility Awareness Method (reversible)
  - In order for pregnancy to occur, the sperm from the male must meet the egg from the female. The egg from the female is typically released only one time per month, called ovulation, so the sperm has a limited time window to meet the egg.

The FAM is based on avoiding sexual intercourse when it is most likely that the sperm and egg can meet. FAM must also take into consideration that sperm can live in a woman's body up to 5 days.

Table 9.1.3 : Type, Effectiveness, Risk, and Use of Common Contraceptive Methods

Name(s)	Type	Percentage of unwanted pregnancy within first year of typical use	Protect against STD's?	Side effects and risks* *These are not all of the possible side effects and risks. Talk to your doctor or nurse for more information.	How often you have to take or use
Abstinence (no sexual contact)	Natural-reversible	Unknown (0 for perfect use)	Yes	No medical side effects	No action required, but it does take willpower. You may want to have a back-up birth control method, such as condoms.
Female sterilization (tubal ligation, "getting your tubes tied")	Surgical-permanent	Less than 1%	No	Pain, bleeding, risk of infection	Surgery completed one time. No action required after surgery
Male sterilization (vasectomy)	Surgical-permanent	Less than 1%	No	Pain, bleeding, risk of infection	Surgery completed one time. No action required after surgery
Implantable rod (Implanon®, Nexplanon®)	Hormonal-reversible	Less than 1%	No	Headache, irregular periods, weight gain, sore breasts. Less common risk includes difficulty in removing the implant	No action required for up to 3 years before removing or replacing
Copper intrauterine device (IUD) (ParaGard®)	Nonhormonal-reversible	Less than 1%	No	Cramps for a few days after insertion. Missed periods, bleeding between periods, heavier periods. Less common but serious risks include pelvic inflammatory disease and the IUD being expelled from the uterus or going through the wall of the uterus.	No action required for up to 10 years before removing or replacing
Hormonal intrauterine devices (IUDs) (Liletta, Mirena®, and Skyla®)	Hormonal-reversible	Less than 1%	No	Irregular periods, lighter or missed periods. Ovarian cysts. Less common but serious risks include pelvic inflammatory disease and the IUD being expelled from the uterus or going through the wall of the uterus.	No action required for 3 to 5 years, depending on the brand, before removing or replacing
Shot/injection (Depo-Provera®)	Hormonal-reversible	4-6%	No	Bleeding between periods, missed periods Weight gain Changes in mood Sore breasts Headaches Bone loss with long-term use (bone loss may be reversible once you stop using this type of birth control)	Get a new shot every 3 months

Name(s)	Type	Percentage of unwanted pregnancy within first year of typical use	Protect against STD's?	Side effects and risks* *These are not all of the possible side effects and risks. Talk to your doctor or nurse for more information.	How often you have to take or use
Oral contraceptives, combination hormones ("the pill" or "mini-pill))	Hormonal-reversible	7-9%	No	Headache, nasuea, sore breasts, changes in your period, changes in mood, weight gain, high blood pressure. Less common but serious risks include blood clots, stroke and heart attack; the risk is higher in smokers and women older than 35	Take at the same time every day
Skin patch (Xulane®)	Hormonal-reversible	7-9% May be less effective in women weighing 198 pounds or more	No	Skin irritation, headache, nasuea, sore breasts, changes in your period, changes in mood, weight gain, high blood pressure. Less common but serious risks include blood clots, stroke and heart attack; the risk is higher in smokers and women older than 35	Apply to skin for 21 days, remove for 7 days, replace with a new patch
Vaginal ring (NuvaRing®)	Hormonal-reversible	7-9%	No	Vaginal irritation and discharge, headache, nasuea, sore breasts, changes in your period, changes in mood, weight gain, high blood pressure. Less common but serious risks include blood clots, stroke and heart attack; the risk is higher in smokers and women older than 35	Insert into the vagina for 21 days, remove for 7 days, replace with a new ring
Diaphragm with spermicide (Koromex®, Ortho-Diaphragm®)	Barrier-reversible	12%	No	Irritation, allergic reactions, urinary tract infection (UTI), vaginal infections. Rarely, toxic shock if left in for more than 24 hours. Using a spermicide often might increase your risk of getting HIV.	Insert into vagina before sexual intercourse. Remove after intercourse. Get refitted if you gain or lose weight or give birth
Sponge with spermicide (Today Sponge®)	Barrier-reversible	12-27% 12% for those who haven't had a child, 27% for those who have given birth	No	Irritation, allergic reactions, urinary tract infection (UTI), vaginal infections. Rarely, toxic shock if left in for more than 24 hours. Using a spermicide often might increase your risk of getting HIV.	Insert into vagina before sexual intercourse. Remove after intercourse.
Cervical cap with spermicide (FemCap®)	Barrier-reversible	17-29%	No	Irritation, allergic reactions, urinary tract infection (UTI), vaginal infections. Rarely, toxic shock if left in for more than 24 hours. Using a spermicide often might increase your risk of getting HIV.	Insert into vagina before sexual intercourse. Remove after intercourse (up to 2 days after).

Name(s)	Type	Percentage of unwanted pregnancy within first year of typical use	Protect against STD's?	Side effects and risks* *These are not all of the possible side effects and risks. Talk to your doctor or nurse for more information.	How often you have to take or use
Male condom	Barrier-reversible	13-18%	Yes	Condom may tear, break or slip off. Irritation or allergic reactions to latex condoms	Put on penis before sexual intercourse. Use each time you have sex. Never use a male and female condom together.
Female condom ("internal condom")	Barrier-reversible	21	Yes	Condom may tear or slip out. Irritation or allergic reactions could occur.	Insert into vagina or anus before sexual intercourse. Use each time you have sex. Never use a male and female condom together.
Withdrawal — when a man takes his penis out of a woman's vagina (or "pulls out") before he ejaculates (has an orgasm or "comes")	Natural-reversible	22	No	Sperm can be released before the man pulls out, putting you at risk for pregnancy.	Use each time you have sex
Fertility Awareness Method: Calendar, temperature, or rhythm method	Natural-reversible	24	No	Can be hard to know the days you are most fertile (when you need to avoid having sex or use back-up birth control)	Depending on method used, takes planning each month
Spermicide alone	Barrier-reversible	28 Works best if used along with a barrier method, such as a diaphragm	No	Irritation, allergic reactions, urinary tract infection (UTI), vaginal infections. Using a spermicide often might increase your risk of getting HIV.	Use each time you have sex

Abortion and Roe v. Wade

"Jane Roe," a woman who wanted to safely and legally end her pregnancy, challenged a Texas statute that made it a crime to perform an abortion unless the woman's life was in danger. In the ruling, the U.S. Supreme Court recognized for the first time that the constitutional right to privacy "is broad enough to encompass a woman's decision whether or not to terminate her pregnancy" (Roe v. Wade, 1973). Roe v. Wade has come to be known as the case that legalized abortion nationwide. On June 24, 2022, after upholding this constitutional right for nearly 50 years, the U.S. Supreme Court ruled that "the Constitution does not confer a right to abortion," thus voted to reverse their decision, leaving the ability to have an abortion to state law. It is estimated that about half of the states in America will either completely ban, or severely reduce, access to a legal and safe abortion.

There is no way to know how many women died receiving illegal abortions prior to the legalization of abortion in 1973. However, since the early 20th century, researchers, scientists, and doctors have attempted to estimate the number of illegal abortions performed and the corresponding death rate. Some estimates state that it could have been as low as 200,000 illegal abortions to 1.2 million illegal abortions performed each year causing as many as 5,000 to 10,000 annual deaths.

Although we do not know exactly how many deaths occured prior to the legalization of abortion in 1973, we do know that after 1973 when abortions were legal they were very safe causing less than 1 death per 100,000 people. Legal abortions are so safe that in 2018 there were only two deaths total from complications of an abortion. Thus, the death rate before 1973 and after were very likely dramatically different. The rate of complication for abortion is less than childbirth itself, and even lower than wisdom teeth removal.

Legal abortions in the U.S. are not only safe, but also very common. In the US, in 2019, there were 195 abortions per 1,000 live births, meaning about one out of every five pregnancies was terminated through abortion[7]. In 2019, the majority of abortions occurred early in gestation (≤9 weeks), when the risks for complications are lowest. In addition, over the past 10 years, the number of abortions performed ≤9 weeks' gestation increased from 74.8% in 2010 to 77.4% in 2019. Abortion can be completed with medication or by a procedure which is often called surgical abortion or aspiration abortion.

A committee of the National Academies of Sciences, Engineering, and Medicine reviewed the data available and confirmed in their report in 2018 that all forms of abortion including medication and aspiration abortion are safe and effective and that the only factors decreasing safety are those decreasing access[8][9]. A medication abortion can be completed at home, is non-invasive, and can be done up to 11 weeks, whereas an aspiration abortion is performed in a hospital or clinic and can be done up to 16 weeks.

It will be years before data is available to understand how the U.S. Supreme Court's decision to overturn the constitutional right to an abortion may impact women's health across the U.S., especially on a state-by-state basis where access may lead to health disparities.

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9.2: Contraception

> In 2008, there were 6.4 million pregnancies to the 62 million women of reproductive age (15–44) in the United States. Sixty-six percent of these pregnancies resulted in live births and 19% in induced abortions. And, nearly half of pregnancies among American women—more than three million each year—are unintended.
>
> —Guttmacher Institute

Unintended Pregnancy

An unintended pregnancy is a pregnancy that is either mistimed or unwanted at the time of conception. It is a core concept in understanding the fertility of populations and the unmet need for contraception. Unintended pregnancy is associated with an increased risk of morbidity for women, and with health behaviors during pregnancy that are associated with adverse effects. For example, women with an unintended pregnancy may delay prenatal care, which may affect the health of the infant. Women of all ages may have unintended pregnancies, but some groups, such as teens, are at a higher risk.

Efforts to decrease unintended pregnancy include finding better forms of contraception, and increasing contraceptive use and adherence.

What is contraception?

Contraception, also known as birth control, is designed to prevent pregnancy. Some types of birth control include (but are not limited to):

- Barrier methods, such as condoms, the diaphragm, and the cervical cap, are designed to prevent the sperm from reaching the egg for fertilization.Intrauterine device, or IUD, is a small device that is inserted into the uterus by a health care provider. The IUD prevents a fertilized egg from implanting in the uterus. An IUD can stay in the uterus for up to 10 years until it is removed by a health care provider.
- Hormonal birth control, such as birth control pills, injections, skin patches, and vaginal rings, release hormones into a woman's body that interfere with fertility by preventing ovulation, fertilization, or implantation.
- Sterilization is a method that permanently prevents a woman from getting pregnant or a man from being able to get a woman pregnant. Sterilization involves surgical procedures that must be done by a health care provider and usually cannot be reversed.

The choice of birth control depends on factors such as a person's overall health, age, frequency of sexual activity, number of sexual partners, desire to have children in the future, and family history of certain diseases. A woman should talk to her health care provider about her choice of birth control method.

It is important to remember that even though birth control methods can prevent pregnancy, they do not all protect against sexually transmitted diseases or HIV.

Contraception Methods

There is no "best" method of birth control. Each method has its pros and cons.

All women and men can have control over when, and if, they become parents. Making choices about birth control, or contraception, isn't easy. There are many things to think about. To get started, learn about birth control methods you or your partner can use to prevent pregnancy. You can also talk with your doctor about the choices.

Before choosing a birth control method, think about:

- Your overall health
- How often you have sex
- The number of sex partners you have

- If you want to have children someday
- How well each method works to prevent pregnancy
- Possible side effects
- Your comfort level with using the method

What are the different types of birth control?

You can choose from many methods of birth control. They are grouped by how they work:

Continuous abstinence

This means not having sex (vaginal, anal, or oral) *at any time*. It is the only sure way to prevent pregnancy and protect against sexually transmitted infections (STIs), including HIV.

Natural family planning/rhythm method

This method is when you do not have sex or use a barrier method on the days you are most fertile (most likely to become pregnant). You can read about barrier methods in the following chart.

A woman who has a regular menstrual cycle has about 9 or more days each month when she is able to get pregnant. These fertile days are about 5 days before and 3 days after ovulation, as well as the day of ovulation.

To have success with this method, you need to learn about your menstrual cycle. Then you can learn to predict which days you are fertile or "unsafe." To learn about your cycle, keep a written record of:

- When you get your period
- What it is like (heavy or light blood flow)
- How you feel (sore breasts, cramps)

This method also involves checking your cervical mucus and recording your body temperature each day. Cervical mucus is the discharge from your vagina. You are most fertile when it is clear and slippery like raw egg whites. Use a basal thermometer to take your temperature and record it in a chart. Your temperature will rise 0.4 to 0.8° F on the first day of ovulation. You can talk with your doctor or a natural family planning instructor to learn how to record and understand this information.

Barrier methods—put up a block, or barrier, to keep sperm from reaching the egg

Contraceptive Sponge

Before having sex, you wet the sponge and place it, loop side down, inside your vagina to cover the cervix. The sponge is effective for more than one act of intercourse for up to 24 hours. It needs to be left in for at least 6 hours after having sex to prevent pregnancy. It must then be taken out within 30 hours after it is inserted.

Only one kind of contraceptive sponge is sold in the United States. It is called the Today Sponge. Women who are sensitive to the spermicide nonoxynol-9 should not use the sponge.

Diaphragm, cervical cap, and cervical shield

These barrier methods block the sperm from entering the cervix (the opening to your womb) and reaching the egg.

- The diaphragm is a shallow latex cup.
- The cervical cap is a thimble-shaped latex cup. It often is called by its brand name, FemCap.
- The cervical shield is a silicone cup that has a one-way valve that creates suction and helps it fit against the cervix. It often is called by its brand name, Lea's Shield.

The diaphragm and cervical cap come in different sizes, and you need a doctor to "fit" you for one. The cervical shield comes in

one size, and you will not need a fitting.

Before having sex, add spermicide (to block or kill sperm) to the devices. Then place them inside your vagina to cover your cervix. You can buy spermicide gel or foam at a drug store.

All three of these barrier methods must be left in place for 6 to 8 hours after having sex to prevent pregnancy. The diaphragm should be taken out within 24 hours. The cap and shield should be taken out within 48 hours.

Female condom

This condom is worn by the woman inside her vagina. It keeps sperm from getting into her body. It is made of thin, flexible, manmade rubber and is packaged with a lubricant. It can be inserted up to 8 hours before having sex. Use a new condom each time you have intercourse. And don't use it and a male condom at the same time.

Male condom

Male condoms are a thin sheath placed over an erect penis to keep sperm from entering a woman's body. Condoms can be made of latex, polyurethane, or "natural/lambskin". The natural kind do not protect against STIs. Condoms work best when used with a vaginal spermicide, which kills the sperm. And you need to use a new condom with each sex act.

Condoms are either:

- Lubricated, which can make sexual intercourse more comfortable
- Non-lubricated, which can also be used for oral sex. It is best to add lubrication to non-lubricated condoms if you use them for vaginal or anal sex. You can use a water-based lubricant, such as K-Y jelly. You can buy them at the drug store. Oil-based lubricants like massage oils, baby oil, lotions, or petroleum jelly will weaken the condom, causing it to tear or break.

Keep condoms in a cool, dry place. If you keep them in a hot place (like a wallet or glove compartment), the latex breaks down. Then the condom can tear or break.

Hormonal methods

These methods prevent pregnancy by interfering with ovulation, fertilization, and/or implantation of the fertilized egg.

Oral contraceptives—combined pill ("The pill")

The pill contains the hormones estrogen and progestin. It is taken daily to keep the ovaries from releasing an egg. The pill also causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining the egg.

Some women prefer the "extended cycle" pills. These have 12 weeks of pills that contain hormones (active) and 1 week of pills that don't contain hormones (inactive). While taking extended cycle pills, women only have their period three to four times a year.

Many types of oral contraceptives are available. Talk with your doctor about which is best for you.
Your doctor may advise you not to take the pill if you:

- Are older than 35 and smoke
- Have a history of blood clots
- Have a history of breast, liver, or endometrial cancer

Antibiotics may reduce how well the pill works in some women. Talk to your doctor about a backup method of birth control if you need to take antibiotics.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

The patch

Also called by its brand name, Ortho Evra, this skin patch is worn on the lower abdomen, buttocks, outer arm, or upper body. It releases the hormones progestin and estrogen into the bloodstream to stop the ovaries from releasing eggs in most women. It also thickens the cervical mucus, which keeps the sperm from joining with the egg. You put on a new patch once a week for 3 weeks. You don't use a patch the fourth week in order to have a period.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Shot/injection

The birth control shot often is called by its brand name Depo-Provera. With this method you get injections, or shots, of the hormone progestin in the buttocks or arm every 3 months. A new type is injected under the skin. The birth control shot stops the ovaries from releasing an egg in most women. It also causes changes in the cervix that keep the sperm from joining with the egg.

Vaginal ring

This is a thin, flexible ring that releases the hormones progestin and estrogen. It works by stopping the ovaries from releasing eggs. It also thickens the cervical mucus, which keeps the sperm from joining the egg.

It is commonly called NuvaRing, its brand name. You squeeze the ring between your thumb and index finger and insert it into your vagina. You wear the ring for 3 weeks, take it out for the week that you have your period, and then put in a new ring.

Women should wait three weeks after giving birth to begin using birth control that contains both estrogen and progestin. These methods increase the risk of dangerous blood clots that could form after giving birth. Women who delivered by cesarean section or have other risk factors for blood clots, such as obesity, history of blood clots, smoking, or preeclampsia, should wait six weeks.

Implantable devices

These devices are inserted into the body and left in place for a few years.

Implantable rod

This is a matchstick-size, flexible rod that is put under the skin of the upper arm. It is often called by its brand name, Implanon. The rod releases a progestin, which causes changes in the lining of the uterus and the cervical mucus to keep the sperm from joining an egg. Less often, it stops the ovaries from releasing eggs. It is effective for up to 3 years.

Intrauterine devices or IUDs

An IUD is a small device shaped like a "T" that goes in your uterus. There are two types:

- **Copper IUD** The copper IUD goes by the brand name ParaGard. It releases a small amount of copper into the uterus, which prevents the sperm from reaching and fertilizing the egg. It fertilization does occur, the IUD keeps the fertilized egg from implanting in the lining of the uterus. A doctor needs to put in your copper IUD. It can stay in your uterus for 5 to 10 years.
- **Hormonal IUD** The hormonal IUD goes by the brand name Mirena. It is sometimes called an intrauterine system, or IUS. It releases progestin into the uterus, which keeps the ovaries from releasing an egg and causes the cervical mucus to thicken so sperm can't reach the egg. It also affects the ability of a fertilized egg to successfully implant in the uterus. A doctor needs to put in a hormonal IUD. It can stay in your uterus for up to 5 years.

Sterilization implant (essure)

Essure is the first non-surgical method of sterilizing women. A thin tube is used to thread a tiny spring-like device through the vagina and uterus into each fallopian tube. The device works by causing scar tissue to form around the coil. This blocks the

fallopian tubes and stops the egg and sperm from joining.

It can take about 3 months for the scar tissue to grow, so it's important to use another form of birth control during this time. Then you will have to return to your doctor for a test to see if scar tissue has fully blocked your tubes.

Surgical sterilization

For women, surgical sterilization closes the fallopian tubes by being cut, tied, or sealed. This stops the eggs from going down to the uterus where they can be fertilized. The surgery can be done a number of ways. Sometimes, a woman having cesarean birth has the procedure done at the same time, so as to avoid having additional surgery later.

For men, having a vasectomy keeps sperm from going to his penis, so his ejaculate never has any sperm in it. Sperm stays in the system after surgery for about 3 months. During that time, use a backup form of birth control to prevent pregnancy. A simple test can be done to check if all the sperm is gone; it is called a semen analysis.

Emergency contraception

Used if a woman's primary method of birth control fails. It should *not* be used as a regular method of birth control. Emergency contraception (Plan B One-Step or Next Step. It is also called the "morning after pill.")

Emergency contraception keeps a woman from getting pregnant when she has had unprotected vaginal intercourse. "Unprotected" can mean that no method of birth control was used. It can also mean that a birth control method was used but it was used incorrectly, or did not work (like a condom breaking). Or, a woman may have forgotten to take her birth control pills. She also may have been abused or forced to have sex. These are just some of the reasons women may need emergency contraception.

Emergency contraception can be taken as a single pill treatment or in two doses. A single dose treatment works as well as two doses and does not have more side effects. It works by stopping the ovaries from releasing an egg or keeping the sperm from joining with the egg. For the best chances for it to work, take the pill as soon as possible after unprotected sex. It should be taken within 72 hours after having unprotected sex.

A single-pill dose or two-pill dose of emergency contraception is available over-the-counter (OTC) for women ages 17 and older.

Can all types of birth control prevent sexually transmitted infections (STIs)?

No. The male latex condom is the *only* birth control method proven to help protect you from STIs, including HIV. Research is being done to find out how effective the female condom is at preventing STIs and HIV. For more information, see Will birth control pills protect me from sexually transmitted infections (STIs), including HIV/AIDS?

How well do different kinds of birth control work? Do they have side effects?

All birth control methods work the best if used correctly and every time you have sex. Be sure you know the right way to use them. Sometimes doctors don't explain how to use a method because they assume you already know. Talk with your doctor if you have questions. They are used to talking about birth control. So don't feel embarrassed about talking to him or her.

Some birth control methods can take time and practice to learn. For example, some people don't know you can put on a male condom "inside out." Also, not everyone knows you need to leave a little space at the tip of the condom for the sperm and fluid when a man ejaculates, or has an orgasm.

Where to Get Birth Control

Where you get birth control depends on what method you choose.

You can buy these forms over the counter:

- Male condoms
- Female condoms

- Sponges
- Spermicides
- Emergency contraception pills (girls younger than 17 need a prescription)

You need a prescription for these forms:

- Oral contraceptives: the pill, the mini-pill
- Skin patch
- Vaginal ring
- Diaphragm (your doctor needs to fit one to your shape)
- Cervical cap
- Cervical shield
- Shot/injection (you get the shot at your doctor's office)
- IUD (inserted by a doctor)
- Implantable rod (inserted by a doctor)

You will need surgery or a medical procedure for:

- Sterilization, female and male

Spermacides

You can buy spermicides over the counter. They work by killing sperm. They come in many forms:

- Foam
- Gel
- Cream
- Film
- Suppository
- Tablet

Spermicides are put in the vagina no more than 1 hour before having sex. If you use a film, suppository, or tablet, wait at least 15 minutes before having sex so the spermicide can dissolve. Do not douche or rinse out your vagina for at least 6 to 8 hours after having sex. You will need to use more spermicide each time you have sex.

Spermicides work best if used along with a barrier method, such as a condom, diaphragm, or cervical cap. Some spermicides are made just for use with the diaphragm and cervical cap. Check the package to make sure you are buying what you need.

All spermicides contain sperm-killing chemicals. Some contain nonoxynol-9, which may raise your risk of HIV if you use it a lot. It irritates the tissue in the vagina and anus, so it can cause the HIV virus to enter the body more freely. Some women are sensitive to nonoxynol-9 and need to use spermicides without it. Medications for vaginal yeast infections may lower the effectiveness of spermicides. Also, spermicides do not protect against sexually transmitted infections.

Withdrawal

Withdrawal is when a man takes his penis out of a woman's vagina (or "pulls out") before he ejaculates, or has an orgasm. This stops the sperm from going to the egg. "Pulling out" can be hard for a man to do. It takes a lot of self-control.

Even if you use withdrawal, sperm can be released *before* the man pulls out. When a man's penis first becomes erect, pre-ejaculate fluid may be on the tip of the penis. This fluid has sperm in it. So you could still get pregnant.

Withdrawal does not protect you from STIs or HIV.

Dental Dams

The dental dam is a square piece of rubber that is used by dentists during oral surgery and other procedures. It is not a method of birth control. But it can be used to help protect people from STIs, including HIV, during oral-vaginal or oral-anal sex. It is placed

over the opening to the vagina or the anus before having oral sex. You can buy dental dams at surgical supply stores.

Learning Activity

For a handy summary of birth control information, see this Frequently Asked Questions Fact Sheet.

Learning Activity

Find out the Real Cost of Contraceptives: *"Choosing the most money-smart method isn't as easy as crunching numbers because costs depend on a variety of factors, including how long you want the birth control to last, how often you need it, and how generous your insurance policy is."*

- Which birth control methods are the most affordable? Why?

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9.3: End-of-Chapter Material

Key takeaways for this Chapter

- Social wellness is an important part of overall wellness.
- Love is difficult to define.
- Sternberg defines love as including varying levels of intimacy, passion, and commitment.
- A person own “love story” may impact their own relationships.
- It is important to understand the differences between healthy and unhealthy relationships.
- Effective communication includes being assertive and using “I” statements.
- Sex and Gender mean two different things.
- Pregnancy occurs when a females egg is fertilized by a males sperm, this is called conception.
- Various contraceptive methods are available that can help to reduce the chances of pregnancy and STD transmission.
- Abortion is the act of ending a pregnancy.

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10: DRUG USE AND ADDICTION

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10.1: Drugs, Abuse, and Addiction

Many people do not understand why or how other people become addicted to drugs. It can be wrongfully assumed that drug abusers lack moral principles or willpower and that they could stop using drugs simply by choosing to change their behavior. In reality, drug addiction is a complex disease, and quitting takes more than good intentions. In fact, because drugs change the brain in ways that foster compulsive drug abuse, quitting is difficult, even for those who are ready to do so. Through scientific advances, we know more about how drugs work in the brain than ever, and we also know that drug addiction can be successfully treated to help people stop abusing drugs and lead productive lives.

Drug abuse and addiction have negative consequences for individuals and for society. Estimates of the total overall costs of substance abuse in the United States, including productivity and health- and crime-related costs, exceed $600 billion annually. This includes approximately $181 billion for illicit drugs, $193 billion for tobacco, and $235 billion for alcohol. As staggering as these numbers are, they do not fully describe the breadth of destructive public health and safety implications of drug abuse and addiction, such as family disintegration, loss of employment, failure in school, domestic violence, and child abuse.

Optional Learning Activity

Read this short article titled: Breaking Bad Habits, Why It's So Hard to Change from *NIH News in Health.*

Wise Choices

- **Avoid tempting situations.** If you always stop for a donut on your way to work, try a different route. Keep fatty foods, cigarettes, alcohol and other tempting items out of your home.
- **Replace unhealthy behaviors with healthy ones.** Try exercise, a favorite hobby or spending time with family.
- **Prepare mentally.** If you can't avoid a tempting situation, prepare yourself in advance. Think about how you want to handle it and mentally practice what you plan.
- **Enlist support.** Ask friends, family and co-workers to support your efforts to change.
- **Reward yourself for small steps.** Give yourself a healthy treat when you've achieved a small goal or milestone.

Have you ever tried any of these strategies to break a bad habit?

What Is Drug Addiction?

Addiction is a chronic, often relapsing brain disease that causes compulsive drug seeking and use, despite harmful consequences to the addicted individual and to those around him or her. Although the initial decision to take drugs is voluntary for most people, the brain changes that occur over time challenge a person's self control and ability to resist intense impulses urging them to take drugs.

Fortunately, treatments are available to help people counter addiction's powerful disruptive effects. Research shows that combining addiction treatment medications with behavioral therapy is the best way to ensure success for most patients. Treatment approaches that are tailored to each patient's drug abuse patterns and any co-occurring medical, psychiatric, and social problems can lead to sustained recovery and a life without drug abuse.

Similar to other chronic, relapsing diseases, such as diabetes, asthma, or heart disease, drug addiction can be managed successfully. And as with other chronic diseases, it is not uncommon for a person to relapse and begin abusing drugs again. Relapse, however, does not signal treatment failure—rather, it indicates that treatment should be reinstated, adjusted, or that an alternative treatment is needed to help the individual regain control and recover.

What Happens to Your Brain When You Take Drugs?

Drugs contain chemicals that tap into the brain's communication system and disrupt the way nerve cells normally send, receive, and process information. There are two primary ways that drugs cause this disruption:

1. by imitating the brain's natural chemical messengers
2. by overstimulating the "reward circuit" of the brain

Some drugs (e.g., marijuana and heroin) have a similar structure to chemical messengers called neurotransmitters, which are naturally produced by the brain. This similarity allows the drugs to "fool" the brain's receptors and activate nerve cells to send abnormal messages.

Other drugs, such as cocaine or methamphetamine, can cause the nerve cells to release abnormally large amounts of natural neurotransmitters (mainly dopamine) or to prevent the normal recycling of these brain chemicals, which is needed to shut off the signaling between neurons. The result is a brain awash in dopamine, a neurotransmitter present in brain regions that control movement, emotion, motivation, and feelings of pleasure. The overstimulation of this reward system, which normally responds to natural behaviors linked to survival (eating, spending time with loved ones, etc.), produces euphoric effects in response to psychoactive drugs. This reaction sets in motion a reinforcing pattern that "teaches" people to repeat the rewarding behavior of abusing drugs.

As a person continues to abuse drugs, the brain adapts to the overwhelming surges in dopamine by producing less dopamine or by reducing the number of dopamine receptors in the reward circuit. The result is a lessening of dopamine's impact on the reward circuit, which reduces the abuser's ability to enjoy the drugs, as well as the events in life that previously brought pleasure. This decrease compels the addicted person to keep abusing drugs in an attempt to bring the dopamine function back to normal, except now larger amounts of the drug are required to achieve the same dopamine high—an effect known as tolerance.

Long-term abuse causes changes in other brain chemical systems and circuits as well. Glutamate is a neurotransmitter that influences the reward circuit and the ability to learn. When the optimal concentration of glutamate is altered by drug abuse, the brain attempts to compensate, which can impair cognitive function. Brain imaging studies of drug-addicted individuals show changes in areas of the brain that are critical to judgment, decision-making, learning and memory, and behavior control. Together, these changes can drive an abuser to seek out and take drugs compulsively despite adverse, even devastating consequences—that is the nature of addiction.

Why Do Some People Become Addicted While Others Do Not?

No single factor can predict whether a person will become addicted to drugs. Risk for addiction is influenced by a combination of factors that include individual biology, social environment, and age or stage of development. The more risk factors an individual has, the greater the chance that taking drugs can lead to addiction. Consider the following risk factors:

- **Biology.** The genes that people are born with--in combination with environmental influences--account for about half of their addiction vulnerability. Additionally, gender, ethnicity, and the presence of other mental disorders may influence risk for drug abuse and addiction.
- **Environment.** A person's environment includes many different influences, from family and friends to socioeconomic status and quality of life in general. Factors such as peer pressure, physical and sexual abuse, stress, and quality of parenting can greatly influence the occurrence of drug abuse and the escalation to addiction in a person's life.
- **Development.** Genetic and environmental factors interact with critical developmental stages in a person's life to affect addiction vulnerability. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it will progress to more serious abuse, which poses a special challenge to adolescents. Because their brains are still developing in the areas that govern decision-making, judgment, and self-control, adolescents may be especially prone to risk-taking behaviors, including trying drugs of abuse.

Prevention Is the Key

Drug addiction is a preventable disease. Results from NIDA-funded research have shown that prevention programs involving families, schools, communities, and the media are effective in reducing drug abuse. Although many events and cultural factors affect drug abuse trends, when youths perceive drug abuse as harmful, they reduce their drug taking. Thus, education and outreach are key in helping youth and the general public understand the risks of drug abuse. Teachers, parents, and medical and public health professionals must keep sending the message that drug addiction can be prevented if one never abuses drugs.

Learning Activity

Watch this video titled Anyone Can Become Addicted to Drugs:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

What Is Addiction?

More than three decades of research supported by the National Institute on Drug Abuse (NIDA) has proven that addiction is a complex brain disease characterized by compulsive, at times uncontrollable, drug craving, seeking, and use that persist despite potentially devastating consequences. Addiction is also a developmental disease; that is, it usually starts in adolescence or even childhood and can last a lifetime if untreated.

Disagreements about the nature of addiction remain: namely, whether it reflects voluntary or involuntary behavior and whether it should be punished or treated as a health issue. Even though the first time a person takes a drug, it is often by choice—to achieve a pleasurable sensation or desired emotional state—we now know from a large body of research that this ability to choose can be affected by drugs. And when addiction takes hold in the brain, it disrupts a person's ability to exert control over behavior—reflecting the compulsive nature of this disease.

The human brain is an extraordinarily complex and fine-tuned communications network made up of billions of cells that govern our thoughts, emotions, perceptions, and drives. Our brains reward certain behaviors such as eating or procreating—registering these as pleasurable activities that we want to repeat. Drug addiction taps into these vital mechanisms geared for our survival. And although not a life necessity, to an addicted person, drugs become life itself, driving the compulsive use of drugs—even in the face of dire life consequences—*that is the essence of addiction*.

How Does Addiction Take Hold in the Brain?

The rewarding effects of drugs of abuse come from large and rapid upsurges in dopamine, a neurochemical critical to stimulating feelings of pleasure and to motivating behavior. The rapid dopamine "rush" from drugs of abuse mimics but greatly exceeds in intensity and duration the feelings that occur in response to such pleasurable stimuli as the sight or smell of food, for example. Repeated exposure to large, drug-induced dopamine surges has the insidious consequence of ultimately blunting the response of the dopamine system to everyday stimuli. Thus the drug disturbs a person's normal hierarchy of needs and desires and substitutes new priorities concerned with procuring and using the drug.

Drug abuse also disrupts the brain circuits involved in memory and control over behavior. Memories of the drug experience can trigger craving as can exposure to people, places, or things associated with former drug use. Stress is also a powerful trigger for craving. Control over behavior is compromised because the affected frontal brain regions are what a person needs to exert inhibitory control over desires and emotions.

That is why addiction is a brain disease. As a person's reward circuitry becomes increasingly dulled and desensitized by drugs, nothing else can compete with them—food, family, and friends lose their relative value, while the ability to curb the need to seek and use drugs evaporates. Ironically and cruelly, eventually even the drug loses its ability to reward, but the compromised brain leads addicted people to pursue it, anyway; the memory of the drug has become more powerful than the drug itself.

When does drug abuse become drug addiction? It rarely happens with the first use of a drug. Drug abuse and drug addiction can be thought of as points along a continuum. Any use of a mind-altering drug or the inappropriate use of medication (either prescription or over-the-counter drugs) is **drug abuse**, but the point when drug abuse becomes drug addiction is less clear. Different people may reach the point of addiction at different stages. Scientists continue to investigate the factors that contribute to the transition to drug addiction.

Drug addiction is defined as the continued compulsive use of drugs despite adverse health or social consequences. Drug-addicted people have lost control of their drug use. Individuals who are addicted to drugs often become isolated from family or friends, have difficulty at work or school, may commit crimes, and become involved with the criminal justice system. For a person addicted to drugs, continuing to take them becomes the primary focus in life.

Certain drugs, including opioids and alcohol, cause strong physical reactions in the body when drug use stops. When a person addicted to heroin stops taking heroin, he or she can experience a variety of symptoms ranging from watery eyes and a runny nose to irritability and loss of appetite and then diarrhea, shivering, sweating, abdominal cramps, increased sensitivity to pain, and sleep problems. In general, withdrawal from heroin makes people feel miserable. Withdrawal from alcohol can cause serious effects such as seizures and even death. Withdrawal from other drugs, such as cocaine and amphetamines, does not lead to strong physical reactions, but it may make the person feel depressed or lethargic. For most drugs, physical withdrawal symptoms can usually be controlled effectively with medications. Even though withdrawal from some drugs does not cause the person abusing them to have physical reactions, stopping drug use is difficult because of the changes the drugs have caused in the brain. Once the drugs stop, the person will have **cravings**, or intense desire for the drugs. Craving arises from the brain's need to maintain a state of homeostasis that now relies on the presence of the drug. A person may experience cravings at any stage of drug abuse or addiction, even early in the experimentation phase of drug abuse. Cravings have a physical basis in the brain. Using PET imaging, scientists have shown that just seeing images of drug paraphernalia can stimulate the amygdala (part of the brain involved in emotional memory) in an addicted person.

Drugs of addiction do not merely cause short-term changes in an individual's cognitive skill and behavior. A drug "high" lasts a short time, ranging from less than an hour to 12 hours, depending on the drug, dose, and route of administration. The changes in the brain that result from continued drug use, however, can last a long time. Scientists believe that some of these changes disappear when drug use stops; some disappear within a short time after drug use stops, and other changes are potentially permanent.

One of the first changes in the brain that may occur in response to repeated drug abuse is tolerance. **Tolerance** develops when a person needs increasing doses of a drug to achieve the same high or "rush" that previously resulted from a lower dose of the drug. Two primary mechanisms underlie the development of tolerance. First, the body may become more efficient at metabolizing the drug, thereby reducing the amount that enters the brain. Second, the cells of the body and brain may become more resistant to the effect of the drug. For example, after continued cocaine use, neurons decrease the number of dopamine receptors, which results in decreasing cocaine's stimulatory effect. Opioids, on the other hand, do not cause a change in the number of receptors. Instead the opioid receptors become less efficient in activating associated cellular processes, thus reducing the effects of the opioids.

In addition to the functional and anatomical changes in the brain, drug abuse puts people at higher risk for other health problems. For example, inhalant abuse can lead to disruption of heart rhythms, and snorting cocaine can lead to ulcerations in the mucous membranes of the nose. In addition, injection drug users (IDUs) are at higher risk of contracting HIV through the sharing of potentially contaminated needles. Similarly, hepatitis B and hepatitis C are much more common among drug addicts than the general population. Tuberculosis is another concern. Drug abuse and addiction also are contributing factors in motor vehicle accidents.

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10.2: Misuse of Prescription Drugs

Prescription Drugs

Most people take medicines only for the reasons their doctors prescribe them. But an estimated 20 percent of people in the United States have used prescription drugs for nonmedical reasons. This is prescription drug abuse. It is a serious and growing problem.

Abusing some prescription drugs can lead to addiction. You can develop an addiction to:

- Narcotic painkillers
- Sedatives and tranquilizers
- Stimulants

Experts don't know exactly why this type of drug abuse is increasing. The availability of drugs is probably one reason. Doctors are prescribing more drugs for more health problems than ever before. Online pharmacies make it easy to get prescription drugs without a prescription, even for youngsters.

Learning Activity

Pillbox was developed to aid in the identification of unknown solid dosage pharmaceuticals. The system combines high-resolution images of tablets and capsules with appearance information (imprint, shape, color, etc.) to enable users to visually search for and identify an unknown solid dosage pharmaceutical.

This system is designed for use by emergency physicians, first responders, other health care providers, Poison Control Center staff, and concerned citizens.

The system enables users to identify solid dosage forms based on physical criteria: imprint (characters or number printed on a medication), shape, color, size, and scoring. Users are shown thumbnail images of possible matches. These images are continually updated as the user enters additional information.

- Visit the Pillbox to check the pills in your family medicine cabinet.
- Find any surprises?

Learning Activity 4.2: Clean out your medicine cabinet.

You may want to consider getting rid of expired medications. For tips, read Spring Cleaning: A Dose of Your Own Medicine

Commonly Abused Prescription Drugs

Medications can be effective when they are used properly, but some can be addictive and dangerous when abused. Some prescribed medications that—when used in ways or by people other than prescribed—have the potential for adverse medical consequences, including addiction.

In 2010, approximately 16 million Americans reported using a prescription drug for nonmedical reasons in the past year; 7 million in the past month.

After marijuana, prescription and over-the-counter medications account for most of the commonly abused drugs.

What types of prescription drugs are abused?

Three types of drugs are abused most often:

- Opioids—prescribed for pain relief
- CNS depressants—barbiturates and benzodiazepines prescribed for anxiety or sleep problems (often referred to as sedatives or tranquilizers)
- Stimulants—prescribed for attention-deficit hyperactivity disorder (ADHD), the sleep disorder narcolepsy, or obesity.

How can you help prevent prescription drug abuse?

- Ask your doctor or pharmacist about your medication, especially if you are unsure about its effects.
- Keep your doctor informed about all medications you are taking, including over-the-counter medications.
- Read the information your pharmacist provides before starting to take medications.
- Take your medication(s) as prescribed.
- Keep all prescription medications secured at all times and properly dispose of any unused medications.

Prescription Drug Advertising

Your healthcare provider is the best source of information about the right medicines for you.

The Food and Drug Administration (FDA) protects public health by assuring the safety, effectiveness, and security of a wide range of products, including human prescription drugs. We also advance public health by helping people get the accurate, science-based information they need to use medicines appropriately and improve their health. Prescription drug advertisements can provide useful information for consumers to work with their health care providers to make wise decisions about treatment.

FDA Authority Over Advertising

The FDA serves the public health and welfare in many ways. One way is overseeing the approval and marketing of prescription drugs. It's authority is based on a number of federal laws, including the Federal Food, Drug, and Cosmetic Act. Among other areas, this law specifically addresses prescription drug advertising. This law requires that advertisements for prescription drugs be accurate and not misleading.

Direct-to-consumer (DTC) advertising is a relatively new area of prescription drug promotion. No federal law has ever banned DTC advertising. Until the mid-1980s, drug companies gave information about prescription drugs only to doctors and pharmacists. When these professionals thought it appropriate, they gave that information to their patients. However, during the 1980s, some drug companies started to give the general public more direct access to this information through DTC ads.

The law requires that product claim ads give a "fair balance" of information about drug risks as compared with information about drug benefits. This means that the content and presentation of a drug's most important risks must be reasonably similar to the content and presentation of its benefits.

This does not mean that equal space must be given to risks and benefits in print ads, or equal time to risks and benefits in broadcast ads. The amount of time or space needed to present risk information will depend on the drug's risks and the way that both the benefits and risks are presented.

Think about the following questions when you see an ad for a prescription drug. Also, think about asking these questions when you talk to your doctor or pharmacist about a drug.

- What condition does this drug treat?
- Why do I think that I might have this condition?
- If I have the condition, am I part of the population the drug is approved to treat?
- Should I take this drug if I have a certain condition?
- Should I take this drug if I am taking certain other drugs?
- Which of the drug's possible side effects am I concerned about?
- How will this drug affect other drugs I am taking?
- Will foods, beverages (alcoholic or non-alcoholic), vitamins, or other supplements affect how this drug works?

- Are there other drugs that treat my condition?
- Is there a less costly drug I could use to treat my condition?
- What else can I do to help deal with my condition? For example, should I exercise or change my diet?
- Do other drugs for my condition have different side effects?
- How can I learn more about this condition and this drug?

Harmful Interactions: Mixing Alcohol with Medicines

You've probably seen this warning on medicines you've taken. The danger is real. Mixing alcohol with certain medications can cause nausea and vomiting, headaches, drowsiness, fainting, or loss of coordination.

It also can put you at risk for internal bleeding, heart problems, and difficulties in breathing. In addition to these dangers, alcohol can make a medication less effective or even useless, or it may make the medication harmful or toxic to your body.

Some medicines that you might never have suspected can react with alcohol, including many medications which can be purchased "over-the-counter"—that is, without a prescription. Even some herbal remedies can have harmful effects when combined with alcohol.

See the NIH publication Harmful Interactions: Mixing Alcohol with Medicines for a list of medications that can cause harm when taken with alcohol and description of the effects that can result. The list gives the brand name by which each medicine is commonly known (for example, Benadryl®) and its generic name or active ingredient (in Benadryl®, this is diphenhydramine). **The list presented here does not include all the medicines that may interact harmfully with alcohol. Most important, the list does not include all the ingredients in every medication.**

Medications are safe and effective when used appropriately. Your pharmacist or other health care provider can help you determine which medications interact harmfully with alcohol.

Did You Know . . .

Mixing alcohol and medicines can be harmful. Alcohol, like some medicines, can make you sleepy, drowsy, or lightheaded. Drinking alcohol while taking medicines can intensify these effects. You may have trouble concentrating or performing mechanical skills. Small amounts of alcohol can make it dangerous to drive, and when you mix alcohol with certain medicines you put yourself at even greater risk. Combining alcohol with some medicines can lead to falls and serious injuries, especially among older people.

Medicines may have many ingredients

Some medications—including many popular painkillers and cough, cold, and allergy remedies—contain more than one ingredient that can react with alcohol. Read the label on the medication bottle to find out exactly what ingredients a medicine contains. Ask your pharmacist if you have any questions about how alcohol might interact with a drug you are taking.

Some medicines contain alcohol

Certain medicines contain up to 10 percent alcohol. Cough syrup and laxatives may have some of the highest alcohol concentrations.

Alcohol affects women differently

Women, in general, have a higher risk for problems than men. When a woman drinks, the alcohol in her bloodstream typically reaches a higher level than a man's even if both are drinking the same amount. This is because women's bodies generally have less water than men's bodies. Because alcohol mixes with body water, a given amount of alcohol is more concentrated in a woman's body than in a man's. As a result, women are more susceptible to alcohol-related damage to organs such as the liver.

Older people face greater risk

Older people are at particularly high risk for harmful alcohol– medication interactions. Aging slows the body's ability to break

down alcohol, so alcohol remains in a person's system longer. Older people also are more likely to take a medication that interacts with alcohol—in fact, they often need to take more than one of these medications.

Timing is important

Alcohol and medicines can interact harmfully even if they are not taken at the same time.

Remember

Mixing alcohol and medicines puts you at risk for dangerous reactions. Protect yourself by avoiding alcohol if you are taking a medication and don't know its effect. To learn more about a medicine and whether it will interact with alcohol, talk to your pharmacist or other health care provider.

Sources

Misuse of Prescription Drugs: Misuse of Prescription Drugs, NLM, NIH, http://www.nlm.nih.gov/medlineplus/prescriptiondrugabuse.html

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10.3: RECOGNIZING DRUGS AND AVOIDING ADDICTION

Learning Objectives

By the end of this chapter you will be able to:

- Explain what occurs in the body when someone has an addiction.
- Recognize risk factors for addiction
- Compare and contrast health effects of common illicit drugs
- Describe impacts of drug use on the individual, family, and community.
- Identify treatments for drug abuse.

Why is it important to understand how different drugs impact the body and mind?

What are the risks associated with using drugs?

What causes addiction?

This chapter focuses on drug use and addiction. Often addiction is associated with the consumption of addictive drugs, however addiction is broader than just the consumption of addictive substances and also includes behavioral addictions, such as the addiction to gambling, pornography, internet use, and exercise. There is debate whether behavioral addictions and substance addictions should be grouped together. This chapter will begin with a focus on substance addiction and will end with a focus on behavioral addictions.

10.3.1: Drug Use and Drug Addiction

10.3.2: Drug Abuse and Addiction

10.3.3: Drug Facts

10.3.4: Types of Drugs, Possible Health Effects, and Treatment Options

10.3.5: Drug Abuse or Addiction Treatment

10.3.6: Behavioral Addiction

10.3.7: Alcohol, Nicotine, e-cigarettes, and Prescription Drugs

10.3.8: Assessing Your Personal Risk Factors for Substance Use and Abuse-

10.3.9: End-of-Chapter Material

10.3.10: Recognizing Drugs and Addiction- Optional Continued Learning

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10.3.1: Drug Use and Drug Addiction

Drug addiction is a complex illness, many people don't understand why or how other people become addicted to drugs. They may mistakenly think that those who use drugs lack moral principles or the willpower to quit without recognizing that drugs change the brain in ways that make quitting hard, even for those who want to. In reality, drug addiction is a complex disease, and quitting usually takes more than good intentions or a strong will. A person may initially choose to take the drug, however over time they are incapable of choosing *not* to take the drug.

Fortunately, researchers know more than ever about how drugs affect the brain and have found treatments that can help people recover from drug addiction and lead productive lives.

Drug Use and Overdose

The National Survey on Drug Use and Health (NSDUH)[1] is published each year to share statistics on drug use in the U.S. Key findings from the 2022 annual report show that drug use is fairly common.

Among people aged 12 or older in year 2022:

- 59.8 percent (or 168.7 million people) used tobacco, alcohol, or an illicit drug in the past month (current user).
- 24.9 percent (or 70.3 million people) used illicit drugs in the past year.
  - Marijuana was the most commonly used illicit drug, with 22 percent (or 61.9 million people) using it in the past year.
- 3.7 percent (or 10.3 million people) misused central nervous system (CNS) stimulants in the past year.
- 3.4 percent (or 9.5 million people) misused opioids (heroin or prescription pain relievers) in the past year.
- 3.3 percent (or 9.3 million people) misused prescription pain relievers in the past year.
- 2.6 percent (or 7.1 million people) used hallucinogens in the past year.
- 17.3 percent (or 48.7 million people) had a Substance Use Disorder in the past year

Unfortunately both first time users and those who have an addiction are both at risk of possible drug overdose. Between 1999-2021 more than a million people have died from a drug overdose. Most recently, the majority of overdoses are caused by synthetic opioids. For example in 2020, about 92,000 drug overdose deaths occurred in the United States and 75% of the overdoses involved opioid use. Data from just 24 states from January–June 2019 showed that Illicitly manufactured fentanyl, heroin, cocaine, or methamphetamine (alone or in combination) were involved in nearly 85% of drug overdose deaths.

Drug Addiction

Addiction is a chronic disease characterized by drug seeking and use that is compulsive, or difficult to control, despite harmful consequences. The initial decision to take drugs is voluntary for most people, but repeated drug use can lead to brain changes that challenge an addicted person's self-control and interfere with their ability to resist intense urges to take drugs. These brain changes can be persistent, which is why drug addiction is considered a "relapsing" disease—people in recovery from drug use disorders are at increased risk for returning to drug use even after years of not taking the drug.

It's common for a person to relapse, but relapse doesn't mean that treatment doesn't work. As with other chronic health conditions, treatment should be ongoing and should be adjusted based on how the patient responds. Treatment plans need to be reviewed often and modified to fit the patient's changing needs.

What happens to the brain when a person takes drugs?

Most drugs affect the brain's "reward circuit" by flooding it with the chemical messenger dopamine. This reward system controls the body's ability to feel pleasure and motivates a person to repeat behaviors needed to thrive, such as eating and spending time with loved ones. This overstimulation of the reward circuit causes the intensely pleasurable "high" that can lead people to take a drug again and again.

As a person continues to use drugs, the brain adjusts to the excess dopamine by making less of it and/or reducing the ability of cells in the reward circuit to respond to it. This reduces the high that the person feels compared to the high they felt when first

taking the drug, an effect known as **tolerance**, which involves taking more of the drug to try to achieve the same dopamine high. It can also cause them to get less pleasure from other things they once enjoyed, like food or social activities.

Long-term use can cause changes in other brain chemical systems and circuits that can negatively impact a persons learning, judgment, decision-making, stress, memory, and behavior. Long-term use can also lead to drug dependence, where your body is used to functioning with the drug in your system. If you are dependent on a drug and the drug is removed, it can cause withdrawals symptoms. **Withdrawal** symptoms vary depending on the type of drug dependence and may include tremors (shaking), cravings, agitation, nausea, sweating, or changes in mood.

Despite being aware of these harmful outcomes, many people who use drugs continue to take them, which is the nature of addiction.

Why do some people become addicted to drugs while others don't?

No one factor can predict if a person will become addicted to drugs. A combination of factors influences risk for addiction. The more risk factors a person has, the greater the chance that taking drugs can lead to addiction. For example:

- Biology
  - The genes that people are born with account for about half of a person's risk for addiction. Gender, ethnicity, and the presence of other mental disorders may also influence risk for drug use and addiction.
- Environment
  - A person's environment includes many different influences, from family and friends to economic status and general quality of life. Factors such as peer pressure, physical and sexual abuse, early exposure to drugs, stress, and parental guidance can greatly affect a person's likelihood of drug use and addiction.
- Developmental stages
  - Genetic and environmental factors interact with critical developmental stages in a person's life to affect addiction risk. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it will progress to addiction. This is particularly problematic for teens. Because areas in their brains that control decision-making, judgment, and self-control are still developing, teens may be especially prone to risky behaviors, including trying drugs.

What are some consequences of drug abuse?

Drug abuse is a serious public health problem that affects many communities and families in some way. Each year drug abuse causes millions of serious illnesses or injuries among Americans. Drug abuse also plays a role in many major social problems, such as drugged driving, violence, stress, and child abuse. Drug abuse can lead to homelessness, crime, and missed work or problems with keeping a job. It harms unborn babies and destroys families.

Some people who are addicted don't believe that they are sick and out of control, so they don't look for treatment. They don't see the problems they are causing themselves and those around them. Other people who are addicted are aware of the problem, but may be so upset and confused that they do not know how to ask for or get help.

Drugs don't just hurt the person taking them. Everyone connected to the person can get hurt. When you or a loved one abuse drugs, everyday life can feel out of control.

Drug abuse affects the family in many ways, including:

- When a person has a drug problem, they have a disease that can hurt the family.
- Drug abuse puts a lot of stress on parents, brothers and sisters, children, grandparents—anyone who is part of the home.
- Family members might fight a lot because of the problems the drug abuse is causing.
- The drug user might do and say things that upset neighbors and friends, and make the family ashamed.

When family members take drugs, you may experience situations such as:

- You generally can't count on them to do what they say they will do.
- They may forget or get distracted because their focus is on getting and taking drugs.
- They might lie or steal money to buy drugs.
- They might get fired from their jobs.
- They might not come home at night.

- They may do bad things they would never do if they weren't abusing drugs.

Drug abuse can cause many problems including: Fighting and violence in and outside the home; money problems; trouble at school; trouble at work, losing a job; trouble in relationships; child abuse, neglect; driving accidents; and arrests and jail.

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10.3.2: Drug Abuse and Addiction

What is drug addiction?

Addiction is defined as a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences. It is considered a brain disease because drugs change the brain by changing its structure and how it works. These brain changes can be long- lasting and can lead to the harmful behaviors seen in people who abuse drugs.

Addiction is a lot like other diseases, such as heart disease. Both disrupt the normal, healthy functioning of the underlying organ, have serious harmful consequences, and are preventable and treatable, but if left untreated, can last a lifetime.

Why do people use drugs?

In general, people begin taking drugs for a variety of reasons:

- *To feel good*
  Most abused drugs produce intense feelings of pleasure. This initial sensation of euphoria is followed by other effects, which differ depending on the type of drug used. For example, with stimulants such as cocaine, the “high” is followed by feelings of power, self-confidence, and increased energy. In contrast, the euphoria caused by opiates, such as heroin, is followed by feelings of relaxation and satisfaction.
- *To feel better*
  Some people who suffer from social anxiety, stress-related disorders, and depression begin abusing drugs in an attempt to lessen feelings of distress. Stress can play a major role in initial drug use, continuing drug abuse, or relapse in patients recovering from addiction.
- *To do better*
  Some people feel pressure to chemically enhance or improve their cognitive or athletic performance, which can play a role in initial experimentation and continued abuse of drugs, such as prescription stimulants or anabolic/androgenic steroids.
- *To satisfy their curiosity and "because others are doing it"*
  In this respect, adolescents are particularly vulnerable because of the strong influence of peer pressure. Teens are more likely than adults to engage in risky or daring behaviors to impress their friends and express their independence from parental and social rules.

If taking drugs makes people feel good or better, what's the problem?

When they first use a drug, people may perceive what seem to be positive effects. They may also believe that they can control their use. However, drugs can quickly take over a person’s life. Over time, if drug use continues, other pleasurable activities become less pleasurable and taking the drug becomes necessary for the user just to feel *normal*. They may then compulsively seek and take drugs even though doing so causes tremendous problems for themselves and their loved ones. Some people may start to feel the need to take higher or more frequent doses, even in the early stages of their drug use. These are the telltale signs of an addiction.

Even relatively moderate drug use poses dangers. Consider how a social drinker can become intoxicated, get behind the wheel of a car, and quickly turn a pleasurable activity into a tragedy that affects many lives.

Is continued drug abuse a voluntary behavior?

The initial decision to take drugs is typically voluntary. However, with continued use, a person’s ability to exert self-control can become seriously impaired; this impairment in self-control is the hallmark of addiction. Brain imaging studies of people with addiction show physical changes in areas of the brain that are critical to judgment, decision making, learning and memory, and behavior control. Scientists believe that these changes alter the way the brain works and may help explain the compulsive and destructive behaviors of addiction.

Why do some people become addicted to drugs while others do not?

As with any other disease, vulnerability to addiction differs from person to person, and no single factor determines whether a person will become addicted to drugs. In general, the more **risk factors** a person has, the greater the chance that taking drugs will lead to abuse and addiction. **Protective factors**, on the other hand, reduce a person's risk of developing addiction. Risk and protective factors may be either environmental, such as conditions at home, at school, and in the neighborhood, or biological, for instance, a person's genes, his or her stage of development, and even a person's gender or ethnicity.

Risk and Protective Factors for Drug Abuse and Addiction	
Risk Factors	**Protective Factors**
Aggressive behavior in childhood	Good self-control
Lack of parental supervision	Parental monitoring and support
Poor social skills	Positive relationships
Drug experimentation	Academic competence
Availability of drugs at school	School anti-drug policies
Community poverty	Neighborhood pride

What environmental factors increase the risk of addiction?

- *Home and family*
  The influence of the home environment, especially during childhood, is a very important factor. Children with parents or older family members who abuse alcohol or drugs or engage in criminal behavior, have an increased risk of developing their own drug problems.
- *Peers and school*
  Friends and acquaintances can have an increasingly strong influence during adolescence. Drug-using peers can sway even those without risk factors to try drugs for the first time. Academic failure or poor social skills can put a child at further risk for using or becoming addicted to drugs.

What biological factors increase risk of addiction?

- *Genetics*
  Scientists estimate that genetic factors account for between 40 and 60 percent of a person's vulnerability to addiction. This includes the effects of environmental factors on the function and expression of a person's genes. A person's stage of development and other medical conditions a person may have are also factors. Adolescents and people with mental disorders are at greater risk of drug abuse and addiction than the general population.
- *Dramatic changes in brain development that occur during adolescence*
  One of the brain areas still maturing during adolescence is the prefrontal cortex—the part of the brain that enables us to

assess situations, make sound decisions, and keep our emotions and desires under control. The fact that this critical part of the adolescent brain is a work in progress puts teenagers at increased risk for making poor decisions, such as trying drugs or continuing to take them. Also, introducing drugs during this period of development may cause brain changes that have profound and long-lasting consequences.

What other factors increase the risk of addiction?

- *Early use*
  Although taking drugs at any age can lead to addiction, research shows that the earlier a person begins to use drugs, the more likely he or she is to develop serious problems. This increased risk may reflect the harmful effects that drugs can have on the developing brain. It may result from a mix of early social and biological vulnerability factors, including unstable family relationships, exposure to physical or sexual abuse, genetic susceptibility, or mental illness. Still, the fact remains that early use is a strong indicator of problems ahead, including addiction.
- *Method of administration*
  Smoking a drug or injecting it into a vein increases its addictive potential. Both smoked and injected drugs enter the brain within seconds, producing a powerful rush of pleasure. However, this intense “high” can fade within a few minutes, taking the abuser down to lower, more normal levels. Scientists believe this starkly felt contrast drives some people to repeated drug usage in an attempt to recapture the fleeting pleasurable state.

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10.3.3: Drug Facts

The following information provides short-term and long-term effects of various drugs along with the health-related issues. Additional drug facts can be reviewed at The National Institute of Drug Abuse- Drug Facts website.

Marijuana

Marijuana is made from the hemp plant, Cannabis sativa. The main psychoactive (mind-altering) chemical in marijuana is delta-9-tetrahydrocannabinol, or THC.

Table \({10{.}3{.}3{.}\eatSpaces{1} \endSpaces}\): Possible Health Effects of Marijuana

Time	Effects
Short-term	Enhanced sensory perception and euphoria followed by drowsiness/relaxation; slowed reaction time; problems with balance and coordination; increased heart rate and appetite; problems with learning and memory; hallucinations; anxiety; panic attacks; psychosis.
Long-term	Mental health problems, chronic cough, frequent respiratory infections.
Other Health-related Issues	Youth: possible loss of IQ points when repeated use begins in adolescence. Pregnancy: babies born with problems involving attention, memory, and problem solving.

Synthetic cannabinoids

Synthetic cannabinoids are human-made mind-altering chemicals that are either sprayed on dried, shredded plant material so they can be smoked or sold as liquids to be vaporized and inhaled in e-cigarettes and other devices. These products are also known as herbal or liquid incense, or synthetic marijuana (or fake weed).

Table \({10{.}3{.}3{.}\eatSpaces{2} \endSpaces}\): Possible Health Effects of Synthetic cannabinoids

Time	Effects
Short-term	Rapid heart rate, vomiting, violent behavior, suicidal thoughts, altered perception, symptoms of psychosis
Long-term	Withdrawal symptoms: headaches, anxiety, depression, irritability
Other Health-related Issues	Overdose may cause: toxic reactions, elevated blood pressure, reduced blood supply to the heart, kidney damage, and seizures Death may occur if mixed with synthetic opioids such as Fentanyl.

Cocaine

Cocaine is a powerfully addictive stimulant drug made from the leaves of the coca plant native to South America.

Table \({10{.}3{.}3{.}\eatSpaces{3} \endSpaces}\): Possible Health Effects of Cocaine

Time	Effects
Short-term	Narrowed blood vessels; enlarged pupils; increased body temperature, heart rate, and blood pressure; headache; abdominal pain and nausea; euphoria; increased energy, alertness; insomnia, restlessness; anxiety; erratic and violent behavior, panic attacks, paranoia, psychosis; heart rhythm problems, heart attack; stroke, seizure, coma.
Long-term	Loss of sense of smell, nosebleeds, nasal damage and trouble swallowing from snorting; infection and death of bowel tissue from decreased blood flow; poor nutrition and weight loss from decreased appetite.

Time	Effects
Other Health-related Issues	Pregnancy: premature delivery, low birth weight, smaller head circumference. Risk of HIV, hepatitis, and other infectious diseases from shared needles.

Methamphetamine

Methamphetamine is an extremely addictive stimulant amphetamine drug.

Table \({10{.}3{.}3{.}\eatSpaces{4} \endSpaces}\): Possible Health Effects of Methamphetamine

Time	Effects
Short-term	Increased wakefulness and physical activity; decreased appetite; increased breathing, heart rate, blood pressure, temperature; irregular heartbeat.
Long-term	Anxiety, confusion, insomnia, mood problems, violent behavior, paranoia, hallucinations, delusions, weight loss, severe dental problems (“meth mouth”), intense itching leading to skin sores from scratching.
Other Health-related Issues	Pregnancy: premature delivery; separation of the placenta from the uterus; low birth weight; lethargy; heart and brain problems. Risk of HIV, hepatitis, and other infectious diseases from shared needles.

Prescription CNS Depressants

Prescription CNS depressants are medicines that include sedatives, tranquilizers, and hypnotics that slow down brain activity and can cause sleepiness and loss of coordination. Continued use can lead to physical dependence and withdrawal symptoms if use is stopped. These includes drugs classified as Benzodiazepines, Non-Benzodiazepine Sedative Hypnotics, and Barbiturates.

Table \({10{.}3{.}3{.}\eatSpaces{5} \endSpaces}\): Possible Health Effects of CNS Depressants

Time	Effects
Short-term	Drowsiness, slurred speech, poor concentration, confusion, dizziness, problems with movement and memory, lowered blood pressure, slowed breathing.
Long-term	Physical dependence, withdrawal, possibility of seizures from rebound effect.
Other Health-related Issues	Sleep medications are sometimes used as date rape drugs (e.g. Rohypnol). Risk of HIV, hepatitis, and other infectious diseases from shared needles.
In Combination with Alcohol	Further slows heart rate and breathing, which can lead to death.

Prescription CNS Stimulants

Prescription stimulants are medicines generally used to treat attention-deficit hyperactivity disorder (ADHD) and narcolepsy—uncontrollable episodes of deep sleep. They increase alertness, attention, and energy.

Table \({10{.}3{.}3{.}\eatSpaces{6} \endSpaces}\): Possible Health Effects of CNS Stimulants

Time	Effects
Short-term	Increased blood pressure and heart rate, increased breathing, decreased blood flow, increased blood sugar, and opened-up breathing passages.
Long-term	Repeated misuse of prescription stimulants, even within a short period, can cause psychosis, anger, or paranoia.

Time	Effects
Other Health-related Issues	At high doses, prescription stimulants can lead to a dangerously high body temperature, an irregular heartbeat, heart failure, and seizures.

Prescription Opioids

Opioids are a class of drugs naturally found in the opium poppy plant. Opioids are often used as medicines because they contain chemicals that relax the body and can relieve pain. Opioids can cause euphoria and are often used non-medically, leading to overdose deaths. Heroin is one of the world's most dangerous opioids, and is never used as a medicine in the United States.

Table \({10{.}3{.}3{.}\eatSpaces{7} \endSpaces}\): Possible Health Effects of Opioids

Time	Effects
Short-term	Pain relief, drowsiness, nausea, constipation, euphoria, confusion, slowed breathing, death.
Long-term	Physical dependence, possible brain damage.
Other Health-related Issues	Pregnancy: Miscarriage, low birth weight, neonatal abstinence syndrome. Older adults: higher risk of accidental misuse or abuse because many older adults have multiple prescriptions, increasing the risk of drug-drug interactions, and breakdown of drugs slows with age; also, many older adults are treated with prescription medications for pain. Risk of HIV, hepatitis, and other infectious diseases from shared needles.
In Combination with Alcohol	Dangerous slowing of heart rate and breathing leading to coma or death.

Heroin

Heroin is an opioid drug made from morphine. Prescription opioid pain medicines such as OxyContin® and Vicodin® have effects similar to heroin. Research suggests that misuse of these drugs may open the door to heroin use.

Table \({10{.}3{.}3{.}\eatSpaces{8} \endSpaces}\): Possible Health Effects of Heroin

Time	Effects
Short-term	Euphoria; warm flushing of skin; dry mouth; heavy feeling in the hands and feet; clouded thinking; alternate wakeful and drowsy states; itching; nausea; vomiting; slowed breathing and heart rate.
Long-term	Collapsed veins; abscesses (swollen tissue with pus); infection of the lining and valves in the heart; constipation and stomach cramps; liver or kidney disease; pneumonia.
Other Health-related Issues	Pregnancy: miscarriage, low birth weight, neonatal abstinence syndrome. Risk of HIV, hepatitis, and other infectious diseases from shared needles.
In Combination with Alcohol	Dangerous slowdown of heart rate and breathing, coma, death.

Fentanyl

Fentanyl is a powerful synthetic opioid that is similar to morphine but is 50 to 100 times more potent. Like morphine, it is a medicine that is typically used to treat patients with severe pain, especially after surgery.

Synthetic opioids, including fentanyl, are now the most common drugs involved in drug overdose deaths in the United States. In 2022, 88 percent of opioid-related deaths involved fentanyl compared to 14.3 percent in 2010. Some drug dealers mix fentanyl with other drugs, such as heroin, cocaine, methamphetamine, and MDMA. This is because it takes very little to produce a high with fentanyl, making it a cheaper option.

Table \({10{.}3{.}3{.}\eatSpaces{9} \endSpaces}\): Possible Health Effects of Heroin

Time	Effects
Short-term	Extreme happiness, drowsiness, nausea, confusion, constipation, sedation, problems breathing, unconsciousness.
Long-term	Physical dependence, possible brain damage, withdrawal symptoms including: muscle and bone pain, sleep problems, diarrhea and vomiting, cold flashes with goose bumps, uncontrollable leg movements, and severe cravings.
Other Health-related Issues	Life-threatening symptoms of Fentanyl overdose include: slow/stop breathing, hypoxia, coma, brain damage, death.

Hallucinogens

Hallucinogens are a diverse group of drugs that alter a person's awareness of their surroundings as well as their own thoughts and feelings. They are commonly split into two categories: classic hallucinogens (such as LSD) and dissociative drugs (such as PCP). Both types of hallucinogens can cause *hallucinations*, or sensations and images that seem real though they are not. Additionally, dissociative drugs can cause users to feel out of control or disconnected from their body and environment. Common classic hallucinogens include: LSD,*Psilocybin, Peyote, DMT, and 251-NBOMe*. Common Dissociative hallucinogens include: PCP, ketamine, DXM, and Salvia.

Table \({10{.}3{.}3{.}\eatSpaces{10} \endSpaces}\): Possible Health Effects of Hallucinogens

Time	Effects
Short-term	Increased heart rate, nausea, intensified feelings and sensory experiences, changes in sense of time, increased blood pressure, breathing rate, or body temperature, loss of appetite, dry mouth, sleep problems, spiritual experiences, feelings of relaxation, uncoordinated movements, excessive sweating, panic, *paranoia*—extreme and unreasonable distrust of others, *psychosis*—disordered thinking detached from reality, and bizarre behaviors.
Long-term	Persistent psychosis, Hallucinogen Persisting Perception Disorder (HPPD), speech problems, memory loss, depression/ suicide.
Other Health-related Issues	Disrupt communication between brain chemical systems throughout the brain and spinal cord. Large or prolonged doses of dissociative drugs, like PCP, can cause seizures, coma, or death. Unintentional injuries could be caused by doing things they wouldn't do in real life, like jumping out of a window.

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10.3.4: Types of Drugs, Possible Health Effects, and Treatment Options

Click on the link below and review the information on commonly abused drugs. Make sure to explore the material, including possible health effects and treatment options when applicable, for the following substances:

- Alcohol
- GHB
- Inhalants
- Marijuana
- Methamphetamine
- Cocaine
- Heroin
- LSD
- MDMA/Molly
- Tobacco

Commonly Abused Drugs

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10.3.5: Drug Abuse or Addiction Treatment

Addiction is treatable and can be successfully managed, but the best is to prevent drug abuse in the first place.

As with most other chronic diseases, such as diabetes, asthma, or heart disease, treatment for drug addiction generally isn't a cure. Because addiction is a chronic disease, people can't simply stop using drugs for a few days and be cured. Most patients need long-term or repeated care to stop using completely and recover their lives.

People who are recovering from an addiction will be at risk for relapse for years and possibly for their whole lives. Research shows that combining addiction treatment medicines with behavioral therapy ensures the best chance of success for most patients. Treatment approaches tailored to each patient's drug use patterns and any co-occurring medical, mental, and social problems can lead to continued recovery.

More good news is that drug use and addiction are preventable. Results from NIDA-funded research have shown that prevention programs involving families, schools, communities, and the media are effective for preventing or reducing drug use and addiction. Although personal events and cultural factors affect drug use trends, when young people view drug use as harmful, they tend to decrease their drug taking. Therefore, education and outreach are key in helping people understand the possible risks of drug use. Teachers, parents, and health care providers have crucial roles in educating young people and preventing drug use and addiction.

Addiction treatment must help the person do the following:

- Stop using drugs
- Stay drug-free
- Be productive in the family, at work, and in society

Based on scientific research since the mid-1970s, the following key principles should form the basis of any effective treatment program:

- Addiction is a complex but treatable disease that affects brain function and behavior.
- No single treatment is right for everyone.
- People need to have quick access to treatment.
- Effective treatment addresses all of the patient's needs, not just his or her drug use.
- Staying in treatment long enough is critical.
- Counseling and other behavioral therapies are the most commonly used forms of treatment.
- Medications are often an important part of treatment, especially when combined with behavioral therapies.
- Treatment plans must be reviewed often and modified to fit the patient's changing needs.
- Treatment should address other possible mental disorders.
- Medically assisted detoxification is only the first stage of treatment.
- Treatment doesn't need to be voluntary to be effective.
- Drug use during treatment must be monitored continuously.
- Treatment programs should test patients for HIV/AIDS, hepatitis B and C, tuberculosis, and other infectious diseases as well as teach them about steps they can take to reduce their risk of these illnesses.

Successful treatment has several steps:

1. Detoxification (the process by which the body rids itself of a drug)
2. Behavioral counseling
    - Behavioral therapies help patients modify their attitudes and behaviors related to drug use and increase healthy life skills. Patients can receive treatment in many different settings with various approaches.
    - Outpatient behavioral treatment includes a wide variety of programs for patients who visit a behavioral health counselor on a regular schedule. Most of the programs involve individual or group drug counseling, or both. These programs typically offer forms of behavioral therapy such as cognitive-behavioral therapy, multidimensional family therapy, and motivational incentives (contingency management). Treatment is sometimes intensive at first, where patients attend multiple outpatient sessions each week. After completing intensive treatment, patients transition to regular outpatient treatment, which meets less often and for fewer hours per week to help sustain their recovery.
    - Inpatient or residential treatment can also be very effective, especially for those with more severe problems (including

co-occurring disorders). Licensed residential treatment facilities offer 24-hour structured and intensive care, including safe housing and medical attention.

3. Medication (for opioid, tobacco, or alcohol addiction)
    - Medications help suppress withdrawal symptoms during detoxification. Detoxification is not in itself “treatment,” but only the first step in the process. Patients who do not receive any further treatment after detoxification usually resume their drug use.
    - Patients can use medications to help re-establish normal brain function and decrease cravings to reduce the chances of a re-lapse. People who use more than one drug, which is very common, need treatment for all of the substances they use.
4. Evaluation and treatment for co-occurring mental health issues such as depression and anxiety
5. Long-term follow-up to prevent relapse

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10.3.6: Behavioral Addiction

Substance and behavioral addictions are known as Addiction Disorders. With substance addiction the person is physically addicted to a substance or drug, however with a behavioral addiction they are addicted to the positive physical and mental feelings associated with the behavior. Both types of addiction impact a persons physical and mental health and both types of addiction have similar negative consequences. Both addictions are characterized by a dependence on a substance or an activity[2].

Experts have identified six criteria to determine a behavioral addiction:

1. Salience: Domination of a person's life by the activity
2. Euphoria: A 'buzz' or a 'high' is derived from the activity
3. Tolerance: The activity has to be undertaken to a progressively greater extent to achieve the same 'buzz'
4. Withdrawal Symptoms: Cessation of the activity leads to the occurrence of unpleasant emotions or physical effects
5. Conflict: The activity leads to conflict with others or self-conflict
6. Relapse and Reinstatement: Resumption of the activity with the same vigor subsequent to attempts to abstain, negative life consequences, and negligence of job, educational or career opportunities.

Common Behavioral Addiction Disorders include gambling addiction, shopping addiction, and internet gaming addiction.

As with drug addiction, the best treatment for behavioral addiction is prevention.

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10.3.7: Alcohol, Nicotine, e-cigarettes, and Prescription Drugs

Click on the following links to learn more about alcohol and alcohol abuse:

- Alcohol Abuse FAQs
- College Drinking

Click on the following link for information about nicotine addiction:

- Nicotine Addiction

Watch the video linked below to learn about the consequences of teens using e- cigarettes:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Transcript

Watch the video linked below to learn more about prescription drug abuse in teens:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

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Transcript

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10.3.8: Assessing Your Personal Risk Factors for Substance Use and Abuse-

Complete **one** of the following Labs to assess your personal risk factors for substance use and abuse. Choose the Lab most relevant for you. Submit the Lab per your Instructor's directions.

If you drink alcohol complete the following Lab:

1. Alcohol Use Lab

If you smoke cigarettes, complete the following Lab:

2. Cigarette Use Lab

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10.3.9: End-of-Chapter Material

Key takeaways for Chapter 8

- Drug addiction is a chronic disease characterized by compulsive, difficult to control drug seeking despite harmful consequences.
- The pleasurable “high” along with changes in the brain can lead to drug dependence and addiction.
- Tolerance to a drug leads to increase use of the drug.
- Withdrawal symptoms can be a sign of drug dependence.
- No single factor can predict whether a person will become addicted to drugs.
- Drug addiction is treatable and can be successfully managed.
- Prevention is key. Teachers, parents, and health care providers have crucial roles in educating young people and preventing drug use and addiction.

References

1. Substance Abuse and Mental Health Services Administration. (2022). Key substance use and mental health indicators in the United States: Results from the 2022 National Survey on Drug Use and Health (HHS Publication No. PEP21-07-01-003, NSDUH Series H-56). Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration. Retrieved from https://www.samhsa.gov/data/
2. Alavi, S. S., Ferdosi, M., Jannatifard, F., Eslami, M., Alaghemandan, H., & Setare, M. (2012). Behavioral Addiction versus Substance Addiction: Correspondence of Psychiatric and Psychological Views. International journal of preventive medicine, 3(4), 290–294.

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- 14.9: Prokaryotic Cell Division has no license indicated.

10.3.10: Recognizing Drugs and Addiction- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

A new way to help young people with their mental health

Break the silence for suicide attempt survivors

Debunking the myths of OCD

How do antidepressants work?

How gratitude rewires your brain

How to discover your “why” in difficult times

How to protect your mental well-being online — from a Gen-Zer

The gift and power of emotional courage

The Housing First approach to homelessness

The psychology of post-traumatic stress disorder

The voices in my head

What causes panic attacks, and how can you prevent them?

What is bipolar disorder?

What makes a good life? Lessons from the longest study on happiness

What’s normal anxiety — and what’s an anxiety disorder?

What's your happiness score?

Why we get mad — and why it's healthy

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11: ALCOHOL AND NICOTINE

11.1: Alcohol

11.2: Tobacco

11.3: Evaluating Alcohol and Tobacco

11.3.1: The Use of Alcohol

11.3.2: Health Effects of Alcohol Abuse

11.3.3: Rethinking Drinking

11.3.4: Tobacco Use

11.3.5: Quitting Smoking

11.3.6: End-of-Chapter Material

11.3.7: Alcohol and Tobacco- Optional Continued Learning

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11.1: Alcohol

Alcohol Abuse

If you are like many Americans, you drink alcohol at least occasionally. For many people, moderate drinking is probably safe. It may even have health benefits, including reducing your risk of certain heart problems. Moderate drinking is one drink a day for women or anyone over 65, and two drinks a day for men under 65.

Some people should not drink at all, including alcoholics, children, pregnant women, people on certain medicines and people with some medical conditions.

Anything more than moderate drinking can be risky. Binge drinking—drinking five or more drinks at one time—can damage your health and increase your risk for accidents, injuries and assault. Years of heavy drinking can lead to liver disease, heart disease, cancer and pancreatitis. It can also cause problems at home, at work and with friends.

Exercise 11.1.1

1. How many drinks for males within a short period of time is considered binge drinking? How many drinks for females within a short period of time is considered binge drinking?
2. True or false: Binge drinking is a risk factor for sexual assault, especially among young women in college settings. Each year, about 1 in 20 college women are sexually assaulted. Binge drinking also increases the chances of car crashes, violence against others, unintended pregnancies, and the spread of HIV and sexually transmitted diseases.
3. What is the most commonly used and abused substance among youth in the United States, more than tobacco and illicit drugs?
4. True or false: Teens and young adults who do not get enough sleep are at risk for automobile crashes, poor grades and performance in school, depressed moods, and problems with peer and adult relationships.

Answer available at the end of this section.

Beyond Hangovers

A brightly colored cosmopolitan is the drink of choice for the glamorous characters in Sex and the City. James Bond depends on his famous martini—shaken, not stirred—to unwind with after confounding a villain. And what wedding concludes without a champagne toast?

Alcohol is part of our culture—it helps us celebrate and socialize, and it enhances our religious ceremonies. But drinking too much—on a single occasion or over time—can have serious consequences for our health. Most Americans recognize that drinking too much can lead to accidents and dependence. But that's only part of the story. In addition to these serious problems, alcohol abuse can damage organs, weaken the immune system, and contribute to cancers. Plus, much like smoking, alcohol affects different people differently. Genes, environment, and even diet can play a role in whether you develop an alcohol-related disease.

On the flip side, some people actually may benefit from drinking alcohol in small quantities. Sound complicated? It sure can be. To stay healthy, and to decide what role alcohol should play in your life, you need accurate, up-to-date information. This brochure is designed to offer you guidance based on the latest research on alcohol's effect on your health.

Moderate and Binge Drinking

Moderate or "low-risk" drinking

Research shows that people who drink moderately may be less likely to experience an alcohol use disorder (AUD). These drinking levels, which differ for men and women, are:

For men:

- No more than 4 drinks on any single day AND no more than 14 drinks per week

For women:

- No more than 3 drinks on any single day AND no more than 7 drinks per week

To stay low risk for AUDs, you must keep within both the single-day and weekly limits.

Even within these limits, you can have problems if you drink too quickly or have other health issues. To keep your risk for problems low, make sure you:

- Drink slowly
- Eat enough while drinking

Certain people should avoid alcohol completely, including those who:

- Plan to drive a vehicle or operate machinery
- Take medications that interact with alcohol
- Have a medical condition that alcohol can aggravate
- Are pregnant or trying to become pregnant

Heavy or “at-risk” drinking

For healthy adults in general, heavy drinking means consuming more than the single-day or the weekly amounts listed above. About 1 in 4 people who drink above these levels already has alcohol dependence or alcohol abuse problems.

Binge drinking

Binge drinking means drinking so much within about 2 hours that blood alcohol concentration (BAC) levels reach 0.08g/dL. For women, this usually occurs after about 4 drinks, and for men, after about 5.

Drinking this way can pose health and safety risks, including car crashes and injuries. Over the long term, binge drinking can damage the liver and other organs.

Learning Activity

Find out about alcohol content in drinks, calories in alcoholic drinks, and the cost of drinking. Use the Cocktail Content Calculator to find out how strong your mixed drink or cocktail is.

1. Do you know how many “standard drinks” are in an alcoholic beverage? Use the Drink Size Calculator to find out.
2. Find out how many calories are in your alcoholic beverage of choice using the Alcohol Calorie Calculator.
3. How much do you spend on alcohol. Use the Alcohol Spending Calculator to find out.

A Little Goes a Long Way: Know the Amounts

Knowing how much alcohol constitutes a “standard” drink can help you determine how much you are drinking and understand the risks. One standard drink contains about 0.6 fluid ounces or 14 grams of pure alcohol. In more familiar terms, the following amounts constitute one standard drink:

- 12 fluid ounces of beer (about 5% alcohol)
- 8 to 9 fluid ounces of malt liquor (about 7% alcohol)
- 5 fluid ounces of table wine (about 12% alcohol)
- 1.5 fluid ounces of hard liquor (about 40% alcohol)

You're chatting with friends at a party and a waitress comes around with glasses of champagne. You drink one, then another, maybe even a few more. Before you realize it, you are laughing more loudly than usual and swaying as you walk. By the end of the evening, you are too slow to move out of the way of a waiter with a dessert tray and have trouble speaking clearly. The next morning, you wake up feeling dizzy and your head hurts. You may have a hard time remembering everything you did the night before.

These reactions illustrate how quickly and dramatically alcohol affects the brain. The brain is an intricate maze of connections that keeps our physical and psychological processes running smoothly. Disruption of any of these connections can affect how the brain works. Alcohol also can have longer-lasting consequences for the brain—changing the way it looks and works and resulting in a range of problems.

Most people do not realize how extensively alcohol can affect the brain. But recognizing these potential consequences will help you make better decisions about what amount of alcohol is appropriate for you.

What happens inside the brain?

The brain's structure is complex. It includes multiple systems that interact to support all of your body's functions—from thinking to breathing to moving.

These multiple brain systems communicate with each other through about a trillion tiny nerve cells called neurons. Neurons in the brain translate information into electrical and chemical signals the brain can understand. They also send messages from the brain to the rest of the body.

Chemicals called *neurotransmitters* carry messages between the neurons. Neurotransmitters can be very powerful. Depending on the type and the amount of neurotransmitter, these chemicals can either intensify or minimize your body's responses, your feelings, and your mood. The brain works to balance the neurotransmitters that speed things up with the ones that slow things down to keep your body operating at the right pace.

Alcohol can slow the pace of communication between neurotransmitters in the brain.

Fetal Alcohol Syndrome

Alcohol can affect the brain at any stage of development—even before birth. Fetal alcohol spectrum disorders are the full range of physical, learning, and behavioral problems, and other birth defects that result from prenatal alcohol exposure. The most serious of these disorders, *fetal alcohol syndrome* (FAS), is characterized by abnormal facial features and is usually associated with severe reductions in brain function and overall growth. FAS is the leading preventable birth defect associated with mental and behavioral impairment in the United States today.

The brains of children with FAS are smaller than normal and contain fewer cells, including neurons. These deficiencies result in life-long learning and behavioral problems. Current research is investigating whether the brain function of children and adults with FAS can be improved with complex rehabilitative training, dietary supplements, or medications.

Alcohol and Heart Disease

Americans know how prevalent heart disease is—about 1 in 12 of us suffer from it. What we don't always recognize are the connections heart disease shares with alcohol. On the one hand, researchers have known for centuries that excessive alcohol consumption can damage the heart. Drinking a lot over a long period of time or drinking too much on a single occasion can put your heart—and your life—at risk. On the other hand, researchers now understand that drinking moderate amounts of alcohol can protect the hearts of some people from the risks of coronary artery disease.

Deciding how much, if any, alcohol is right for you can be complicated. To make the best decision for yourself, you need to know the facts and then consult your physician.

Cancer Risk

Genetics, environment, and lifestyle habits can all heighten your risk of getting cancer. We can't do anything to change our genes, and we often can't do much to change our environment. But lifestyle habits are a different story.

Drinking too much alcohol is one lifestyle habit that can increase your risk of developing certain cancers. This does not mean that anyone who drinks too much will develop cancer. But numerous studies do show the more you drink, the more you increase your chances of developing certain types of cancer.

For example, a group of Italy-based scientists reviewed more than 200 studies examining alcohol's impact on cancer risk. The collective results of these studies clearly demonstrate that the more you drink, the higher your risk for developing a variety of cancers. The National Cancer Institute identifies alcohol as a risk factor for the following types of cancer:

- Mouth
- Esophagus
- Pharynx
- Larynx
- Liver
- Breast

At least 7 out of 10 people with mouth cancer drink heavily. Drinking five or more drinks per day can also increase your risk of developing other types of cancers, including colon or rectal cancer. In fact, summary estimates from the recent World Cancer Research Fund report indicate that women who drink five standard alcohol drinks each day have about 1.2 times the risk of developing colon or rectal cancer than women who do not drink at all.

People who drink are also more likely to smoke, and the combination increases the risk significantly. Smoking alone is a known risk factor for some cancers. But smoking and drinking together intensifies the cancer-causing properties of each substance. The overall effect poses an even greater risk.

The risk of throat and mouth cancers is especially high because alcohol and tobacco both come in direct contact with those areas. Overall, people who drink and smoke are 15 times more likely to develop cancers of the mouth and throat than nondrinkers and nonsmokers. In addition, recent studies estimate that alcohol and tobacco together are responsible for:

- 80 percent of *throat and mouth cancer* in men
- 65 percent of throat and mouth cancer in women
- 80 percent of *esophageal squamous cell carcinoma*, a type of esophagus cancer
- 25 to 30 percent of all liver cancers

Know the Benefits

Research shows that healthy people who drink moderate amounts of alcohol may have a lower risk of developing coronary heart disease than nondrinkers. Moderate drinking is usually defined as no more than two drinks in a given day for men and one drink per day for women who are not pregnant or trying to conceive.

A variety of factors, including diet, genetics, high blood pressure, and age, can cause fat to build up in your arteries, resulting in coronary heart disease. An excess of fat narrows the coronary arteries, which are the blood vessels that supply blood directly to the heart. Clogged arteries reduce blood supply to the heart muscle, and make it easier for blood clots to form. Blood clots can lead to both heart attacks and strokes.

According to recent studies, drinking moderately can protect your heart from these conditions. Moderate drinking helps inhibit and reduce the build-up of fat in the arteries. It can raise the levels of HDL—or "good" cholesterol—in the blood, which wards off heart disease. It can help guard against heart attack and stroke by preventing blood clots from forming and by dissolving blood clots that do develop. Drinking moderately also may help keep blood pressure levels in check.

These benefits may not apply to people with existing medical conditions, or who regularly take certain medications. In addition, researchers discourage people from beginning to drink just for the health benefits. Rather, you can use this research to help you spark a conversation with your medical professional about the best path for you.

Learning Activity

Find out what it takes to cut down or quit drinking alcohol at Rethinking Drinking, Alcohol and Your Health.

- What are your reasons for and against making a change?
- What are small changes that can make a big difference?

See where you stand:

- Check your drinking pattern.
- See if you have signs of a problem.
- Track what you drink with drinking tracker cards.

Decide whether & how to change:

- Weigh your reasons for and against making a change
- Plan a change.
- Choose tips for cutting back or quitting.

Stay in control:

- Handle urges to drink.
- Build skills in refusing drinks.

Sources

Alcohol Abuse: Alcohol Abuse, NIH: National Institute on Alcohol Abuse and Alcoholism via Medline, http://www.nlm.nih.gov/medlineplus/alcohol.html

Quick Quiz: College Health, CDC, http://www.cdc.gov/Features/CollegeHealth/

Beyond Hangovers: Beyond Hangovers, NIAAA, NIH, pubs.niaaa.nih.gov/publications/Hangovers/beyondHangovers.htm

Moderate and Binge Drinking: Moderate & Binge Drinking, National Institute on Alcohol Abuse and Alcoholism, NIAAA, NIH

A Little Goes a Long Way: Know the Amounts: Beyond Hangovers, NIAAA, NIH, pubs.niaaa.nih.gov/publications/Hangovers/beyondHangovers.htm

Answers

Exercise 11.1.1

1. males—5 or more within a short period of time, females—4 or more within a short period of time;
2. true
3. Alcohol
4. true

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11.2: Tobacco

The 30th tobacco-related Surgeon General's report issued since 1964 describes in detail the specific pathways by which tobacco smoke damages the human body. The scientific evidence supports the following conclusions:

There is no safe level of exposure to tobacco smoke.

- Any exposure to tobacco smoke—even an occasional cigarette or exposure to secondhand smoke—is harmful.
- You don't have to be a heavy smoker or a long-time smoker to get a smoking-related disease or have a heart attack or asthma attack that is triggered by tobacco smoke.
- Low levels of smoke exposure, including exposures to secondhand tobacco smoke, lead to a rapid and sharp increase in dysfunction and inflammation of the lining of the blood vessels, which are implicated in heart attacks and stroke.
- Cigarette smoke contains more than 7,000 chemicals and compounds. Hundreds are toxic and at least 69 cause cancer. Tobacco smoke itself is a known human carcinogen.
- Chemicals in tobacco smoke interfere with the functioning of fallopian tubes, increasing risk for adverse pregnancy outcomes such as ectopic pregnancy, miscarriage, and low birth weight. They also damage the DNA in sperm which might reduce fertility and harm fetal development.

Damage from tobacco smoke is immediate.

- The chemicals in tobacco smoke reach your lungs quickly every time you inhale. Your blood then carries the toxicants to every organ in your body.
- The chemicals and toxicants in tobacco smoke damage DNA, which can lead to cancer. Nearly one-third of all cancer deaths every year are directly linked to smoking. Smoking causes about 85% of lung cancers in the U.S.
- Exposure to tobacco smoke quickly damages blood vessels throughout the body and makes blood more likely to clot. This damage can cause heart attacks, strokes, and even sudden death.
- The chemicals in tobacco smoke inflame the delicate lining of the lungs and can cause permanent damage that reduces the ability of the lungs to exchange air efficiently and leads to chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis.

Smoking longer means more damage.

- Both the risk and the severity of many diseases caused by smoking are directly related to how long the smoker has smoked and the number of cigarettes smoked per day.
- Chemicals in tobacco smoke cause inflammation and cell damage, and can weaken the immune system. The body makes white blood cells to respond to injuries, infections, and cancers. White blood cell counts stay high while smoking continues, meaning the body is constantly fighting against the damage caused by smoking which can lead to disease in almost any part of the body.
- Smoking can cause cancer and weaken your body's ability to fight cancer. With any cancer—even those not related to tobacco use—smoking can decrease the benefits of chemotherapy and other cancer treatments. Exposure to tobacco smoke can help tumors grow.
- The chemicals in tobacco smoke complicate the regulation of blood sugar levels, exacerbating the health issues resulting from diabetes. Smokers with diabetes have a higher risk of heart and kidney disease, amputation, eye disease causing blindness, nerve damage and poor circulation.

Cigarettes are designed for addiction.

- The design and contents of tobacco products make them more attractive and addictive than ever before. Cigarettes today deliver nicotine more quickly from the lungs to the heart and brain.
- The powerful addicting elements of tobacco products affect multiple types of nicotine receptors in the brain.
- Evidence suggests that psychosocial, biologic, and genetic factors may also play a role in nicotine addiction.

There is no safe cigarette.

- The evidence indicates that changing cigarette designs over the last five decades, including filtered, low-tar, and "light" variations, have NOT reduced overall disease risk among smokers and may have hindered prevention and cessation efforts.

- The overall health of the public could be harmed if the introduction of novel tobacco products encourages tobacco use among people who would otherwise be unlikely to use a tobacco product or delays cessation among persons who would otherwise quit using tobacco altogether.

The only proven strategy for reducing the risk of tobacco-related disease and death is to never smoke, and if you do smoke to quit.

- Quitting at any age and at any time is beneficial. It's never too late to quit, but the sooner the better.
- Quitting gives your body a chance to heal the damage caused by smoking.
- When smokers quit, the risk for a heart attack drops sharply after just 1 year; stroke risk can fall to about the same as a nonsmoker's after 2–5 years; risks for cancer of the mouth, throat, esophagus, and bladder are cut in half after 5 years; and the risk for dying of lung cancer drops by half after 10 years.
- Smokers often make several attempts before they are able to quit, but new strategies for cessation, including nicotine replacement and non-nicotine medications, can make it easier.

The evidence indicates that changing cigarette designs over the last five decades, including filtered, low-tar, and "light" variations, have NOT reduced overall disease risk among smokers and may have hindered prevention and cessation efforts.

The overall health of the public could be harmed if the introduction of novel tobacco products encourages tobacco use among people who would otherwise be unlikely to use a tobacco product or delays cessation among persons who would otherwise quit using tobacco altogether.

Learning Activity

Follow two people as they attempt to lead healthier lives, and learn how the choices you make depend on what choices are available.

- If you were told you had to quit smoking and lose 20 pounds, how easy would it be for you?

Quitting

The only proven strategy for reducing the risk of tobacco-related disease and death is to never smoke, and if you do smoke to quit.

Quitting at any age and at any time is beneficial. It's never too late to quit, but the sooner the better. Quitting gives your body a chance to heal the damage caused by smoking. When smokers quit, the risk for a heart attack drops sharply after just 1 year; stroke risk can fall to about the same as a nonsmoker's after 2-5 years; risks for cancer of the mouth, throat, esophagus, and bladder are cut in half after 5 years; and the risk for dying of lung cancer drops by half after 10 years. Smokers often make several attempts before they are able to quit, but new strategies for cessation, including nicotine replacement and non-nicotine medications, can make it easier.

Tobacco smoke is a toxic mix of more than 7,000 chemicals. Many are poisons. When these chemicals get deep into your body's tissues, they cause damage. Your body must fight to heal the damage each time you smoke. Over time, the damage can lead to disease.

The chemicals in tobacco smoke reach your lungs quickly when you inhale. What this new report shows is that *these same poisonous chemicals reach every organ in your body*. They go quickly from your lungs into your blood. Then the blood flows through your arteries. It carries the chemicals to tissues in all parts of your body. Your lungs, blood vessels, and other delicate tissues become inflamed and damaged when you smoke.

Smoking Keeps Your Body under Attack

If you spilled drain cleaner on your skin, it would hurt and become inflamed. If you did this many times a day, your skin would not have a chance to heal. It would stay red, irritated, and inflamed. The organs in your body also have a lining of cells similar to skin. Chemicals in tobacco smoke cause inflammation and damage to these cells. When you keep smoking, the damage cannot heal.

Smoking makes your immune system work overtime. Your body makes white blood cells to respond to injuries, infections, and even cancers. Blood tests show that your white blood cell numbers stay high when you smoke. High numbers mean that your body is constantly fighting against the damage caused by tobacco smoke. This constant stress disrupts how your body works. New research shows that stress can lead to disease in almost any part of your body.

Damage is Immediate

The poisons in smoke pose a danger right away. Sudden blood clots, heart attacks, and strokes can be triggered by tobacco smoke. Poisons in tobacco smoke disrupt the way your body heals itself. Even smoking a cigarette now and then is enough to hurt you. Sitting in a smoky bar raises your odds of a heart attack.

The more years you smoke, the more you hurt your body. Scientists now know that your disease risk surges even higher after you have smoked for about 20 years. But research shows that if you quit by age 30, your health could become almost as good as a nonsmoker's. At any age, the sooner you quit, the sooner your body can begin to heal.

Nicotine is Powerfully Addictive

Addiction to nicotine changes the chemical balance in your brain. Addiction keeps people smoking even when they want to quit. Breaking addiction is harder for some people than others. Many people need more than one try in order to quit.

Scientists now know more about why the brain craves nicotine. Like heroin or cocaine, nicotine changes the way your brain works and causes you to crave more and more nicotine. These powerful cravings make it hard for you to think about anything else. Smoking can cause both physical and mental addiction.

Cigarettes are Designed for Addiction

Cigarette makers have long known that nicotine addiction helps sell their products. Cigarettes today deliver more nicotine and deliver it quicker than ever before. The additives and chemicals that tobacco companies put in cigarettes may have helped make them.

You might have thought that "filtered," "low-tar," or "light" cigarettes were less dangerous than others. But research shows that these cigarettes are every bit as addictive and are no safer than other cigarettes. Misleading labels are no longer allowed.

Many teens who try cigarettes don't know how easy it is to become addicted. Nicotine addiction is so powerful that every day about 1,000 teens become daily smokers. Why is this important? Because most current smokers became addicted as teenagers.

You Can Beat Addiction to Tobacco

Smokers who quit go through withdrawal. The first days are the most uncomfortable. The physical symptoms of nicotine addiction end about 3 weeks after you quit smoking. But you may still have an urge to smoke when you wake up, drink coffee, or are out with friends. It takes longer to break these patterns. But you can beat it.

Learning Activity

Youth are being targeted by the big tobacco industry through Hollywood movies. This video was created by the Sudbury & District Health Unit's Youth Program Advisors to raise public awareness of this issue.

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

- What movies and TV shows do you think glorify smoking?

Myths about Smoking and Cigarettes

Smoking is just a choice.

The first time? Yes. After just a few cigarettes? No. Addiction to nicotine can happen quickly. It changes the chemical balance in your brain. Smoking may seem like it's just a choice or a habit. In fact, most people who use tobacco are addicted. Breaking nicotine addiction is harder for some people than others. Quitting can take several tries. But don't give up. If you need help to quit, ask your doctor about nicotine replacement, medicines, or coaching.

Filters make cigarettes safer.

Filters do not protect you. They are designed to make smoke particles smaller. That makes nicotine easier to absorb. This increases addiction. Cigarettes have been engineered to speed up nicotine's path to your brain. Their design feeds addiction. Light or low-tar cigarettes may sound less dangerous. They aren't. These misleading labels are no longer allowed. No cigarette is safe. Tobacco smoke contains more than 7,000 chemicals. At least 250 are toxic.

An occasional cigarette is no big deal.

Smoking doesn't just cause diseases for heavy smokers or longtime smokers. The 2010 Surgeon General's Report shows how breathing tobacco smoke can cause immediate harm. Tobacco smoke can trigger sudden heart attacks and death, even in nonsmokers. Each cigarette you smoke hurts your lungs, your blood vessels, and cells throughout your body. Smoking a few cigarettes a week can cause a heart attack. Cutting back is not enough to protect you. You have to quit entirely.

It's too late to quit—the damage is already done.

It's true that the longer you use tobacco, the more you hurt your body. But at any age, the sooner you quit, the sooner your health can improve. The 2010 Surgeon General's Report shows how using tobacco causes disease almost everywhere in your body. Within 20 minutes after quitting, your body starts to heal. After 2 to 5 years, your risk for stroke is similar to that of a nonsmoker. In 10 years, your lung cancer risk is cut in half.

Secondhand smoke may bother people, but it isn't dangerous.

Tens of thousands of nonsmokers die every year from breathing others' secondhand smoke. Breathing the chemicals in tobacco smoke changes your blood's chemistry almost immediately. Deadly clots can form and block arteries to your heart or brain. When you smoke at work, home, or at a restaurant, everyone there breathes poisons. If you smoke in your car, rolling down a window does not protect your passengers. It is not healthy to breathe any amount of tobacco smoke.

The little bit of smoke that my kids get doesn't hurt them.

Don't smoke or let others smoke around your children. They can get bronchitis, pneumonia, and ear infections from smoke. Even if you only smoke by an open window, some of the smoke stays in your house and poisons the air your children breathe. Children with asthma can have a serious, even deadly, asthma attack from breathing secondhand smoke. The best way to protect children is to quit smoking. If you or someone else in your household are not ready to quit, be sure to make your home and car 100% smoke-free.

Sources

Source: A Report of the Surgeon General: How Tobacco Smoke Causes Disease, The Biology and Behavioral Basis for Smoking-Attributable Disease Fact Sheet 2010, http://www.surgeongeneral.gov/library/tobaccosmoke/factsheet.htmlMore Information

Myths about Smoking and Cigarettes: Myths about Smoking and Cigarettes, CDC, http://www.cdc.gov/tobacco/data_statistics/sgr/2010/myths/pdfs/myths.pdf

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11.3: EVALUATING ALCOHOL AND TOBACCO

Learning Outcomes

By the end of this chapter you will be able to:

- Define what is meant by a drink.
- Explain what excessive alcohol consumption entails.
- Estimate Blood Alcohol Concentrations (BAC).
- Describe short term and long term effects of alcohol consumption.
- Explain the harmful effects of Nicotine.
- Describe the short term and long term effects of tobacco use.

How much alcohol or tobacco is safe for you to consume?

How does alcohol or tobacco impact physical and emotional health?

How many people suffer from diseases causes by alcohol and tobacco?

What are steps you can take to reduce or eliminate your use of alcohol and tobacco?

Why is it important for your health to understand the use of alcohol and tobacco? Because each year, a large numbuer of deaths are attributed to the use of tobacco (480,000 deaths) or alcohol (140,000 deaths) in the United States. Using tobacco or alcohol are a lifestyle choice that increases your risk of death. It is important for you to be aware of the risks.

11.3.1: The Use of Alcohol

11.3.2: Health Effects of Alcohol Abuse

11.3.3: Rethinking Drinking

11.3.4: Tobacco Use

11.3.5: Quitting Smoking

11.3.6: End-of-Chapter Material

11.3.7: Alcohol and Tobacco- Optional Continued Learning

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11.3.1: The Use of Alcohol

What is a “drink”?

In the United States, a standard drink contains 0.6 ounces (14.0 grams or 1.2 tablespoons) of pure alcohol. Generally, this amount of pure alcohol is found in:

- 12-ounces of beer (5% alcohol content).
- 5-ounces of wine (12% alcohol content).
- 1.5-ounces of 80-proof (40% alcohol content) distilled spirits or liquor (e.g., gin, rum, vodka, whiskey).

Understanding Intoxication Levels: Blood Alcohol Concentration (BAC)

A blood alcohol test measures the level of Alcohol in your blood. This is typically done by using a breathalyzer or a blood test. Typically a blood alcohol concentration (BAC) greater than 0.08% is an indicator of intoxication, it means that you have 0.08 g of alcohol for every 100 ml of blood in your body. All states in the United States have adopted 0.08% as the legal limit for operating a motor vehicle for drivers aged 21 years or older (except for Utah, which adopted a 0.05% legal limit in 2018).

The liver is the main organ that processes, or metabolizes, alcohol and it can only process a small amount at a time, which is on average about one standard drink per hour. If you drink more alcohol than your liver can process then you will begin to feel the effects of intoxication. As blood alcohol concentration (BAC) increases, so does the effect of alcohol—as well as the risk of harm. When BAC reaches high levels, blackouts (gaps in memory), loss of consciousness (passing out), and death can occur.

It is important to recognize that the “one drink per hour” is an average and the actual time it takes your body to metabolize alcohol can vary for each person, for example it varies between men and women, whether you have eaten food, and the amount of alcohol consumed.

Examples of BAC Differences

- A male and female who weigh the same, eat the exact same meal, and drink the same amount of alcohol will have different BAC. Women tend to have higher body fat percentage than men and less total blood volume, which means there will be a higher concentration of alcohol in their blood thus increasing their BAC.
- Genetic differences can lead to differences in the amounts of enzymes that breakdown alcohol thus impacting the bodies ability to metabolize alcohol and increasing BAC.
- Females have lower amounts of an enzyme called Alcohol dehydrogenase (ADH). ADH is responsible for metabolizing alcohol in both the stomach and the liver. Since women have lower amounts of the enzyme they will have higher BAC than Males.
- A person who regularly drinks can build up tolerance because their body may increase production of the enzymes that breakdown alcohol.
- A person who drinks excessively for a long time might cause liver damage, which means their liver cannot effectively metabolize alcohol thus increasing their BAC.
- Men have a greater ratio of muscle to fat than do women. Muscle has a large amount of blood that flows through the muscle tissue. Fat has a much smaller amount of blood. The functional difference this makes is that alcohol is more diluted in a man’s body due to this larger volume of blood. Since women tend to have a higher percentage of body fat than men, this results in a higher BAC level for women compared to men.
- As the percentage of body fat increases, the BAC increases—this is because the total body water is lower, and that means that the alcohol is confined to this smaller volume.
- Absorption of alcohol is dependent on how quickly it can move through your stomach, this is called the gastric emptying rate. If your stomach is empty, gastric emptying increases, but if your stomach is full the gastric emptying slows down. Thus a full stomach will mean that the alcohol will take longer to absorb.

Alcohol Consumption Levels

Although the majority of U.S. adults consume alcoholic beverages, the Dietary Guidelines for Americans recommends limited

consumption of alcohol and encourages people who have never drank alcohol to continue to abstain.

For those who choose to consume alcohol it is recommended to limit yourself to a **moderate consumption level** which is defined as up to 1 drink per day for women and up to 2 drinks per day for men.

People should avoid **excessive alcohol consumption**, which includes binge drinking, heavy drinking, and any drinking by pregnant women or people younger than age 21.

Binge drinking is the most common form of excessive drinking. About 66 percent of adults ages 21 through 59 report alcoholic beverage consumption in the past month, and of those, approximately half report binge drinking, sometimes multiple times per month, which can lead to high BAC levels.

A person is considered to be a **binge drinker** if they consume the following:

- For women, 4 or more drinks during a single occasion.
- For men, 5 or more drinks during a single occasion.

A person is considered to be a **heavy drinker** if they consume the following:

- For women, 8 or more drinks per week.
- For men, 15 or more drinks per week.

There are some people who should not drink any alcohol, including those who are:

- Younger than age 21.
- Pregnant or may be pregnant.
- Driving, planning to drive, or participating in other activities requiring skill, coordination, and alertness.
- Taking certain prescription or over-the-counter medications that can interact with alcohol.
- Suffering from certain medical conditions.
- Recovering from alcoholism or are unable to control the amount they drink.

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11.3.2: Health Effects of Alcohol Abuse

Drinking too much, on a single occasion or over time, can take a serious toll on your health. Here's how alcohol can affect your body:

- Brain
  - Alcohol interferes with the brain's communication pathways, and can affect the way the brain looks and works. These disruptions can change mood and behavior, and make it harder to think clearly and move with coordination.
  - Learning and memory problems, including dementia and poor school performance.
  - Mental health problems, including depression and anxiety.
  - Social problems, including lost productivity, family problems, and unemployment.
  - Violence, including homicide, suicide, sexual assault, and intimate partner violence.
- Heart
  - Drinking a lot over a long time or too much on a single occasion can damage the heart, causing problems including:
    - Cardiomyopathy – Impaired ability of the heart to deliver blood to the body, can lead to heart failure
    - Arrhythmias – Irregular heart beat
    - Stroke
    - High blood pressure
- Liver
  - Heavy drinking takes a toll on the liver, and can lead to a variety of problems and liver inflammations including:
    - Steatosis, or fatty liver: A condition where normal liver tissue is replaced by more than 5-6 percent fat. The accumulation of fat can cause inflammation, cell death, and scarring, which can lead to liver fibrosis.
    - Alcoholic hepatitis: Inflammation of the liver caused by drinking alcohol that can result in scar tissue.
    - Liver Fibrosis: Occurs when the liver is damaged and the organ develops scar tissue in response to the inflammation. Advanced liver fibrosis results in cirrhosis, liver failure, and portal hypertension and often requires liver transplantation.
    - Cirrhosis of the liver: A condition in which your liver is scarred and permanently damaged.
- Pancreas
  - Alcohol causes the pancreas to produce toxic substances that can eventually lead to pancreatitis, a dangerous inflammation and swelling of the blood vessels in the pancreas that prevents proper digestion.
- Cancer
  - Drinking too much alcohol can increase your risk of developing certain cancers, including cancers of the mouth, esophagus, throat, liver, and breast
- Immune System
  - Drinking too much can weaken your immune system, making your body a much easier target for disease. Chronic drinkers are more liable to contract diseases like pneumonia and tuberculosis than people who do not drink too much. Drinking a lot on a single occasion slows your body's ability to ward off infections, even up to 24 hours after getting drunk.
  - Risky sexual behaviors, including unprotected sex or sex with multiple partners. These behaviors can result in unintended pregnancy or sexually transmitted diseases, including HIV.

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11.3.3: Rethinking Drinking

Does alcohol impact my calorie intake?

Alcoholic beverages are not a component of the USDA Dietary Patterns and the calories consumed are considered discretionary. Alcohol provides 7 calories per gram consumed, and the ingredients in certain mixed drinks, including soda, mixers, and heavy cream, also can contribute to intake of added sugars and saturated fat. Thus, regular consumption of alcoholic beverages can make it challenging for adults to meet food group and nutrient needs while not consuming excess calories.

Why is being able to “hold your liquor” a concern?

For some people, it takes quite a few drinks to get a buzz or feel relaxed. Often they are unaware that being able to “hold your liquor” isn’t protection from alcohol problems, but instead a reason for caution. They tend to drink more, socialize with people who drink a lot, and develop a tolerance to alcohol. As a result, they have an increased risk for developing alcohol use disorder. The higher alcohol levels can also harm the liver, heart, and brain without the person drinking noticing until it’s too late. And all people who drink need to be aware that even moderate amounts of alcohol can significantly impair driving performance, even when they don’t feel a buzz from drinking.

Why are women’s low-risk limits different from men’s?

Research shows that women start to have alcohol-related problems at lower drinking levels than men do. One reason is that, on average, women weigh less than men. In addition, alcohol disperses in body water, and pound for pound, women have less water in their bodies than men do. So after a man and woman of the same weight drink the same amount of alcohol, the woman’s blood alcohol concentration will tend to be higher, putting her at greater risk for harm.

Isn’t drinking good for the heart?

The short answer is, it is unknown whether light-moderate alcohol consumption has positive health impacts, such as decreasing your risk of cardiovascular disease. Many studies have indicated that moderate alcohol consumption has protective health benefits (e.g., reducing risk of heart disease), and others show this may not be true. Thus, there is not a solid conclusion to this question and it warrants more research.

Can I do anything to protect my liver from the effects of too much alcohol?

There are no guarantees that anything will protect the liver from too much alcohol. Liver damage from heavy drinking happens in stages. Some relatively mild damage may happen after a single binge drinking episode, but this reverses itself if the heavy drinking stops. If heavy drinking continues, however, liver damage can progress through several more advanced stages, and repair becomes much more difficult, if not impossible. When the damage goes as far as cirrhosis, the only treatment is liver transplant. The best way to protect your liver’s health is by staying within the low-risk drinking limits or — if you already have liver damage or any signs of an alcohol problem — by quitting.

Also, it’s best if people who drink avoid acetaminophen[1] (found in Tylenol® and other medications). Even the standard recommended dose of acetaminophen can increase the risk of liver damage, particularly among people who drink heavily.

Quitting or Reducing Drinking

The first step, of course, is to decide whether cutting down or quitting is best for you. If you are thinking about quitting, recognize that one size doesn’t fit all, and it’s important to find options that appeal to you. Changing habits such as smoking, overeating, or drinking too much can take a lot of effort, and you may not succeed with the first try. Setbacks are common, but you learn more each time. Each try brings you closer to your goal. Whatever course you choose, give it a fair trial.

Rethink drinking: Begin by evaluating your own drinking

- Make a list of Pros & Cons: What are your reasons for and against making a change?
- Are you ready to change? See what to do if you're not quite ready to change your drinking.
- To cut down or to quit ... Consider which is best for you.
- Create a Change Plan to help you solidify your goal and how you'll reach it.

Thinking about cutting back on alcohol?

- Review Tips to Try Cutting Back on Alcohol and select two or three to try in the next week or two. It may help to have reminders to reinforce your decision to make a change, such as automated smartphone alerts that you send yourself.

Support for Quitting Drinking

- You do not need to quit on your own, there is support available to help you!
- Try the NIAAA Alcohol Treatment Navigator. The *Navigator* helps adults find alcohol treatment for themselves or an adult loved one. The *Navigator* will steer you toward *evidence-based* treatment, which applies knowledge gained through decades of carefully designed scientific research. If you are seeking help for a teen, check out these recommended adolescent treatment resources. If you are seeking treatment for yourself, you are taking an important step in your route to recovery. You may wish to ask someone you trust to help you through the process and for support along the way.
- Evidence-based behavioral treatments, or "talk therapy," include:
  - Cognitive-behavioral therapy (CBT).
    - This form of therapy is focused on identifying the feelings and situations (called "cues") that lead to heavy drinking, and managing stress that can lead to relapse. The goal is to change the thought processes that lead to alcohol misuse and to develop the skills necessary to cope with everyday situations that might trigger problem drinking.
  - Motivational enhancement therapy.
    - This therapy focuses on helping the patient identify the pros and cons of seeking treatment, form a plan for making changes in drinking behavior, build confidence, and develop the skills needed to stick to the plan.
  - Contingency management approaches.
    - This approach is used to reinforce positive behaviors such as abstinence or regular attendance.
  - 12-Step Facilitation Therapy
    - An engagement strategy used in counseling sessions to increase a patient's active involvement in 12-step-based mutual help groups (such as AA), in addition to professionally-led outpatient treatment. The counselor works with the patient to encourage, review, and reinforce their participation in AA, in a structured process that may include reading assignments, journaling, and setting AA participation goals for the week.

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11.3.4: Tobacco Use

“More doctors smoke Camels than any other cigarette.”

“Reach for a Lucky instead of a sweet.”

“Lucky Strike Cigarettes . . . are less irritating to sensitive and tender throats than other cigarettes.”

“Lucky Strike- To keep a slender figure no one can deny”

“Viceroys filter the smoke! As your dentist, I recommend Viceroys.”

With doctors, dentists, and researchers proclaiming the healthful effects of smoking, smoking rates increased throughout the first half of the 20th century until 1964. In 1964 the U.S. Public Health Service released the first publication linking cigarette smoking to lung cancer, laryngeal cancer, and chronic bronchitis, it was known as the Surgeon Generals Report on Smoking and Health. The report ranked as among the top news stories of 1964. A year later the Federal Cigarette Labeling and Advertising Act of 1965 was passed requiring cigarette packages to include a health warning this was followed by the Public Health Cigarette Smoking Act of 1969 which regulated the advertising of tobacco products banning cigarette advertising in the broadcast media. With this report and the two Acts, cigarette smoking began to decline[2].

It is now well known, documented, and accepted that all forms of tobacco are harmful, and there is no safe level of exposure to tobacco. Tobacco use is the leading preventable cause of disease, disability, and death in the United States. According to the Centers for Disease Control and Prevention (CDC), cigarette smoking results in more than 480,000 premature deaths in the United States each year, about 1 in every 5 U.S. deaths. In 2020, 12.5% (nearly 13 of every 100) U.S. adults aged 18 years or older) currently smoked cigarettes. This means an estimated 30.8 million adults in the United States currently smoke cigarettes. Over 16 million people live with at least one disease caused by smoking, and 58 million nonsmoking Americans are exposed to secondhand smoke. Some good news is that smoking has declined from 20.9% (nearly 21 of every 100 adults) in 2005 to 18.7% (nearly 19 of every 100 adults) in 2022.

Secondhand Smoke

The harmful effects of smoking extend far beyond the smoker. Exposure to secondhand smoke can cause serious diseases and death. Since the 1964 Surgeon General’s Report, 2.5 million adults who were nonsmokers died because they breathed secondhand smoke[3]. Exposure to secondhand smoke causes an estimated 41,000 deaths each year among adults in the United States, causing 7,333 annual deaths from lung cancer and 33,951 annual deaths from heart disease.

Electronic Cigarettes

What are they?

E-cigarettes are battery-operated devices that typically produce a flavored nicotine vapor that looks like tobacco smoke. E-cigarettes are sometimes called “e-cigs,” “vapes,” “e-hookahs,” “vape pens,” and “electronic nicotine delivery systems (ENDS).” Some e-cigarettes look like regular cigarettes, cigars, or pipes. Some look like USB flash drives, pens, and other everyday items.

Are e-cigarettes less harmful than regular cigarettes?

Although e-cigarette vapor does not contain the tar currently responsible for most lung cancer and other lung diseases, that doesn’t mean e-cigarettes are safe. Many studies suggest e-cigarettes and noncombustible tobacco products may be less harmful than combustible cigarettes. However, there is not yet enough evidence to support claims that e-cigarettes and other ENDS are effective tools for quitting smoking.

E-cigarette aerosol generally contains fewer toxic chemicals than the deadly mix of 7,000 chemicals in smoke from regular cigarettes. However, e-cigarette aerosol is not harmless. It can contain harmful and potentially harmful substances, including

nicotine, heavy metals like lead, volatile organic compounds, and cancer-causing agents. It is difficult for consumers to know what e-cigarette products contain. For example, some e-cigarettes marketed as containing zero percent nicotine have been found to contain nicotine

The U.S. Food and Drug Administration (FDA) has established rules for e-cigarettes and their liquid solutions in an effort to help protect the public from the dangers of tobacco use. Because e-cigarettes contain nicotine derived from tobacco, they are now subject to government regulation as tobacco products, including the requirement that both in-store and online purchasers be at least 18 years of age.

Can e-cigarettes help people quit smoking traditional cigarettes?

Because they deliver nicotine without burning tobacco, e-cigarettes are thought by many to be a safer alternative to conventional cigarettes, and some people even think they may help smokers lower nicotine cravings while they are trying to quit smoking. However, e-cigarettes are not currently approved by the FDA as a quit smoking aid. The U.S. Preventive Services Task Force, a group of health experts that makes recommendations about preventive health care, has concluded that evidence is insufficient to recommend e-cigarettes for smoking cessation in adults.

In a 2021 review of 61 studies focused on the use of e-cigarettes as a tool for quitting[4], the researchers were moderately confident that nicotine e-cigarettes help more people to stop smoking than nicotine replacement therapy or nicotine-free e-cigarettes, however more research is needed.

Smokeless Tobacco (Chewing Tobacco)

Smokeless tobacco is associated with many health problems. Smokeless tobacco contains cancer-causing agents and nicotine, which is highly addictive. Because young people who use smokeless tobacco can become addicted to nicotine, they may be more likely to also become cigarette smokers later.

Smokeless tobacco comes in three types: Chewing tobacco (loose leaf, plug, or twist and may come in flavors), Snuff (moist, dry, or in packets [U.S. snus]), and Dissolvables (lozenges, sticks, strips, orbs).

Using smokeless tobacco:

- Can lead to nicotine addiction
- Causes cancer of the mouth, esophagus (the passage that connects the throat to the stomach), and pancreas
- Is associated with diseases of the mouth
- Can increase risks for early delivery and stillbirth when used during pregnancy
- Can cause nicotine poisoning in children
- May increase the risk for death from heart disease and stroke

Health Effects of Tobacco Use

Smoking leads to disease and disability and harms nearly every organ of the body.

Although nicotine is addictive and can be toxic if ingested in high doses, it does not cause cancer—other chemicals are responsible for most of the severe health consequences of tobacco use. Tobacco smoke is a complex mixture of chemicals such as carbon monoxide, tar, formaldehyde, cyanide, and ammonia—many of which are known carcinogens. Carbon monoxide increases the chance of cardiovascular diseases. Tar exposes the user to an increased risk of lung cancer, emphysema, and bronchial disorders. Smoking has also been linked to leukemia, cataracts, and pneumonia. On average, adults who smoke die 10 years earlier than nonsmokers.

Smoking and Cancer

Cigarette smoking accounts for about one-third of all cancers, including cancers of the blood (acute myeloid leukemia), bladder, cervix, colon, rectum, esophagus, kidney, renal pelvis, larynx, liver, mouth, throat, pancreas, stomach, trachea, lungs, and bronchi. If nobody smoked, one of every three cancer deaths in the United States would not happen.

Although smoking increases your risk of almost all cancers, it directly accounts for about 85-90 percent of lung cancer cases, or nearly 9 out of 10 lung cancers are caused by smoking cigarettes. Smokeless tobacco (such as chewing tobacco and snuff) also increases the risk of cancer, especially oral cancers. More people in the United States, both men and women, die from lung cancer than any other type of cancer. Although the risks of smoking are more clear today than in 1964, smokers have a greater risk for lung cancer today than they did in 1964, even though they smoke fewer cigarettes.

Quitting smoking lowers the risks for cancers of the lung, mouth, throat, esophagus, and larynx.

- Within 5 years of quitting, your chance of getting cancer of the mouth, throat, esophagus, and bladder is cut in half.
- Ten years after you quit smoking, your risk of dying from lung cancer drops by half.

Smoking and Cardiovascular Disease

In addition to cancer, smoking causes lung diseases such as chronic bronchitis and emphysema, and increases the risk of heart disease, including stroke, heart attack, vascular disease, and aneurysm. One out of every four deaths from Cardiovascular Disease is caused by a person choosing to smoke.

Smoking can:

- Raise triglycerides (a type of fat in your blood)
- Lower “good” cholesterol (HDL)
- Make blood sticky and more likely to clot, which can block blood flow to the heart and brainDamage cells that line the blood vessels
- Increase the buildup of plaque (fat, cholesterol, calcium, and other substances) in blood vessels
- Cause thickening and narrowing of blood vessels

Secondhand Smoke and CVD

Nonsmokers exposed to secondhand smoke at home or work increase their risk of developing heart disease by 25-30 percent and lung cancer by 20-30 percent. Non-smokers exposed to secondhand smoke may experience coughing, overproduction of phlegm, reduced lung function and respiratory infections, including pneumonia and bronchitis. Breathing secondhand smoke can interfere with the normal functioning of the heart, blood, and vascular systems in ways that increase your risk of having a heart attack. Even briefly breathing secondhand smoke can damage the lining of blood vessels and cause your blood to become stickier. These changes can cause a deadly heart attack.

Each year about 150,000 – 300,000 children younger than 18 months old experience respiratory tract infections caused by secondhand smoke. Children exposed to secondhand smoke are at an increased risk of ear infections, severe asthma, respiratory infections and death. In fact, more than 100,000 babies have died in the past 50 years from sudden infant death syndrome (SIDS), and other health complications as a result of parental smoking. Children who grow up with parents who smoke are more likely to become smokers, thus placing themselves (and their future families) at risk for the same health problems as their parents when they become adults.

There is no safe level of exposure to tobacco smoke.

Smoking and Your Brain

Cigarettes and other forms of tobacco—including cigars, pipe tobacco, snuff, and chewing tobacco—contain the addictive drug **nicotine**. Nicotine is readily absorbed into the bloodstream when a tobacco product is chewed, inhaled, or smoked. A typical smoker will take 10 puffs on a cigarette over the period of about 5 minutes that the cigarette is lit. Thus, a person who smokes about 1 pack (25 cigarettes) daily gets 250 “hits” of nicotine each day.

Upon entering the bloodstream, nicotine immediately stimulates the adrenal glands to release the hormone epinephrine (adrenaline). Epinephrine stimulates the central nervous system and increases blood pressure, respiration, and heart rate.

Similar to other addictive drugs like cocaine and heroin, nicotine increases levels of the neurotransmitter dopamine, which affects the brain pathways that control reward and pleasure. For many tobacco users, long-term brain changes induced by continued nicotine exposure result in addiction—a condition of compulsive drug seeking and use, even in the face of negative

consequences. Studies suggest that additional compounds in tobacco smoke, such as acetaldehyde, may enhance nicotine's effects on the brain.

When an addicted user tries to quit, he or she experiences withdrawal symptoms including irritability, attention difficulties, sleep disturbances, increased appetite, and powerful cravings for tobacco. Treatments can help smokers manage these symptoms and improve the likelihood of successfully quitting.

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11.3.5: Quitting Smoking

Although quitting can be difficult, the health benefits of smoking cessation are immediate and substantial—including reduced risk for cancers, heart disease, and stroke.

What are the benefits of quitting smoking?

You will see immediate positive health improvements upon the cessation of smoking these include:

- Within 20 minutes, your heart rate and blood pressure drop.
- 12 hours, the carbon monoxide level in your blood drops to normal.
- 2-12 weeks, your circulation improves and your lung function increases.
- 1-9 months, coughing and shortness of breath decrease.
- 1 year, your risk of coronary heart disease is about half that of a smoker's.
- 5 years, your stroke risk is reduced to that of a nonsmoker 5 to 15 years after quitting.
- 10 years, your risk of lung cancer falls to about half that of a smoker and your risk of cancer of the mouth, throat, esophagus, bladder, cervix, and pancreas decreases.
- 15 years, the risk of coronary heart disease is that of a nonsmoker's.

In addition, people who quit smoking will have an improved sense of smell, and food will taste better.

How does quitting smoking impact life expectancy?

Data from the U.S. National Health Interview Survey show that people who quit smoking, regardless of their age, are less likely to die from smoking-related illness than those who continue to smoke. Smokers who quit before age 40 reduced their chance of dying prematurely from smoking-related diseases by about 90 percent, and those who quit by age 45-54 reduced their chance of dying prematurely by about two-thirds.

People who quit smoking, regardless of their age, have substantial gains in life expectancy compared with those who continue to smoke. Those who quit between the ages of 25 and 34 years lived about 10 years longer; those who quit between ages 35 and 44 lived about 9 years longer; those who quit between ages 45 and 54 lived about 6 years longer; and those who quit between ages 55 and 64 lived about 4 years longer.

Does quitting smoking lower the risk of cancer?

Yes. Quitting smoking reduces the risk of developing and dying from cancer. Although it is never too late to get a benefit from quitting, the benefit is strongest among those who quit at a younger age.

The risk of premature death and the chance of developing cancer from smoking depend on many factors, including the number of years a person smokes, the number of cigarettes he or she smokes per day, the age at which he or she began smoking, and whether or not he or she was already ill at the time of quitting. For people who have already developed cancer, quitting smoking reduces the risk of developing a second cancer.

Should someone already diagnosed with cancer bother to quit smoking?

Yes. Cigarette smoking has a profound adverse impact on health outcomes in cancer patients. For patients with some cancers, quitting smoking at the time of diagnosis may reduce the risk of dying by 30 percent to 40 percent. For those having surgery, chemotherapy, or other treatments, quitting smoking helps improve the body's ability to heal and respond to therapy. It also lowers the risk of pneumonia and respiratory failure. Moreover, quitting smoking may lower the risk of the cancer returning, of dying from the cancer, of a second cancer developing, and of dying from other causes.

Treatments for Tobacco Addiction

Tobacco addiction is a chronic disease that often requires multiple attempts to quit. Although some smokers are able to quit without help, many others need assistance. Both behavioral interventions (counseling) and medication can help smokers quit; but the combination of medication with counseling is more effective than either alone.

The U.S. Department of Health and Human Services' (HHS) has established a national toll-free quitline, 800-QUIT-NOW, to serve as an access point for any smoker seeking information and assistance in quitting. NIDA's scientists are looking at ways to make smoking cessation easier by developing tools to make behavioral support available over the internet or through text-based messaging. In addition, NIDA is developing strategies designed to help vulnerable or hard-to-reach populations quit smoking.

Behavioral Treatments

Behavioral treatments employ a variety of methods to help smokers quit, ranging from self-help materials to counseling. These interventions teach people to recognize high-risk situations and develop coping strategies to deal with them.

Nicotine Replacement Treatments

Nicotine replacement therapies (NRTs) were the first pharmacological treatments approved by the Food and Drug Administration (FDA) for use in smoking cessation therapy. Current FDA-approved NRT products include nicotine chewing gum, the nicotine transdermal patch, nasal sprays, inhalers, and lozenges. NRTs deliver a controlled dose of nicotine to a smoker in order to relieve withdrawal symptoms during the smoking cessation process. They are most successful when used in combination with behavioral treatments.

Other Medications

Bupropion and varenicline are two FDA-approved non-nicotine medications that have helped people quit smoking. Bupropion, a medication that goes by the trade name Zyban, was approved by the FDA in 1997, and Varenicline tartrate (trade name: Chantix) was approved in 2006. It targets nicotine receptors in the brain, easing withdrawal symptoms and blocking the effects of nicotine if people resume smoking.

Current Treatment Research

Scientists are currently developing new smoking cessation therapies. For example, they are working on a nicotine vaccine, which would block nicotine's reinforcing effects by causing the immune system to bind to nicotine in the bloodstream preventing it from reaching the brain. In addition, some medications already in use might work better if they are used together. Scientists are looking for ways to target several relapse symptoms at the same time—like withdrawal, craving and depression.

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11.3.6: End-of-Chapter Material

Key takeaways for this Chapter

- Both alcohol and tobacco increase your risk of disease
- A drink is considered 12-ounces of beer, 5-ounces of wine, or 1.5-ounces of 80-proof liquor
- BAC, Blood Alcohol Concentration, measures how much alcohol is in the blood.
- People should avoid binge drinking and heavy drinking.
- Nicotine is the drug in tobacco.
- Secondhand smoke is harmful to non-smokers.

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11.3.7: Alcohol and Tobacco- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

A brief history of alcohol

How caffeine and alcohol affect your sleep

How do cigarettes affect the body?

How does alcohol cause hangovers?

How does alcohol make you drunk?

The past, present and future of nicotine addiction

What happened when the United States tried to ban alcohol

What you should know about vaping and e-cigarettes

You may be accidentally investing in cigarette companies

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12: BODY COMPOSITION

By Scott Flynn

Learning Objectives

- What is body composition?
- How does body composition affect a person's health?
- What are the health risks and costs associated with overweight and obesity?
- What is the significance of body fat distribution?
- What is Body Mass Index (BMI) and why is it important?

12.1: Body Weight versus Body Composition

12.2: Diseases Associated with Excessive Body Fat

12.3: How Much Fat is Needed?

12.4: Body Fat Distribution

12.5: Body Mass Index

12.6: How to Measure Body Composition

12.7: Weighing in on the U.S.

12.8: What Can Be Done?

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12.1: Body Weight versus Body Composition

According to surveys, the top reason American females exercise is for weight control. For males, the top reason is to improve muscle tone while weight control ranks as the fourth most important reason.[1] Levels of attractiveness based on weight and visible musculature are significant points of emphasis in American culture. As such, individuals with well-toned muscles and low body weight are marketed as *superior* within the context of attractiveness, financial success, and multiple other traits. Unfortunately, this emphasis, as seen in mainstream media, can result in unrealistic ideals and potentially harmful behaviors, such as eating disorders.

Unlike the mainstream outlets, which focus on the association between fat levels and physical attractiveness, this chapter focuses on the health-related consequences related to good and bad body composition. **Body composition** is defined as the body's relative amount of fat-free mass (FFM) and fat mass (FM) and is generally expressed as a percentage of total body weight. FFM includes bones, muscles, ligaments, body fluids and other organs, while FM is limited to fat tissue.

The Importance of Measuring Body Composition Rather Than Just Tracking Body Weight

Tracking weight can be helpful, but body composition measurements help separate a person's actual weight from the weight that could be unhealthy.

For example, an individual who weighs 200 pounds and has 8% body fat, such as an athlete, only carries around 16 pounds of FM. However, a 200-pound person who has a sedentary lifestyle and a body composition of 20%, carries 40 pounds of FM. Weight alone, in this case, does not distinguish between FFM and FM and would suggest both individuals have similar health. As body fat percentage increases, the potential for various diseases also increases significantly.

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12.2: Diseases Associated with Excessive Body Fat

According to the National Institute of Health (NIH), a wide array of diseases can be linked to excessive body fat.[2] Some of them are:

- Type II Diabetes Mellitus
- Hypertension
- Cancer
- Cerebrovascular Disease (Stroke)
- Cardiovascular Disease
- Metabolic Syndrome
- Lung Disorders
  - Sleep Apnea
  - Asthma
- Musculoskeletal Diseases
  - Osteoarthritis
  - Gout
- Gallbladder Disease
- Pancreatitis
- Non-Alcohol Fatty Liver Disease
- Dementia
- Psychological Problems and Quality of Life
- Kidney Disease
- Pregnancy Problems

An explanation of how being overweight relates to each disease (those highlighted) can be viewed by clicking on the following link.

NIH-Explanation of Disease Risk Associated with Overweight

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12.3: How Much Fat is Needed?

Fat is a necessary component of daily nutrition. It is needed for healthy cellular function, energy, cushioning for vital organs, insulation, and for food flavor.

Fat storage in the body consists of two types of fat: essential and nonessential fat.**Essential fat** is the minimal amount of fat necessary for normal physiological function. For males and females, essential fat values are typically considered to be 3% and 12%, respectively. Fat above the minimal amount is referred to as **nonessential fat**. It is generally accepted that an overall range of 10-22 percent for men and 20-32 percent for women is considered satisfactory for good health. A body composition within the recommended range suggests a person has less risk of developing obesity-related diseases, such as diabetes, high blood pressure, and even some cancers.

A woman's essential fat range is naturally greater than a man's because of fat deposits in breasts, uterus and sex-specific sites. In both males and females, non- essential fat reserves can be healthy, especially in providing substantial amounts of energy.

Excessive body fat is categorized by the terms overweight and obesity. These terms do not implicate social status or physical attractiveness, but rather indicate health risks. **Overweight** is defined as the accumulation of non-essential body fat to the point that it adversely affects health. According to the American College of Sports Medicine (ACSM), the threshold for being characterized as overweight is having a body composition of FM greater than 32% and 19% for females and males, aged 20-39, respectively.[3]

Obesity is characterized by excessive accumulation of body fat and can be defined as a more serious degree of being overweight. Classifications of obesity begin at body composition of FM greater than 39% and 25% in females and males ages 20- 39, respectively. [4]

Other Health Risks

Diseases are not the only concern with an unhealthy body fat percentage. Several others are listed below.

- *Performance of physical activity*
  An important component of a healthy lifestyle and weight management is regular physical activity and exercise. To the contrary, those who live a sedentary lifestyle will find it more difficult to maintain a healthy body weight or develop adequate musculature, endurance, and flexibility. Unfortunately, additional body weight makes it more difficult to be active because it requires more energy and places a higher demand on weak muscles and the cardiovascular system. The result is a self-perpetuating cycle of inactivity leading to more body weight, which leads to more inactivity.
- *Emotional wellness*
  Studies indicate obesity is associated with a 25% increase in anxiety and mood disorders, regardless of age or gender. Other studies suggest increases in BMI significantly increase the incidence of personality disorders and anxiety and mood disorders. Additional studies have been able to associate a higher incidence of psychological disorders and suicidal tendencies in obese females compared with obese males.[5]
- *Pre-mature death*
  The association between obesity and diseases, such as cancer, CVD, and diabetes, suggests that people with more body fat generally have shorter lifespans. The Center for Disease Control (CDC) estimates up to 365,000 deaths each year can be linked with obesity, representing nearly 15% of all deaths. Other studies have tied the Years of Life Lost to body mass index measurements, estimating anywhere from 2 to 20 years can be lost, depending on ethnicity, age at time of obese classification, and gender.[6]
- *Economic impact*
  The physical harm caused by obesity and overweight is mirrored by its economic impact on the health care system. The CDC has estimated the medical costs to be about $147 billion in 2008, which includes preventative, diagnostic, and treatments. Overweight and obesity also contribute to loss of productivity at work through absenteeism and *presenteeism*, defined as being less productive while working. The annual nationwide productive costs fall within the range of from $3.38 to $6.38 billion.[7]

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12.4: Body Fat Distribution

Body composition measurements can help determine health risks and assist in creating an exercise and nutrition plan to maintain a healthy weight. However, the presence of unwanted body fat is not the only concern associated with an unhealthy weight. Where the fat is stored, or fat distribution, also affects overall health risks.

Non-essential fat is primarily stored in**adipose tissue**, or fat cells, located on the surface of the body and surrounding the body's organs. Surface fat, located just below the skin, is called **subcutaneous fat**. Fat that lies deeper in the body surrounding the body's organs is called **visceral fat**. Unlike subcutaneous fat, visceral fat is more often associated with abdominal fat. Researchers have found that excessive belly fat decreases insulin sensitivity, making it easier to develop type II diabetes. It may also negatively impact blood lipid metabolism, contributing to more cases of cardiovascular disease and stroke in patients with excessive belly fat.[8]

Body fat distribution can easily be determined by simply looking in the mirror. The outline of the body, or body shape, would indicate the location of where body fat is stored. Abdominal fat storage patterns are generally compared to the shape of an apple, called the **android shape**. This shape is more commonly found in males and post- menopausal females. In terms of disease risk, this implies males and post- menopausal females are at greater risk of developing health issues associated with excessive visceral fat. Individuals who experience chronic stress tend to store fat in the abdominal region.

A pear-shaped body fat distribution pattern, or **gynoid shape**, is more commonly found in pre-menopausal females. Gynoid shape is characterized by fat storage in the lower body such as the hips and buttocks. This shape may be connected to females' child-bearing abilities as enzymes associated with fat-storage and mobilization are activated during certain times of pregnancy and post- partum.

Besides looking in the mirror to determine body shape, people can use an inexpensive tape measure to measure the diameter of their hips and waist. Many leading organizations and experts currently believe a waist circumference of 40 or greater for males and 35 or greater for females significantly increases risk of disease.[9]

In addition to measuring waist circumference, measuring the waist and the hips and using a waist-to-hip ratio (waist circumference divided by the hip circumference) is equally effective at predicting body fat-related health outcomes. According to the National Heart, Lung, and Blood Institute, a ratio of greater than 0.82 for females and 0.94 for males is associated with a higher risk of developing heart disease, diabetes, and hypertension.[10]

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In addition to body composition and waist/hip circumferences, measuring body mass has also been used as an effective method to assess health risks. **Body mass index (BMI)** is a measurement of height (m2) and weight (kg) suggesting that a person's body's weight should be proportional to his or her height. For example, based on the BMI scale, a female with a height of 5'6" should not weigh more than 155 lbs. If her weight exceeded 155 lbs., she would be categorized as "overweight."

$$BMI = \frac{Weight(kg)}{Height(m^2)} \tag{12.5.1}$$

Among several criticisms, the BMI method has been faulted for not distinguishing between FM and FFM, since only the overall weight is taken into account. For athletes, who may be more massive as a result of larger muscles, this criticism holds true. For example, a professional football player who weighs 215 pounds and stands at 6'3" would have the exact same BMI as a relatively sedentary arm-chair quarterback who also weighs 215 pounds with the same height. This discrepancy also exists when applying BMI to the senior population. As age increases, muscle mass declines. Seniors who have experienced years of muscle mass decline but increased body fat may maintain a constant weight despite having a very different body composition.

Other criticisms of using BMI as a health risk assessment tool include its failure to take age or gender into account. As discussed previously, females naturally have more body fat yet are classified in the same context as males. Because this measurement is so widely used by physicians, patients continue to express concerns about the validity of BMI as an indication of fatness.

Regardless of the criticisms, BMI as used for the general population, has been shown to be a reasonable predictor of health outcomes. At its core, it is not intended to be an estimate of body composition, i.e., measure FM and FFM. Instead, it is intended to be used as an estimate of healthy/unhealthy levels of body fat. When used as a means of tracking weight changes over time it can be a valuable tool in predicting health and for recommending lifestyle modifications.[11]

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12.6: How to Measure Body Composition

Multiple methods exist to estimate body composition. Remember, body composition is the ration of FM and FFM used to help determine health risks. Of the other methods already mentioned (waist, waist- to-hip ratio, and BMI), none provide estimates of body composition but do provide measurements of other weight- related health markers, such as abdominal fat. Experts have designed several methods to estimate body composition. While they are not flawless, they do provide a fairly accurate representation of body composition. The most common are:

- *Hydrostatic Weighing (Underwater Weighing)*
  At one time, hydrostatic weighing (also and maybe more accurately called **hydrodensitometry**) was considered the criterion for measuring body composition. Many other methods are founded on this model, in one form or another. This method attempts to measure the density of the body by applying Archimedes' principle: density = mass/volume. The mass and volume components are measured by using dry weight and then weight while being submerged in a water tank. Since fat is less dense than muscle tissue, a person with more body fat will weigh less in the water than a similar person with more lean mass. Using the measurements, the density can be determined and converted into body fat percentage. With a small margin of error (around 1-2%) this method is very accurate. Unfortunately, the expense and practicality of building and maintaining a water tank limits access for most. Also, for those with a fear of water, this would obviously not be the preferred method.
- *Dual Energy X-Ray Absorptiometry (DEXA)*
  Replacing underwater weighing as the new "gold standard," is DEXA. While underwater weighing accurately compartmentalizes FM and FFM, DEXA adds a third compartment by using low-radiation X-rays to distinguish bone mineral. This addition slightly increases the accuracy of DEXA by eliminating some of the guess work associated with individual differences, such as total body water and bone mineral density.

  Originally, DEXA scanners were designed to determine and help diagnose bone density diseases. As a result, they can be found in many physicians' offices. However, a full body scan, which takes only a few minutes, is all that is needed to also determine body fat percentage. Major disadvantages to this method are its high cost and the need for a well-trained professional to operate the equipment and analyze the results.

- *Air Displacement (Plethysmography)*
  A good alternative to more expensive methods, air displacement determines body density using the same principle as underwater weighing, by measuring mass and volume. Clearly, the main difference is that mass and volume are being determined by air displacement rather than water displacement. Using a commercial device (the Bod Pod is most commonly referenced), a person sits in a chamber that varies the air pressure allowing for body volume to be assessed. Air displacement provides a viable alternative for those with a fear of water.

  Like many other methods, the expense, availability, and training of personnel Air Displacement requires limit accessibility. Additionally, its accuracy is slightly less than underwater weighing.

- *Bio-electrical Impedance Analysis (BIA)*
  BIA takes a slightly different approach to measuring FFM. The premise behind BIA is that FFM will be proportional to the electrical conductivity of the body. Fat-tissue contains little water, making it a poor conductor of electricity; whereas, lean tissue contains mostly water and electrolytes, making it an excellent conductor. BIA devices emit a low-level electrical current through the body and measure the amount of resistance the current encounters. Based on the level of impedance, a pre-programed equation is used to estimate body fat percentage.

  The most accurate BIA devices use electrodes on the feet and hands to administer the point-to-point electrical current. The margin of error for these devices falls in the range of 3–5%. Portable or handheld BIA devices that only measure lower or upper body conductivity have a higher margin of error (4–8%).

  Because BIA devices primarily measure hydration, circumstances that may influence hydration status at the time of measurement must be taken into account. Recent exercise, bladder content, hydration habits, and meal timing can cause wide measurement variations and influence accuracy. However, this method is generally inexpensive, often portable, and requires limited training to use, making it a very practical option.

- *Skinfold Analysis*
  Skinfold analysis is a widely used method of assessing body composition because of its simplicity, portability, and

affordability. It is also fairly accurate when administered properly. Margins of error are about 4–7%, depending on the quality of the skinfold calipers and skill of the administrator/technician. The assumption of skinfold measurement is that the amount of subcutaneous fat is proportionate to overall body fat. As such, a technician pinches the skin at various sites and uses calipers to measure and record the diameter of the skin folds. These numbers can then be plugged into an equation to generate an estimate of body fat percentage.

The proportionality of subcutaneous fat and overall body fat depends on age, gender, ethnicity, and activity rates. As such, technicians should use the skinfold technique specific to the equation that accounts for those variables to improve accuracy.

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12.7: Weighing in on the U.S.

Despite the well-known health concerns implicated in overweight and obesity and the availability of multiple methods for assessment and tools to improve body composition, current trends in the United States and around the world are moving in the wrong direction. The unprecedented number of obese Americans has led experts to label it an epidemic, much like they would a disease in a developing country. According to the CDC, the number of American adults (>20 years) that fall into the overweight classification based on BMI are 70.7%. Of those, 37.9% fall within the obese classification. In 1962, the overweight and obesity rates for adults in the U.S. were 32% and 13%, respectively. In other words, overweight trends have more than doubled and obesity rates have almost tripled over the past 50+ years.[12]

Of more concern are the increasing number of obese children ages 6-11 and adolescents ages 12-19, amounting to 17.4% and 20.6%, respectively.[13] While those numbers have stabilized over the past decade, this has led to a dramatic increase in insulin resistance, a form of diabetes formerly known as adult onset diabetes.

With such a diverse population in the U.S. and with an understanding of how BMI is calculated, it is only natural to question the high number of overweight and obese citizens based on BMI alone. However, it is generally believed this is an accurate portrayal of weight status. In a study attempting to compare BMI measurements to actual body fat percentage, it was determined that the total number of obese citizens may be underestimated, and its current prevalence may be worse than is currently being reported.

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12.8: What Can Be Done?

With the available tools to identify health risks associated with body fat, anyone concerned about their health should gather as much data about body composition and body fat distribution as possible. Compiling multiple measurements and analyzing them provides a better idea of a person's current health status and will help determine the next course of action. For example, BMI alone can be beneficial. But when combined with waist circumference, a greater understanding of risk can be achieved. Likewise, when combining BMI and waist circumference with body fat percentage, an ideal conclusion of health status can be made.

In the lab accompanying this chapter, you will be guided through the process of assessing your BMI, waist circumference, waist-to-hip ratio, and body fat percentage.

The next course of action is to set goals and formulate a plan to get to a healthy range of weight and body fat percentage. Where weight loss is needed, the plan should include a balance of calorie restriction and physical activity/exercise. This might also include tracking your current eating and activity habits. More specific information on weight management strategies will be discussed in a later chapter.

Low Body Composition

Because more people experience excess body fat, the focus up to this point has been on health concerns related to overweight and obesity. However, fat is an essential component to a healthy body, and in rare cases, individuals have insufficient fat reserves, which can also be a health concern. The range of essential body fat for males is 3-5% and 8-12% for females. Attempting to, or intentionally staying in those ranges, through excessive exercise or calorie restriction is not recommended. Unfortunately, low body fat is often associated with individuals struggling with eating disorders, the majority of whom are females.

The main concern of low body fat relates to the number and quality of calories being consumed. Foods not only provide energy but also provide the necessary nutrients to facilitate vital body functions. For example, low amounts of iron from a poor diet can result in anemia. Potassium deficiencies can cause hypokalemia leading to cardiovascular irregularities. If adequate calcium is not being obtained from foods, bone deficiencies will result. Clearly, having low body fat, depending on the cause, can be equally as detrimental to health as having too much.

The health concerns most often linked to low body fat are:

- Reproductive disorders
  - Infrequent or missing menstrual cycles
- Respiratory disorders
- Immune System disorders
- Circulatory disorders
- Premature death

In some cases, despite attempts to gain weight, individuals are unable to gain the pounds needed to maintain a healthy weight. In these cases, as in the case of excess fat, a holistic approach should be taken to determine if the low levels of body fat are adversely affecting health. These individuals should monitor their eating habits to assure they are getting adequate nutrition for their daily activity needs. Additionally, other lifestyle habits should be monitored or avoided, such as smoking, which may suppress hunger.

Additional reading on low body fat and its impact can be found on the Livestrong.com website, on this page: At what body fat percent do you start losing your period?.

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13.1: Exercise- Not a Passing Fad

The benefits of physical activity and exercise are universally recognized—and have been for far longer than one might think. Our Paleolithic ancestors regularly engaged in physical activity to survive. However, rather than chasing after a soccer ball to win a game or taking a leisurely stroll down a tree-lined path, they "worked out" by chasing after their next meal. For them, no exercise meant no food. How's that for a health benefit?

With the advent of sedentary agriculture some 10,000 years ago, that same level of peak performance was no longer necessary. As our ancestors continued to devise more advanced means of acquiring food, physical activity declined. It wasn't until the fourth century BCE, that the Greek physician Herodicus, recognized the importance of being physically active outside of a hunter-gatherer society. He practiced gymnastic medicine, a branch of Greek medicine that relied on vigorous exercise as a treatment. During that same time period, Hippocrates, who is often referred to as the Father of Modern Medicine, asserted, "If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health." In the 12 century CE, the Jewish philosopher Rabbi Moses ben Maimon, a physician to the Sultan of Egypt, stated, "Anyone who lives a sedentary life and does not exercise, even if he eats good foods and takes care of himself according to proper medical principles, all his days will be painful ones and his strength will wane." The 15th century theologian and scholar Robert Burton went so far as to declare that *not* exercising, or "idleness" as he referred to it in his widely read tome, *The Anatomy of Melancholy*, was the "bane of body and mind." Burton also warned that the lack of exercise was the sole cause of melancholy (the name given depression at that time) and "many other maladies." Burton claimed that idleness was one of the seven deadly, as well as "the nurse of naughtiness," and the "chief author of mischief." For Burton, exercise was not only essential for good health, but a means of avoiding eternal damnation.

By the 16th century, the benefits of exercise were widely accepted, at least among the wealthy and the educated, who had access to leisure. During this time period, H. Mercuralis defined exercise as "the deliberate and planned movement of the human frame, accompanied by breathlessness, and undertaken for the sake of health or fitness." This definition is still widely used today.

Beyond the physical health benefits, there are affective benefits associated with group games and activities. Ancient Mayans organized the first team game called the Ball Game. It consisted of two teams trying to get a ball through a hoop mounted approximately 23 feet on a wall. The rules were to get the ball through the hoop using certain parts of the body. In some cases the captain of the losing team gave himself as a human sacrifice to the winning team, an act that was believed by the Mayans to be a vital part of prosperity.

American Indians are thought to have founded the modern game of lacrosse, as well as other stick games. Lacrosse, which received its name from French settlers, was more than a form of recreation. It was a cultural event used to settle disputes between tribes.



Figure 13.1.1: *Lacrosse Players. George Catlin. Date*

unknown.

The outcome of the game, as well as the choosing of teams, was thought to be controlled supernaturally. As such, game venues and equipment were prepared ritualistically.

From Ancient History to Modern Times

In retrospect, the perceived benefits of exercise have changed very little since Herodicus or the American Indians. Mounting research supports historical assertions that exercise is vital to sustaining health and quality of life. Culturally, sports play a huge role in growth and development of youth and adults. Physically, there is indisputable evidence that regular exercise promotes healthy functioning of the brain, heart, and the skeletal and muscular systems. Exercise also reduces risk for chronic diseases, such as cancer, diabetes, and obesity. Regular exercise can even improve emotional health and overall wellbeing.

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13.2: What are Physical Activity and Exercise?

Physical activity is defined as any movement carried out by skeletal muscle that requires energy and is focused on building health. Health benefits include improved blood pressure, blood-lipid profile, and heart health. Acceptable physical activity includes yard work, house cleaning, walking the dog, or taking the stairs instead of the elevator. Physical activity does not have to be done all it once. It can be accumulated through various activities throughout the day. Although typing on a phone or laptop or playing video games does involve skeletal muscle and requires a minimal amount of energy, the amount required is not sufficient to improve health.

Despite the common knowledge that physical activity is tremendously beneficial to one's health, rates of activity among Americans continue to be below what is needed. According to the Center for Disease Control (CDC), only 1 in 5 (21%) of American adults meet the recommended physical activity guidelines from the Surgeon General. Less than 3 in 10 high school students get 60 minutes or more of physical activity per day. Non-Hispanic whites (26%) are more active than their Hispanic (16%) and Black counterparts (18%) as is the case for males (54%) and females (46%). Those with more education and those whose household income is higher than poverty level are more likely to be physically active.1

The word *exercise*, although often used interchangeably with the phrase *physical activity*, denotes a sub-category of physical activity. **Exercise** is a planned, structured, and repetitive movement pattern intended to improve fitness. As a positive side-effect, it significantly improves health as well. Fitness improvements include the heart's ability to pump blood, increased muscle size, and improved flexibility.

Components of Health-Related Fitness

In order to carry out daily activities without being physically overwhelmed, a minimal level of fitness is required. To perform daily activities without fatigue, it is necessary to maintain health in five areas: cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition. These five areas are called the components of health- related fitness. Development of these areas will improve your quality of life, reduce your risk of chronic disease, and optimize your health and well-being. Each of these 5 areas will be explored in depth at a later time. Below is a brief description of each.

- *Cardiorespiratory endurance*Cardiorespiratory endurance is the ability to carry out prolonged, large muscle, dynamic movements at a moderate to high level of intensity. This relates to your heart's ability to pump blood and your lungs' ability to take in oxygen.
- *Muscular strength*
  Muscular strength is the ability of the muscles to exert force over a single or maximal effort.
- *Muscular endurance*
  Muscular endurance is the ability to exert a force over a period of time or repetitions.
- *Flexibility*
  Flexibility is the ability to move your joints through a full range of motion.
- *Body Composition*
  Body composition is the relative amount of fat mass to fat-free mass.

As previously stated, these areas are significant in that they influence your quality of life and overall health and wellness.

Skill-Related Components of Fitness

In addition to the 5 health-related components, there are 6 skill-related components that assist in developing optimal fitness: speed, agility, coordination, balance, power, and reaction time. Although important, these areas do not directly affect a person's health. A person's ability to perform ladder drills (also known as agility drills) is not related to his/her heart health. However, coordination of muscle movements may be helpful in developing muscular strength through resistance training. As such, they may indirectly affect the 5 areas associated with health-related fitness. Skill- related components are more often associated with sports performance and skill development.

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13.3: Health Benefits Associated with Regular Physical Activity

Table 13.3.1: Health Benefits Associated with Regular Physical Activity in Children and Adolescents

Strong Evidence	Moderate Evidence
• Improved cardiorespiratory and muscular fitness • Improved bone health • Improved cardiovascular and metabolic health biomarkers • Favorable body composition	• Reduced symptoms of depression

Table 13.3.2: Health Benefits Associated with Regular Physical Activity in Adults and Older Adults

Strong Evidence	Moderate to Strong Evidence	Moderate Evidence
• Lower risk of early death • Lower risk of coronary heart disease • Lower risk of stroke • Lower risk of high blood pressure • Lower risk of adverse blood lipid profile • Lower risk of type 2 diabetes • Lower risk of metabolic syndrome • Lower risk of colon cancer • Lower risk of breast cancer • Prevention of weight gain • Weight loss, particularly when combined with reduced calorie intake • Improved cardiorespiratory and muscular fitness • Prevention of falls • Reduced depression • Better cognitive function (for older adults)	• Better functional health (for older adults) • Reduced abdominal obesity	• Lower risk of hip fracture • Lower risk of lung cancer • Lower risk of endometrial cancer • Weight maintenance after weight loss • Increased bone density • Improved sleep quality

These studies have also prompted questions as to what type and how much physical activity is needed for various health benefits. That led to the development of The Physical Activity Guidelines for Americans, which gives guidance on the amount of physical activity that will provide health benefits for all Americans. Although some health benefits seem to begin with as little as 60 minutes (1 hour) a week, research shows that a total amount of 150 minutes (2 hours and 30 minutes) a week of moderate-intensity aerobic activity, such as brisk walking, consistently reduces the risk of many chronic diseases and other adverse health outcomes. For more details on the Physical Activity Guidelines for Americans please see the table below:

Table 13.3.3For Important Health Benefits Adults Need at Least

2 hours and 30 minutes (150 minutes) of moderate aerobic activity every week (i.e., brisk walking) every week OR 1 hour and 15 minutes (75 minutes) of vigorous intensity aerobic activity (i.e., jogging or running) every week; OR An equivalent mix of moderate-and-vigorous intensity aerobic activity	AND	Muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs hips, back, abdomen, chest, shoulders, and arms)

Although the Guidelines focus on the health benefits of physical activity, these benefits are not the only reason why people are active. Physical activity gives people a chance to have fun, be with friends and family, enjoy the outdoors, improve their personal appearance, and improve their fitness so that they can participate in more intensive physical activity or sporting events. Some people are active because they feel it gives them certain health benefits (such as feeling more energetic) that aren't yet conclusively proven for the general population. The Guidelines encourage people to be physically active for any and all reasons that are meaningful for them. Nothing in the Guidelines is intended to mean that health benefits are the only reason to do physical activity.

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13.4: Health Related Components of Physical Fitness

In many studies related to physical fitness and health, researchers have focused on **exercise,** as well as on the more broadly defined concept of **physical activity**. Physical activity is defined by the World Health Organization as any bodily movement produced by skeletal muscles that requires energy expenditure, while exercise is a form of physical activity that is planned, structured, repetitive, and performed with the goal of improving health or fitness. So, although all exercise is physical activity, not all physical activity is exercise. Although physical activity and exercise are defined concepts, the ultimate focus of the health related components of physical fitness is to provide a framework for components that are necessary for good health. They are cardiorespiratory (CR) endurance (also called aerobic endurance), flexibility, muscular strength, muscular endurance, and body composition.

Cardiorespiratory Endurance

- ***Aerobic endurance:*** The ability of the heart, blood vessels, and lungs to work together to accomplish three goals:
  1. deliver oxygen to body tissues
  2. deliver nutrients
  3. remove waste products.
- CR endurance exercises involve large muscle groups in prolonged, dynamic movement (ex. running, swimming, etc)

Table 13.4.1

Examples of Different Aerobic Physical Activities and Intensities	
Moderate Intensity	Vigorous Intensity
• Walking briskly (3 miles per hour or faster, but not race-walking) • Water aerobics • Bicycling slower than 10 miles per hour • Tennis (doubles) • Ballroom dancing • General gardening	• Racewalking, jogging, or running • Swimming laps • Tennis (singles) • Aerobic dancing • Bicycling 10 miles per hour or faster • Jumping rope • Heavy gardening (continuous digging or hoeing, with heart rate increases) • Hiking uphill or with a heavy backpack

Frequency and Duration

Aerobic physical activity should preferably be spread throughout the week. Research studies consistently show that activity performed on at least 3 days a week produces health benefits. Spreading physical activity across at least 3 days a week may help to reduce the risk of injury and avoid excessive fatigue.

Both moderate- and vigorous-intensity aerobic activity should be performed in episodes of at least 10 minutes. Episodes of this duration are known to improve cardiovascular fitness and some risk factors for heart disease and type 2 diabetes.

Intensity

The *Guidelines* for adults focus on two levels of intensity: moderate-intensity activity and vigorous–intensity activity. To meet the Guidelines, adults can do either moderate-intensity or vigorous-intensity aerobic activities, or a combination of both. It takes less time to get the same benefit from vigorous-intensity activities as from moderate-intensity activities. A general rule of thumb is that 2 minutes of moderate-intensity activity counts the same as 1 minute of vigorous-intensity activity. For example, 30 minutes of moderate-intensity activity a week is roughly the same as 15 minutes of vigorous-intensity activity. A person doing moderate-intensity aerobic activity can talk, but not sing, during the activity. A person doing vigorous intensity activity cannot say more than a few words without pausing for a breath.

Muscular Strength and Endurance

- **Muscular strength:** The ability of muscles to exert maximal effort.
- **Muscular endurance:** The ability of muscles to exert submaximal effort repetitively (contract over and over again or hold a contraction for a long time).

Activities for Muscular Strength and Endurance

These kind of activities, which includes **resistance training** and lifting weights, causes the body's muscles to work or hold against an applied force or weight. These activities often involve relatively heavy objects, such as weights, which are lifted multiple times to train various muscle groups. Muscle-strengthening activity can also be done by using elastic bands or body weight for resistance (climbing a tree or doing push-ups, for example).

Activities for Muscular Strength and Endurance also has three components:

- **Intensity,** or how much weight or force is used relative to how much a person is able to lift;
- **Frequency**, or how often a person does muscle strengthening activity; and
- **Repetitions**, or how many times a person lifts a weight (analogous to duration for aerobic activity). Repetitions play a key role in determining if an activity is improving muscular strength or endurance. Low repetitions with more weight will focus more on muscular strength, while high repetitions with less weight will focus more on muscular endurance. The effects of muscle-strengthening activity are limited to the muscles doing the work. It's important to work all the major muscle groups of the body: the legs, hips, back, abdomen, chest, shoulders, and arms.

Muscle-strengthening activities provide additional benefits not found with aerobic activity. The benefits of muscle-strengthening activity include increased bone strength and muscular fitness. Muscle-strengthening activities can also help maintain muscle mass during a program of weight loss.

Muscle-strengthening activities make muscles do more work than they are accustomed to doing. That is, they overload the muscles. Resistance training, including weight training, is a familiar example of muscle-strengthening activity. Other examples include working with resistance bands, doing calisthenics that use body weight for resistance (such as push-ups, pull-ups, and sit-ups), carrying heavy loads, and heavy gardening (such as digging or hoeing).

Muscle-strengthening activities count if they involve a moderate to high level of intensity or effort and work the major muscle groups of the body: the legs, hips, back, chest, abdomen, shoulders, and arms. Muscle strengthening activities for all the major muscle groups should be done at least 2 days a week.

No specific amount of time is recommended for muscle strengthening, but muscle strengthening exercises should be performed to the point at which it would be difficult to do another repetition without help. When resistance training is used to enhance muscle strength, one set of 8 to 12 repetitions of each exercise is effective, although two or three sets may be more effective. Development of muscle strength and endurance is progressive over time. Increases in the amount of weight or the days a week of exercising will result in stronger muscles.

Flexibility

Flexibility is the ability of moving a joint through the range of motion. Flexibility is an important part of physical fitness. Some types of physical activity, such as dancing, require more flexibility than others. Stretching exercises are effective in increasing flexibility, and thereby can allow people to more easily do activities that require greater flexibility. For this reason, flexibility activities are an appropriate part of a physical activity program, even though they have no known health benefits and it is unclear whether they reduce risk of injury. Time spent doing flexibility activities by themselves does not count toward meeting the aerobic or muscle-strengthening Guidelines. Although there are not specific national guidelines for flexibility, adults should do flexibility exercises at least two or three days each week to improve range of motion. This can be done by holding a stretch for 10-30 seconds to the point of tightness or slight discomfort. Repeat each stretch two to four times, accumulating 60 seconds per stretch.

Body composition

The percentage of the body composed of lean tissue (muscle, bone, fluids, etc.) and fat tissue. Changes in body composition

usually occur as a result of improvements in the other components of health related physical fitness, as well as changes in eating habits. This is discussed in more detail in the Weight Management and Healthy Eating Chapter.

There are also other components of fitness related to sports performance rather than just health. They are called skill-related components of fitness or motor fitness and include power, speed, agility, balance, and coordination. For the purpose of this class we will focus mainly on the health-related components of fitness.

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13.5: Adding Physical Activity to Your Life

Overcoming the Barrier to Being Physical Active

Given the health benefits of regular physical activity, we might have to ask why two out of three (60%) Americans are not active at recommended levels.

Many technological advances and conveniences that have made our lives easier and less active, as well as many personal variables, including physiological, behavioral, and psychological factors, may affect our plans to become more physically active. In fact, the 10 most common reasons adults cite for not adopting more physically active lifestyles are (Sallis and Hovell, 1990; Sallis et al., 1992):

- Do not have enough time to exercise
- Find it inconvenient to exercise
- Lack self-motivation
- Do not find exercise enjoyable
- Find exercise boring
- Lack confidence in their ability to be physically active (low self-efficacy)
- Fear being injured or have been injured recently
- Lack self-management skills, such as the ability to set personal goals, monitor progress, or reward progress toward such goals
- Lack encouragement, support, or companionship from family and friends, and
- Do not have parks, sidewalks, bicycle trails, or safe and pleasant walking paths convenient to their homes or offices.

Understanding common barriers to physical activity and creating strategies to overcome them may help you make physical activity part of your daily life. Please visit the link below to see a full table of SUGGESTIONS FOR OVERCOMING PHYSICAL ACTIVITY BARRIERS:

courses.candelalearning.com/...yto-your-life/

Creating your own Fitness Program

The first step to implementing a fitness program is to identify your goals. As discussed in earlier chapters, goals should be specific, measurable, action-oriented, realistic and time-bound (SMART). Progress can be difficult to track if goals are vague and open-ended, such as "*I will exercise more*." Here is an example of a SMART goal for fitness:

- Specific: "*I will walk for 30 minutes a day 3-5 days per week*"
- Measurable: *"I will improve my resting heart rate over the next month"*
- Action-Oriented: "*I will research walking routes around my home and campus"*
- Realistic: *"I will increase my walking to 45 minutes per day in one month"*
- Time Bound: *"I will try this walking program for one month and then reassess my goals"*

You can also make a SMART Goal in one statement, such as "*I will walk for 30 minutes 3-5 days per week for the next month in order to improve my resting heart rate*."

FITT Principle

Using the FITT principle is one way remember the guidelines for physical activity and create a prescription for improvement in your health-related physical fitness.

- **Frequency:** how often a person performs a health-related physical activity.
- **Intensity:** how hard a person exercises during a physical activity period. Intensity can be measured in different ways, depending on the related health-related component.
- **Time:** also known as duration. Refers to the amount of time or repetitions when performing a physical activity.

- **Type:** the kind of exercise or physical activity a person is performing.

Adapted from:

www.ode.state.or.us/teachlear...tprinciple.pdf)

Table 13.5.1

	Cardiorespiratory	Flexibility	Muscular Endurance	Muscular Strength
F Frequency	3-5 times per week Increase frequency as you get into better shape	Should be a regular part of your warm-up and cool-down Increase frequency as you get into better shape	Daily for some muscle groups Perform 3-4 times per week Increase frequency as you get into better shape	Perform 3 times per week Different muscle groups each time you work out Increase frequency as you get into better shape
I Intensity	50%-60% of heart rate reserve Increase intensity as you get into better shape	Stretch all major muscles and joints; hold for 15-30 seconds Perform 1-3 repetitions Increase intensity as you get into better shape	Less than 50% of your predicted 1-rep max Start with body weight then add resistance 15 or more reps/1-3 sets Increase intensity as you get into better shape	60%-80% of 1-rep max 8-12 reps / 1-3 sets Increase intensity as you get into better shape
T Time	20-60 minutes of continuous activity Increase the time as you get into better shape	10-20 minutes Increase the time as you get into better shape	30-60 minutes Increase the time as you get into better shape	15-60 minutes Increase the time as you get into better shape
T Type	Running, cycling, swimming, and activities that use large muscles	Perform static stretches and controlled dynamic stretches	Resistance training (body weight/ tubing/medicine balls/free weights)	Resistance training (body weight/ tubing/medicine balls/free weights)

Measuring Intensity

Target Heart Rate and Estimated Maximum Heart Rate

Exercise intensity can be measured using either heart rate or the rating of perceived exertion (RPE) method. We will look at each of these methods in turn. There are two methods of using heart rate to measure exercise intensity: the percentage of maximal heart rate method and the heart rate reserve (HRR), or karvonen method.

As its name suggests, the percentage of maximal heart rate method involves prescribing exercise at a certain percentage of maximum heart rate. To find out a person's true maximum heart rate we need to measure it in a laboratory. However, for most people this is impractical; therefore we can estimate maximum heart rate using the formula '220 – age'.

Example 1: Percentage Heart Rate Method

Case study: 'Mariella', age 30

1. **Calculate maximum heart rate (HR_{max})**
   - Estimated HR_{max}= 220 – age
   - = 220 – 30= **190 bpm** (beats per minute)
2. **Calculate exercise intensity**
   - ACSM guidelines = 55–90% of HR_{max}
   - Lower target (55%) = 190 × 55%
   - = 190 × 0.55 = **104.5 bpm** (we would round this up to 105 bpm)
   - Upper target (90%) = 190 × 90%
   - = 190 × 0.90 = **171 bpm**

This formula gives us an idea of maximum heart rate, but we must remember that it is just an estimate and not completely accurate. Therefore using this method, according to ACSM guidelines, Mariella should exercise at a heart rate somewhere between **105 and 171 bpm**. This is quite a wide range so, depending on her fitness levels, you would need to decide whether to prescribe Mariella exercise to the upper or lower end of this scale.

Please note that there are online calculators available to calculate all of this information for you. Once such calculator can be found at:

http://www.sparkpeople.com/resource/...tor_target.asp

The HRR method is thought to be more accurate than the percentage of maximal heart rate method because it takes the individual's resting heart rate into account. The formula for calculating HRR can be seen in Box 2. The ACSM recommends that to improve aerobic fitness, exercise intensity should be set at either 40–85 per cent of (HRR) or 55–90 per cent of maximum heart rate (HR_{max}) (Pollock et al., 1998). These ranges are deliberately broad to reflect different levels of fitness; that is, someone with relatively low levels of fitness who has just started an exercise programme may need to work on the lower end of the scale, whereas someone who has a higher level of fitness, perhaps who has been exercising for a while, may need to work at an intensity towards the upper end of the scale. This demonstrates the importance of *progression* in an exercise programme.

Example 2: Heart Rate Reserve Method

Case study: 'Mariella', age 30

1. **Calculate maximum heart rate (HR_{max})**
   - Estimated HR_{max} = 220 - age
   - = 220 – 30 = **190 bpm** (beats per minute)
2. **Measure resting heart rate (HR_{rest})**
   - You would measure this either using a heart rate monitor or manually, using your fingers. Ideally it should be measured first thing in the morning. Let's imagine that Mariella's HR_{rest} has been measured at **70 bpm.**
3. **Calculate heart rate reserve (HRR)**
   - HRR = HR_{max} – HR_{rest} = 190 – 70 = **120 bpm**
4. **Calculate exercise intensity**
   - ACSM guidelines = 40–85% HRR
   - Lower target (40%) = (HHR × 40%) + HR_{rest}
   - = (120 × 0.40) + 70
   - = 48 + 70 = **118 bpm**
   - Upper target (85%) = (HHR × 85%) + HR_{rest}
   - = (120 × 0.85) + 70
   - = 102 + 70
   - = **172 bpm**

Using this method, according to ACSM guidelines, Mariella should exercise somewhere between **118 and 172 bpm**.

Borg Scale

An alternative to using heart rate methods is the RPE method of measuring exercise intensity. However, you should note that it

is difficult to give a general recommendation for RPE, as it is by its very nature open to personal interpretation; that is, what I consider to be a 12 may be different to what you consider to be a 12. RPE can be a useful way of measuring exercise intensity when heart rate monitoring is difficult or inappropriate. For example, some types of medication (e.g. beta blockers) given to people with hypertension lower the heart rate, and therefore heart rate measurement is not appropriate for people on this type of medication. The **Borg Rating of Perceived Exertion (RPE) Scale** is one way to measure perceived exertion. In medicine, this is used to document the patient's exertion during a test, and sports coaches use the scale to assess the intensity of training and competition. The original scale introduced by Gunnar Borg rated exertion on a scale of 6-20. The seemingly odd range of 6-20 is to follow the general heart rate of a healthy adult by multiplying by 10. For instance, a perceived exertion of 12 would be expected to coincide with a heart rate of roughly 120 beats per minute.

Set Points on Scale

It ranges from 6 to 20, where 6 means "no exertion at all" and 20 means "maximal exertion." Choose the number from below that best describes your level of exertion. This will give you a good idea of the intensity level of your activity, and you can use this information to speed up or slow down your movements to reach your desired range.

Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

6. No exertion at all
7. Extremely light (7.5)
8. Very light
9. Light
10. Somewhat hard
11. Hard
12. Very Hard
13. Extremely hard
14. Maximal exertion

9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes.

13 On the scale is "somewhat hard" exercise, but it still feels OK to continue.

17, Or "very hard," is very strenuous. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

19 on the scale is an extremely strenuous exercise level. For most people this is the most strenuous exercise they have ever experienced.

Taking Your Heart Rate

Generally, to determine whether you are exercising within the heart rate target zone, you must stop exercising briefly to take your pulse. You can take the pulse at the neck, the wrist, or the chest. We recommend the wrist. You can feel the radial pulse on the artery of the wrist in line with the thumb. Place the tips of the index and middle fingers over the artery and press lightly. Do not use the thumb. Take a full 60-second count of the heartbeats, or take for 30 seconds and multiply by 2. Start the count on a beat, which is counted as "zero." If this number falls between 85 and 119 bpm in the case of the 50-year old person, he or she is active within the target range for moderate-intensity activity.



Figure 13.5.1 Taking your heart rate

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13.6: IMPLEMENTING YOUR FITNESS PLAN

The Beneficial Effects of Increasing Physical Activity: It's About Overload, Progression, and Specificity

Creating a safe and effective fitness program involves knowing certain basic principles of physical fitness: overload, progression, and specificity. **Overload** is the physical stress placed on the body when physical activity is greater in amount or intensity than usual. The body's structures and functions respond and adapt to these stresses. For example, aerobic physical activity places a stress on the cardiorespiratory system and muscles, requiring the lungs to move more air and the heart to pump more blood and deliver it to the working muscles. This increase in demand increases the efficiency and capacity of the lungs, heart, circulatory system, and exercising muscles. In the same way, muscle–strengthening and bone-strengthening activities overload muscles and bones, making them stronger. **Progression** is closely tied to overload. Once a person reaches a certain fitness level, he or she progresses to higher levels of physical activity by continued overload and adaptation. Small, progressive changes in overload help the body adapt to the additional stresses while minimizing the risk of injury. **Specificity** means that the benefits of physical activity are specific to the body systems that are doing the work. For example, aerobic physical activity largely benefits the body's cardiovascular system. These principles should be taken into consideration during any exercise program if you expect to meet your goals.

Designing a program

Warm-up and Cool down Activities

Warm-up and cool-down activities are an important part of a person’s physical activity plan. Commonly, the warm-up and cool-down involve doing an activity at a slower speed or lower intensity. A warm-up before moderate-or vigorous-intensity aerobic activity allows a gradual increase in heart rate and breathing at the start of the episode of activity. A cool down after activity allows a gradual decrease at the end of the episode. Time spent doing warm-up and cool-down may count toward meeting the aerobic activity Guidelines if the activity is at least moderate intensity (for example, walking briskly as a warm-up before jogging). A warm-up for muscle-strengthening activity commonly involves doing exercises with lighter weight.

Physical Activity in a Weight Control Plan

The health benefits of physical activity are generally independent of body weight. The good news for people needing to lose weight is that regular physical activity provides major health benefits, no matter how their weight changes over time. Along with appropriate dietary intake, physical activity is an important part of maintaining healthy weight, losing weight, and keeping extra weight off once it has been lost. Physical activity also helps reduce abdominal fat and preserve muscle during weight loss. Adults should aim for a healthy, stable body weight. The amount of physical activity necessary to achieve this weight varies greatly from person to person.

The first step in achieving or maintaining a healthy weight is to meet the minimum level of physical activity in the Guidelines. For some people, this will result in a stable and healthy body weight, but for many it may not. People who are at a healthy body weight but slowly gaining weight can either gradually increase the level of physical activity (toward the equivalent of 300 minutes a week of moderate-intensity aerobic activity), or reduce caloric intake, or both, until their weight is stable. By regularly checking body weight, people can find the amount of physical activity that works for them.

Many adults will need to do more than the 150 minutes a week of moderate-intensity aerobic physical activity as part of a program to lose weight or keep it off. These adults should do more physical activity and/or further reduce their caloric intake. Some people will need to do the equivalent of 300 or more minutes of moderate-intensity physical activity a week to meet their weight-control goals. Combined with restricting caloric intake, these adults should gradually increase minutes or the intensity of aerobic physical activity per week, to the point at which the physical activity is effective in achieving a healthy weight.

Adults should strongly consider walking as one good way to get aerobic physical activity. Many studies show that walking has health benefits and a low risk of injury. It can be done year-round and in many settings. It is important to remember that all activities—both baseline and physical activity—“count” for energy balance. Active choices, such as taking the stairs rather than

the elevator or adding short episodes of walking to the day, are examples of activities that can be helpful in weight control. For weight control, vigorous intensity activity is far more time-efficient than moderate-intensity activity. For example, an adult who weighs 165 pounds (75 kg) will burn 560 calories from 150 minutes of brisk walking at 4 miles an hour (these calories are in addition to the calories normally burned by a body at rest). That person can burn the same number of additional calories in 50 minutes by running 5 miles at a 10 minutes-per-mile pace.

Achieving Your Physical Activities: The Possibilities are endless

These examples show how it's possible to meet the Guidelines by doing moderate-intensity or vigorous-intensity activity or a combination of both. Physical activity at this level provides substantial health benefits.

Ways to get the equivalent of 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic physical activity a week plus muscle-strengthening activities:

- Thirty minutes of brisk walking (moderate intensity) on 5 days, exercising with resistance bands (muscle strengthening) on 2 days;
- Twenty-five minutes of running (vigorous intensity) on 3 days, lifting weights on 2 days (muscle strengthening);
- Thirty minutes of brisk walking on 2 days, 60 minutes (1 hour) of social dancing (moderate intensity) on 1 evening, 30 minutes of mowing the lawn (moderate intensity) on 1 afternoon, heavy gardening (muscle strengthening) on 2 days;
- Thirty minutes of an aerobic dance class on 1 morning (vigorous intensity), 30 minutes of running on 1 day (vigorous intensity), 30 minutes of brisk walking on 1 day (moderate intensity), calisthenics (such as sit-ups, push-ups) on 3 days (muscle strengthening);
- Thirty minutes of biking to and from work on 3 days (moderate intensity), playing softball for 60 minutes on 1 day (moderate intensity), using weight machines on 2 days (muscle-strengthening on 2 days); and
- Forty-five minutes of doubles tennis on 2 days (moderate intensity), lifting weights after work on 1 day (muscle strengthening), hiking vigorously for 30 minutes and rock climbing (muscle strengthening) on 1 day.

Ways to be Even More Active

For adults who are already doing at least 150 minutes of moderate-intensity physical activity, here are a few ways to do even more. Physical activity at this level has even greater health benefits.

- Forty-five minutes of brisk walking every day, exercising with resistance bands on 2 or 3 days;
- Forty-five minutes of running on 3 or 4 days, circuit weight training in a gym on 2 or 3 days;
- Thirty minutes of running on 2 days, 45 minutes of brisk walking on 1 day, 45 minutes of an aerobics and weights class on 1 day, 90 minutes (1 hour and 30 minutes) of social dancing on 1 evening, 30 minutes of mowing the lawn, plus some heavy garden work on 1 day;
- Ninety minutes of playing soccer on 1 day, brisk walking for 15 minutes on 3 days, lifting weights on 2 days; and
- Forty-five minutes of stationary bicycling on 2 days, 60 minutes of basketball on 2 days, calisthenics on 3 days.

Be Safe and Active

Although physical activity has many health benefits, injuries and other adverse events do sometimes happen. The most common injuries affect the musculoskeletal system (the bones, joints, muscles, ligaments, and tendons). Other adverse events can also occur during activity, such as overheating and dehydration. On rare occasions, people have heart attacks during activity.

The good news is that scientific evidence strongly shows that physical activity is safe for almost everyone. Moreover, the health benefits of physical activity far outweigh the risks. Still, people may hesitate to become physically active because of concern they'll get hurt. For these people, there is even more good news: They can take steps that are proven to reduce their risk of injury and adverse events.

The Guidelines in this module provide advice to help people do physical activity safely. Most advice applies to people of all ages. Specific guidance for particular age groups and people with certain conditions is also provided.

Physical Activity is Safe for Almost Everyone

Most people are not likely to be injured when doing moderate-intensity activities in amounts that meet the *Physical Activity*

Guidelines. However, injuries and other adverse events do sometimes happen. The most common problems are musculoskeletal injuries. Even so, studies show that only one such injury occurs for every 1,000 hours of walking for exercise, and fewer than four injuries occur for every 1,000 hours of running.

Both physical fitness and total amount of physical activity affect risk of musculoskeletal injuries. People who are physically fit have a lower risk of injury than people who are not. People who do more activity generally have a higher risk of injury than people who do less activity. To do physical activity safely and reduce risk of injuries and other adverse events, people should:

- Understand the risks and yet be confident that physical activity is safe for almost everyone.
- Choose to do types of physical activity that are appropriate for their current fitness level and health goals, because some activities are safer than others.
- Increase physical activity gradually over time whenever more activity is necessary to meet guidelines or health goals. Inactive people should "start low and go slow" by gradually increasing how often and how long activities are done.
- Protect themselves by using appropriate gear and sports equipment, looking for safe environments, following rules and policies, and making sensible choices about when, where, and how to be active.
- Be under the care of a health-care provider if they have chronic conditions or symptoms. People with chronic conditions and symptoms should consult their health-care provider about the types and amounts of activity appropriate for them.

Choose Appropriate Types and Amounts of Activity

People can reduce their risk of injury by choosing appropriate types of activity. The safest activities are moderate intensity and low impact, and don't involve purposeful collision or contact. Walking for exercise, gardening or yard work, bicycling or exercise cycling, dancing, swimming, and golf are activities with the lowest injury rates. In the amounts commonly done by adults, walking (a moderate–intensity and low-impact activity) has a third or less of the injury risk of running (a vigorous-intensity and higher impact activity).

The risk of injury for a type of physical activity can also differ according to the purpose of the activity. For example, recreational bicycling or bicycling for transportation leads to fewer injuries than training for and competing in bicycle races. People who have had a past injury are at risk of injuring that body part again. The risk of injury can be reduced by performing appropriate amounts of activity and setting appropriate personal goals. Performing a variety of different physical activities may also reduce the risk of overuse injury. The risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity.

Increase Physical Activity Gradually Over Time

Scientific studies indicate that the risk of injury to bones, muscles, and joints is directly related to the gap between a person's usual level of activity and a new level of activity. The size of this gap is called the amount of overload. Creating a small overload and waiting for the body to adapt and recover reduces the risk of injury. When amounts of physical activity need to be increased to meet the Guidelines or personal goals, physical activity should be increased gradually over time, no matter what the person's current level of physical activity. Scientists have not established a standard for how to gradually increase physical activity over time. The following recommendations give general guidance for inactive people and those with low levels of physical activity on how to increase physical activity:

- Use relative intensity (intensity of the activity relative to a person's fitness) to guide the level of effort for aerobic activity.
- Generally, start with relatively moderate-intensity aerobic activity. Avoid relatively vigorous-intensity activity, such as shoveling snow or running. Adults with a low level of fitness may need to start with light activity, or a mix of light- to moderate-intensity activity.
- First, increase the number of minutes per session (duration), and the number of days per week (frequency) of moderate-intensity activity. Later, if desired, increase the intensity.
- Pay attention to the relative size of the increase in physical activity each week, as this is related to injury risk. For example, a 20-minute increase each week is safer for a person who does 200 minutes a week of walking (a 10 percent increase), than for a person who does 40 minutes a week (a 50 percent increase).

The available scientific evidence suggests that adding a small and comfortable amount of light- to moderate–intensity activity, such as 5 to 15 minutes of walking per session, 2 to 3 times a week, to one's usual activities has a low risk of musculoskeletal injury and no known risk of severe cardiac events. Because this range is rather wide, people should consider three factors in individualizing their rate of increase: age, level of fitness, and prior experience. The amount of time required to adapt to a new level of activity probably depends on age. Youth and young adults probably can safely increase activity by small amounts every week or 2. Older adults appear to require more time to adapt to a new level of activity, in the range of 2 to 4 weeks.

Level of Fitness

Less fit adults are at higher risk of injury when doing a given amount of activity, compared to fitter adults. Slower rates of increase over time may reduce injury risk. This guidance applies to overweight and obese adults, as they are commonly less physically fit.

Prior Experience

People can use their experience to learn to increase physical activity over time in ways that minimize the risk of overuse injury. Generally, if an overuse injury occurred in the past with a certain rate of progression, a person should increase activity more slowly the next time.

Take Appropriate Precautions

Taking appropriate precautions means using the right gear and equipment, choosing safe environments in which to be active, following rules and policies, and making sensible choices about how, when, and where to be active.

Use Protective Gear and Appropriate Equipment

Using personal protective gear can reduce the frequency of injury. Personal protective gear is something worn by a person to protect a specific body part. Examples include helmets, eyewear and goggles, shin guards, elbow and knee pads, and mouth guards. Using appropriate sports equipment can also reduce risk of injury. Sports equipment refers to sport or activity-specific tools, such as balls, bats, sticks, and shoes. For the most benefit, protective equipment and gear should be:

1. The right equipment for the activity
2. Appropriately fitted
3. Appropriately maintained
4. Used consistently and correctly.

Be Active in Safe Environments

People can reduce their injury risks by paying attention to the places they choose to be active. To help themselves stay safe, people can look for:

- Physical separation from motor vehicles, such as sidewalks, walking paths, or bike lanes;
- Neighborhoods with traffic-calming measures that slow down traffic;
- Places to be active that are well-lighted, where other people are present, and that are well-maintained (no litter, broken windows);
- Shock-absorbing surfaces on playgrounds;
- Well-maintained playing fields and courts without holes or obstacles;
- Breakaway bases at baseball and softball fields; and
- Padded and anchored goals and goal posts at soccer and football fields.

Follow Rules and Policies That Promote Safety

Rules, policies, legislation, and laws are potentially the most effective and wide-reaching way to reduce activity-related injuries. To get the benefit, individuals should look for and follow these rules, policies, and laws. For example, policies that promote the use of bicycle helmets reduce the risk of head injury among cyclists. Rules against diving into shallow water at swimming pools prevent head and neck injuries.

Make Sensible Choices about How, When, and Where To Be Active

A person's choices can obviously influence the risk of adverse events. By making sensible choices, injuries and adverse events can be prevented. Consider weather conditions, such as extremes of heat and cold. For example, during very hot and humid weather, people lessen the chances of dehydration and heat stress by:

- Exercising in the cool of early morning as opposed to mid-day heat;
- Switching to indoor activities (playing basketball in the gym rather than on the playground);
- Changing the type of activity (swimming rather than playing soccer);
- Lowering the intensity of activity (walking rather than running); and
- Paying close attention to rest, shade, drinking enough fluids, and other ways to minimize effects of heat.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries.

Exposure to air pollution is associated with several adverse health outcomes, including asthma attacks and abnormal heart rhythms. People who can modify the location or time of exercise may wish to reduce these risks by exercising away from heavy traffic and industrial sites, especially during rush hour or times when pollution is known to be high. However, current evidence indicates that the benefits of being active, even in polluted air, outweigh the risk of being inactive.

Advice from Health-Care Providers The protective value of a medical consultation for persons with or without chronic diseases who are interested in increasing their physical activity level is not established. People without diagnosed chronic conditions (such as diabetes, heart disease, or osteoarthritis) and who do not have symptoms (such as chest pain or pressure, dizziness, or joint pain) do not need to consult a health-care provider about physical activity.

Inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries. A person who is habitually active with moderate-intensity activity can gradually increase to vigorous intensity without needing to consult a health-care provider. People who develop new symptoms when increasing their levels of activity should consult a health-care provider.

Health-care providers can provide useful personalized advice on how to reduce risk of injuries. For people who wish to seek the advice of a health-care provider, it is particularly appropriate to do so when contemplating vigorous-intensity activity, because the risks of this activity are higher than the risks of moderate-intensity activity.

The choice of appropriate types and amounts of physical activity can be affected by chronic conditions. People with symptoms or known chronic conditions should be under the regular care of a health-care provider. In consultation with their provider, they can develop a physical activity plan that is appropriate for them. People with chronic conditions typically find that moderate-intensity activity is safe and beneficial. However, they may need to take special precautions. For example, people with diabetes need to pay special attention to blood sugar control and proper footwear during activity.

13.6.1: Additional Safety Concerns

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13.6.1: Additional Safety Concerns

As activity rates among Americans increase, specifically outdoor activities, safety concerns also rise. Unfortunately, the physical infrastructure of many American cities does not accommodate active lifestyles. Limited financial resources and de-emphasis on public health means local and state governments are unlikely to allocate funds for building roads with sidewalks, creating walking trails that surround parks, or adding bike lanes. In addition, time constraints and inconvenience make it challenging for participants to travel to areas where these amenities are available. As a result, exercise participants share roads and use isolated trails/pathways, inherently increasing the safety risks of being active.

A key principle in outdoor safety is to recognize and avoid the extremes. For example, avoid roads that experience heavy traffic or are extremely isolated. Avoid heavy populated areas as well as places where no one is around. Do not exercise in the early morning or late at night, during extreme cold or extreme heat. To minimize safety risks during these types of environmental conditions, do not use headphones that could prevent you from hearing well and remaining alert, do not exercise alone, prepare for adequate hydration in the heat, and use warm clothing in extreme cold to avoid frostbite. Extreme conditions require extra vigilance on your part.

A second key principle, whether outdoor or indoor, is to simply use common sense. While this caveat seems obvious, it gets ignored far too often. Always remember the purpose of your exercise is for enjoyment and improved health. If these objectives could be compromised by going for a run at noon in 95-degree heat, or lifting large amounts of weight without a spotter, you should reconsider your plan. Before exercising in what could be risky conditions, ask yourself, “Is there a safer option available?”

Lastly, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy nature, but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions are additional variables to avoid in order to complete your exercise session without an accident.

The document linked below from the University of Texas at San Antonio Police Department outlines specific safety tips that will help you stay safe in your activities.

Safety Tips for Runners, Walkers, and Joggers

Environmental Conditions

When exercising outdoors, you must consider the elements and other factors that could place you at increased risk of injury or illness.

Heat-Related Illness

Heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, contributed to 7,233 deaths in the United States between 1999 and 2009. A 2013 report released by the Center for Disease Control stated that about 658 deaths from heat-related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.[8]

The number one risk factor associated with heat-related illness is hydration, the starting point of all heat-related illness. Unfortunately, sweat loss can occur at a faster rate than a person can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring hydration levels can assist in preventing illness. One simple method, while not full proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2–3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout (see lab). This is a great way to see firsthand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre- and post-body weight by drinking fluids during and after the workout to restore what was lost. This method, when combined with urine-

monitoring, can provide a fairly accurate assessment of hydration levels.

The best preventative measure for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48–64 oz. per day, per person. In an effort to individualize hydration, experts now recommend basing fluid intake on individual size, gender, activity levels, and climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.[9] For a 150-pound individual, this would mean 75–150 ounces of water per day! While there is still considerable debate over the exact amounts, no one disputes the importance of continually monitoring your hydration using one of the techniques described previously. Insufficient hydration leads to poor performance, poor health, and potentially serious illness.

It should be noted that electrolyte "sport" drinks, such as Gatorade and PowerAde, are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost through sweating during physical activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can create conditions equally as dangerous if you fail to take proper precautions. To minimize the risk of cold-related illness, you must prevent the loss of too much body heat. The three major concerns related to cold- related illnesses are hypothermia, frost-nip, and frost bite.

As with heat-related illness, the objective of preventing cold-related illness is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear, indicating the need to take action. Some of those symptoms include:

- Shivering
- Numbness and stiffness of joints and appendages
- Loss of dexterity and/or poor coordination
- Peeling or blistering of skin, especially to exposed areas
- Discoloration of the skin in the extremities

When walking or jogging in the cold, it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- *Hydration is key*.
  Cold air is usually drier air, which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.
- *Stay dry*.
  Heat loss occurs 25x faster in water than on dry land. As such, keeping shoes and socks dry and clothing from accumulating too much sweat will allow for more effective body temperature regulation.
- *Dress appropriately*.
  Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture-wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin, and any additional layers of clothing, without it becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can breathe.
- *Cover the extremities*.
  Those parts of the body farthest away from the heart (toes, fingers, and ears) tend to get coldest first. Take the appropriate steps to cover those areas by using gloves, moisture-wicking socks, and a winter cap to cover your head.

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13.8: Principles of Adaptation to Stress

The human body adapts well when exposed to stress. The term *stress*, within the context of exercise, is defined as an exertion above the normal, everyday functioning. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. For example, a secretary who sits at a desk all day may push his/her cardiorespiratory system to its limits simply by walking up several flights of stairs. For an avid runner, resistance training may expose the runner's muscles to muscular contractions the athlete is not accustomed to feeling. Although stress is relative to each individual, there are guiding principles in exercise that can help individuals manage how much stress they experience to avoid injury and optimize their body's capacity to adapt. Knowing a little about these principles provides valuable insights needed for organizing an effective fitness plan.

Overload Principle

Consider the old saying, "No pain, no gain." Does exercise really have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even increased sweating for temperature regulation. As these subsequent adaptations occur, the stress previously experienced during the same activity, feels less stressful in future sessions. As a result of the adaptation, more stress must be applied to the system in order to stimulate improvements, a principle known as the **overload principle**.

For example, a beginning weightlifter performs squats with 10 repetitions at 150 pounds. After 2 weeks of lifting this weight, the lifter notices the 150 pounds feels easier during the lift and afterwards causes less fatigue. The lifter adds 20 pounds and continues with the newly established stress of 170 pounds. The lifter will continue to get stronger until his/her maximum capacity has been reached, or the stress stays the same, at which point the lifter's strength will simply plateau. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

FITT

In exercise, the amount of stress placed on the body can be controlled by four variables: **F**requency, **I**ntensity, **T**ime (duration), and **T**ype, better known as FITT. The FITT principle, as outlined by the American College of Sports Medicine (ACSM) falls under the larger principle of overload.

Frequency and Time

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A beginner may determine that 2–3 exercise sessions a week are sufficient enough to stimulate improvements. On the other hand, a seasoned veteran may find that 2–3 days is not enough to adequately stress the system. According to the overload principle, as fitness improves, so must the stress to ensure continued gains and to avoid plateauing.

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon.

Although independent of one another, frequency and time are often combined into the blanket term, **volume**. The idea is that volume more accurately reflects the amount of stress experienced. This can be connected to the **progression principle**. For example, when attempting to create a jogging plan, you may organize 2 weeks like this:

- Week 1: three days a week at 30 minutes per session
- Week 2: four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, the aggressive nature of the progression is revealed. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes, equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burnout, severe fatigue, and injury. The progression principle relates to an optimal overload of the body by finding an amount that will drive adaptation without compromising safety.

Type of Exercise

Simply put, the type of exercise performed should reflect a person's goals. In cardiorespiratory fitness, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. As such, these activities can be used to build lung capacity and improve cellular and heart function.

However, the more specific the exercise, the better. While vigorous ballroom dancing will certainly help develop the cardiorespiratory system, it will unlikely improve a person's 10k time. To improve performance in a 10k, athletes spend the majority of their time training by running, as they will have to do in the actual 10k. Cyclists training for the Tour de France, spend up to six hours a day in the saddle, peddling feverishly. These athletes know the importance of training the way they want their body to adapt. This concept, called the **principle of specificity**, should be taken into consideration when creating a training plan.

In this discussion of type and the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity and requires energy (ATP) to be produced primarily through anaerobic pathways, that is, pathways not requiring oxygen to produce ATP. Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces requires aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter, so the energy systems will adequately adapt.

Likewise, force stress accounts for the amount of force required during an activity. In weightlifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers, which are unable to generate as much force as the fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory systems. As an adaptation to the heat, the amount of sweating increases as does plasma volume, making it much easier to keep the body at a normal temperature during exercise. The only way to adapt is through heat exposure, which can take days to weeks to properly adapt.

In summary, to improve performance, being specific in your training, or training the way you want to adapt, is paramount.

Intensity

Intensity, the degree of difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the other components, intensity drives adaptation. Because of its importance, it is imperative for those beginning a fitness program to quantify intensity, as opposed to estimating it as hard, easy, or somewhere in between. Not only will this numeric value provide a better understanding of the effort level during the exercise session, but it will also help in designing sessions that accommodate individual goals.

How then can intensity be measured? Heart rate is one of the best ways to measure a person's effort level for cardiorespiratory fitness. Using a percentage of maximum lifting capacity would be the measure used for resistance training.

Rest, Recovery, and Periodization

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The **principle of rest and recovery** (**or principle of recuperation**) suggests that rest and recovery from the stress of exercise must take place in proportionate amounts to avoid too much stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without overstressing the athlete. This training principle, called **periodization**, is especially important to serious athletes but can be applied to most exercise plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest.

Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macrocycles, respectively. An example of this might be:

Week	Frequency	Intensity	Time	Type
1	3 days	40% HRR	25 min	walk
2	4 days	40% HRR	30 min	walk
3	4 days	50% HRR	35 min	walk
4	2 days	30% HRR	30 min	other

As this table shows, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be “stress” weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as**overtraining syndrome**. Overtraining syndrome is not well understood. However, experts agree that a decline in performance resulting from psychological and physiological factors cannot be fixed by a few days’ rest. Instead, weeks, months, and sometimes even years are required to overcome the symptoms of overtraining syndrome. Symptoms include the following:

- Weight loss
- Loss of motivation
- Inability to concentrate or focus
- Feelings of depression
- Lack of enjoyment in activities
- Normally considered enjoyable
- Sleep disturbances
- Change in appetite

Reversibility

Chronic adaptations are not permanent. As the saying goes, “Use it or lose it.”
The **principle of reversibility** suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called **detraining**, adaptations will recede.

In cardiorespiratory endurance, key areas, such as VO_{2max}, stroke volume, and cardiac output all declined with detraining while submaximal heat rate increased. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase, VO_{2max} had fallen by 27% and stroke volume and cardiac output had fallen by 25%. The most well-trained subjects in the study had to train for nearly 40 days following bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in the blood after a 2- minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid

was dramatically affected.[2]

Not only is endurance training affected, but muscular strength, muscular endurance, and flexibility all show similar results after a period of detraining.

Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their VO_{2max}, increasing their time to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen was seen by individuals and families. Those who saw the most improvements saw similar percentage improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

In addition to genes, other factors can affect the degree of adaptation, such as a person's age, gender, and training status at the start of a program. As one might expect, rapid improvement is experienced by those with a background that includes less training, whereas those who are well trained improve at a slower rate.

Activity Guidelines

Below are links to the physical activity guidelines provided by the US Department of Health and Human Services and the American College of Sports Medicine (ACSM). As you review these recommendations, notice how closely they follow the FITT pattern described earlier in the chapter.

NIH Recommendations for Physical Activity

ACSM Physical Activity Guidelines

Fitness Guidelines

The recommendations linked above pertain to physical activity only. While they can be applied to fitness, more specific guidelines have been set to develop fitness. As stated previously, physical activity is aimed at improving health; exercise is aimed at improving health and fitness. These guidelines will be referenced often as each health-related component of fitness is discussed.

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13.9: Creating a Successful Fitness Plan

Often, the hardest step in beginning a new routine is simply starting the new routine. Old habits, insufficient motivation, lack of support, and time constraints all represent common challenges when attempting to begin a new exercise program. Success, in this case, is measured by a person's ability to consistently participate in a fitness program and reap the fitness benefits associated with a long-term commitment.

Think Lifestyle

Beginning a fitness program is a daunting task. To illustrate the concept of lifestyle, consider attendance at fitness centers during the month of January. Attendance increases dramatically, driven by the number 1 New Year's resolution in America: losing weight. Unfortunately, as time marches on, most of these new converts do not. By some estimates, as many as 80% have stopped coming by the second week in February. As February and March approach, attendance continues to decline, eventually falling back to pre-January levels.

Why does this occur? Why aren't these new customers able to persist and achieve their goal of a healthier, leaner body? One possible explanation: patrons fail to view their fitness program as a lifestyle. The beginning of a new year inspires people to make resolutions, set goals, as they envision a new and improved version of themselves. Unfortunately, most of them expect this transformation to occur in a short period of time. When this does not happen, they become discouraged and give up.

Returning to teen level weight and/or fitness may be an alluring, well-intended goal, but one that is simply unrealistic for most adults. The physical demands and time constraints of adulthood must be taken into consideration for any fitness program to be successful. Otherwise, any new fitness program will soon be abandoned and dreams of physical perfection fade, at least until next January.

Like any other lifestyle habit, optimal health and fitness do not occur overnight. Time and, more importantly, consistency, drive successful health and fitness outcomes. The very term *lifestyle* refers to changes that are long term and become incorporated into a person's daily routine. Unlike many fad diets and quick fixes advertised on television, successful lifestyle changes are also balanced and reasonable. They do not leave you feeling depressed and deprived after a few days. Find a balance between what you want to achieve and what you are realistically able to do. Finally, you must do more than simply change your behaviors. You must also modify your mental perception to promote long-term health. Find a compelling reason for incorporating healthier behaviors into your daily routine.

The steps below will guide you through this process. Before beginning a fitness program, you should understand the safety concerns associated with exercise.

Safety First: Assessing Your Risk

The physical challenges of beginning a new exercise program increase the risk of injury, illness, or even death. Results from various studies suggest vigorous activity increases the risk of acute cardiac heart attacks and/or sudden cardiac death.3 While that cautionary information appears contradictory to the previously identified benefits of exercise, the long-term benefits of exercise unequivocally outweigh its risks. In active young adults (younger than 35), incidence of cardiac events are still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 experience a cardiac event. 4

Of those rare cardiac incidents that do occur, the presence of preexisting heart disease is the common thread, specifically, atherosclerosis. **Atherosclerosis** causes arteries to harden and become clogged with plaque, which can break apart, move to other parts of the body, and clog smaller blood vessels. As such, it is important to screen individuals for risk factors associated with heart disease before they begin an exercise program.

The American College of Sports Medicine recommends a thorough pre-screening to identify any risk of heart disease. The 7 major risk factors associated with increased risk of heart disease are identified below.[5]

- *Family history*
  Having a father or first-degree male relative who has experienced a cardiac event before the age of 55, or a mother or first-

degree female relative who has experienced a cardiac event before age 65, could indicate a genetic predisposition to heart disease.
- *Cigarette smoking*
  The risk of heart disease is increased for those who smoke or have quit in the past 6 months.
- *Hypertension*
  Having blood pressure at or above 140 mm/HG systolic, 90 mm/Hg diastolic is associated with increased risk of heart disease.
- *Dyslipidemia*
  Having cholesterol levels that exceed recommendations (130 mg/dL, HDL below 40 mg/dL), or total cholesterol of greater than 200 mg/dL increases risk.
- *Impaired fasting glucose (diabetes)*Blood sugar should be within the recommended ranges.
- *Obesity*
  Body mass index greater than 30, waist circumference of larger than 102 cm for men and larger than 88 cm for women, or waist to hip ratio of less than 0.95 men, or less than 0.86 women increases risk of heart disease.
- *Sedentary lifestyle*
  Persons not meeting physical activity guidelines set by US Surgeon General's Report have an increased risk of heart disease.

In addition to identifying your risk factors, you should also complete a Physical Activity Readiness Questionnaire (PAR-Q) before beginning an exercise program. The PAR-Q asks yes or no questions about symptoms associated with heart disease. Based on your responses on the PAR-Q, you will be placed into a risk category: low, moderate, high.

- Low risk persons include men younger than 45, and women younger than 55, who answer no to all of the PAR-Q questions and have one or no risk factors. Although further screening is a good idea, such as getting physician's approval, it isn't necessary.
- Moderate risk persons are men of or greater than 45, women 55 or those who have two or more risk factors. Because of the connection between cardiac disease, the seven risk factors, and risk during exercise, it is recommended you get a physician's approval before beginning an exercise program.
- High risk persons answer yes to one or more of the questions on the PAR-Q. Physician's approval is required before beginning a program.

Once you have determined your ability to safely exercise, you are ready to take the next steps in beginning your program. Additional safety concerns, such as where you walk and jog, how to be safe during your workout, and environmental conditions, will be addressed at a later time.

As you review the remaining steps, a simple analogy may help to better conceptualize the process.

Imagine you are looking at a map because you are traveling to a particular location and you would like to determine the best route for your journey. To get there, you must first determine your current location and then find the roads that will take you to your desired location. You must also consider roads that will present the least amount of resistance, provide a reasonably direct route, and do not contain any safety hazards along the way. Of course, planning the trip, while extremely important, is only the first step. To arrive at your destination, you must actually drive the route, monitoring your car for fuel and/or malfunction, and be prepared to reroute should obstacles arise.

Preparing yourself for an exercise program and ultimately, adopting a healthier lifestyle, requires similar preparation. You will need to complete the following steps:

- *Assess your current fitness*Where are you on the map?
- *Set goals*
  What is your destination's location?
- *Create a plan*
  What route will you choose?
- *Follow through*Start driving!

Assess Your Condition

To adequately prepare, you will need to take a hard look at your current level of

fitness. With multiple methods of assessing your fitness, you should select the one that most closely applies to you. Obtaining a good estimate will provide you a one-time glance at your baseline fitness and health and provide a baseline measurement for

gauging the efficacy of your fitness program in subsequent reassessments.

Assessments are specific to each health- related component of fitness. You will have the opportunity to assess each one in the near future.

Set Goals

Using the map analogy, now that you know your current location, you must determine your destination and the best route for getting there. You can start by setting goals. In his bestselling book, *The 7 Habits of Highly Effective People*, author Stephen Covey suggests you should "Begin with the end in mind."7 While Covey's words may not be directly aimed at those seeking to complete a fitness program, his advice is useful to anyone making a significant lifestyle change. To be successful, you must develop a clear vision of your destination. Setting specific goals about how you want to feel and look, increases your chances of success. Without specific goals to measure the success of your efforts, you could possibly exceed your target and believe you failed.

The art of setting goals includes stating them in a clearly defined and measurable way. Consider exactly what you would like to accomplish, make certain your goals can be measured, and establish a reasonable timeframe in which to achieve your goals.

Goals that meet these guidelines are referred to as S.M.A.R.T. goals.

- **S**pecific
  Be as specific and detailed as possible in creating your goal.
- **M**easurable: If your goal cannot be measured, you will not know when you have successfully completed the goal.
- **A**ttainable
  Consider whether you have the resources—such as time, family support, and financial means—to obtain your goal.
- **R**ealistic
  While your goal should be challenging, it should not exceed reasonable expectations.
- **T**imeframe
  Set a deadline to accomplish your goal.

A well-stated goal contains all of the SMART components listed above. Take a look at the well-stated example below:

Example 13.9.1:

I will improve my 12-minute distance by 10% within 2 months of the first assessment.

Note, all the ingredients of a well-stated goal are present. It is specific (improve 12- minute distance by 10%), measurable (10% improvement), attainable and realistic (the degree of improvement is reasonable in that time frame), and includes a time frame (a clear deadline of 2 months).

Less effective goals would be stated like this:

- I will run farther next time I assess my fitness.
- I want to jog faster.
- I will lose weight

And a common one:

- I will exercise 3 days a week at 60% max heart rate for 45 minutes per session for 2 months.

At a closer glance, none of these examples contain all of the ingredients of a well- stated goal. How can "faster" be measured? "Farther" is not specific enough, nor is "lose weight." In the last example, this is not a goal at all. It is a plan to achieve a goal that has not been stated.

In the end, setting up well-stated goals will give you the best chance to convert good intentions into a healthier lifestyle.

To complete this step, write down 2-3 personal goals, stated in the SMART format, and put them in a place you will see them frequently.

Create a Plan

Once you know exactly what you want to achieve, generate a strategy that will help you reach your goals. As you strategize, your goal is to determine the frequency, the intensity, and the duration of your exercise sessions. While doing this, it is imperative to keep in mind a few key principles.

First, use your goals as the foundation for your program. If your goal is related to weight loss, this should drive the frequency, duration, and intensity of your daily workouts as these variables will influence your body's use of fat for fuel and the number of calories burned. If you feel more interested in improving your speed, you will need to dedicate more workout time to achieving those results.

Another key principle is the importance of safety. The importance of designing a program that is safe and effective cannot be overstated. You can minimize any risks by relying on the expert recommendations of the US Department of Health and Human Services and the American College of Sports Medicine previously outlined and linked here. These highly reputable organizations have conducted extensive research to discover the optimal frequency, intensity, and duration for exercise.

Follow Through

Once you have assessed your current fitness levels, set goals using the SMART guidelines, and created your personalized fitness plan, you should feel very proud of yourself! You have made significant progress toward achieving a healthier lifestyle. Now is when the "rubber hits the road." (Literally so, if your plan includes walking or jogging.) Now that you have invested time and energy to develop a thoughtful, well-designed fitness program, it is time to reap the returns of good execution. The assessment, planning and preparation are really the hardest parts. Once you know what to do and how to do it, success is simply a matter of doing it.

Unfortunately, the ability to stick with a program proves difficult for most. To prevent getting derailed from your program, identify barriers that may prevent you from consistently following through. One of the most common challenges cited is a shortage of time. Work schedules, school, child care, and the activities of daily living can leave you with little time to pursue your goals. Make a list of the items that prevent you from regularly exercising and then analyze your schedule and find a time for squeezing in your exercise routine. Regardless of when you schedule your exercise, be certain to exercise consistently. Below are a few additional tips for achieving consistency in your daily fitness program:

- *Think long term; think lifestyle.*
  The goal is to make exercise an activity you enjoy every day throughout your life. Cultivating a love for exercise will not occur overnight and developing your ideal routine will take time. Begin with this knowledge in mind and be patient as you work through the challenges of making exercise a consistent part of your life.
- *Start out slowly.*
  Again, you are in this for the long haul. No need to overdo it in the first week. Plan for low intensity activity, for 2–3 days per week, and for realistic periods of time (20–30 minutes per session).
- *Begin with low Intensity/low volume.*
  As fitness improves, you will want to gradually increase your efforts in terms of quantity and quality. You can do this with more time and frequency (called volume) or you can increase your intensity. In beginning a program, do not change both at the same time.
- *Keep track.*
  Results from a program often occur slowly, subtly, and in a very anti- climactic way. As a result, participants become discouraged when immediate improvements are not visible. Keeping track of your consistent efforts, body composition, and fitness test results and seeing those subtle improvements will encourage and motivate you to continue.
- *Seek support.*
  Look for friends, family members, clubs, or even virtual support using apps and other online forums. Support is imperative as it provides motivation, accountability, encouragement, and people who share a common interest, all of which are factors in your ability to persist in your fitness program.
- *Vary your activities from time to time.*
  Your overall goals are to be consistent, build your fitness, and reap the health benefits associated with your fitness program. Varying your activities occasionally will prevent boredom. Instead of walking, play basketball or ride a bike. Vary the location of your workout by discovering new hiking trails, parks or walking paths.
- *Have fun.*
  If you enjoy your activities, you are far more likely to achieve a lasting lifestyle change. While you cannot expect to be exhilarated about exercising every day, you should not dread your daily exercise regimen. If you do, consider varying your

activities more, or finding a new routine you find more enjoyable.

- *Eat healthier.*
  Nothing can be more frustrating than being consistent in your efforts without seeing the results on the scale. Eating a balanced diet will accelerate your results and allow you to feel more successful throughout your activities.

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13.10: Additional Safety Concerns

As activity rates among Americans increase, specifically outdoor activities, safety concerns also rise. Unfortunately, the physical infrastructure of many American cities does not accommodate active lifestyles. Limited financial resources and de-emphasis on public health means local and state governments are unlikely to allocate funds for building roads with sidewalks, creating walking trails that surround parks, or adding bike lanes. In addition, time constraints and inconvenience make it challenging for participants to travel to areas where these amenities are available. As a result, exercise participants share roads and use isolated trails/pathways, inherently increasing the safety risks of being active.

A key principle in outdoor safety is to recognize and avoid the extremes. For example, avoid roads that experience heavy traffic or are extremely isolated. Avoid heavy populated areas as well as places where no one is around. Do not exercise in the early morning or late at night, during extreme cold or extreme heat. To minimize safety risks during these types of environmental conditions, do not use headphones that could prevent you from hearing well and remaining alert, do not exercise alone, prepare for adequate hydration in the heat, and use warm clothing in extreme cold to avoid frostbite. Extreme conditions require extra vigilance on your part.

A second key principle, whether outdoor or indoor, is to simply use common sense. While this caveat seems obvious, it gets ignored far too often. Always remember the purpose of your exercise is for enjoyment and improved health. If these objectives could be compromised by going for a run at noon in 95-degree heat, or lifting large amounts of weight without a spotter, you should reconsider your plan. Before exercising in what could be risky conditions, ask yourself, “Is there a safer option available?”

Lastly, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy nature, but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions are additional variables to avoid in order to complete your exercise session without an accident.

The document linked below from the University of Texas at San Antonio Police Department outlines specific safety tips that will help you stay safe in your activities.

Safety Tips for Runners, Walkers, and Joggers

Environmental Conditions

When exercising outdoors, you must consider the elements and other factors that could place you at increased risk of injury or illness.

Heat-Related Illness

Heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, contributed to 7,233 deaths in the United States between 1999 and 2009. A 2013 report released by the Center for Disease Control stated that about 658 deaths from heat-related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.[8]

The number one risk factor associated with heat-related illness is hydration, the starting point of all heat-related illness. Unfortunately, sweat loss can occur at a faster rate than a person can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring hydration levels can assist in preventing illness. One simple method, while not full proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2–3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout (see lab). This is a great way to see firsthand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre- and post-body weight by drinking fluids during and after the workout to restore what was lost. This method, when combined with urine-

monitoring, can provide a fairly accurate assessment of hydration levels.

The best preventative measure for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48–64 oz. per day, per person. In an effort to individualize hydration, experts now recommend basing fluid intake on individual size, gender, activity levels, and climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.[9] For a 150-pound individual, this would mean 75–150 ounces of water per day! While there is still considerable debate over the exact amounts, no one disputes the importance of continually monitoring your hydration using one of the techniques described previously. Insufficient hydration leads to poor performance, poor health, and potentially serious illness.

It should be noted that electrolyte "sport" drinks, such as Gatorade and PowerAde, are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost through sweating during physical activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can create conditions equally as dangerous if you fail to take proper precautions. To minimize the risk of cold-related illness, you must prevent the loss of too much body heat. The three major concerns related to cold- related illnesses are hypothermia, frost-nip, and frost bite.

As with heat-related illness, the objective of preventing cold-related illness is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear, indicating the need to take action. Some of those symptoms include:

- Shivering
- Numbness and stiffness of joints and appendages
- Loss of dexterity and/or poor coordination
- Peeling or blistering of skin, especially to exposed areas
- Discoloration of the skin in the extremities

When walking or jogging in the cold, it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- *Hydration is key*.
  Cold air is usually drier air, which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.
- *Stay dry*.
  Heat loss occurs 25x faster in water than on dry land. As such, keeping shoes and socks dry and clothing from accumulating too much sweat will allow for more effective body temperature regulation.
- *Dress appropriately*.
  Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture-wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin, and any additional layers of clothing, without it becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can breathe.
- *Cover the extremities*.
  Those parts of the body farthest away from the heart (toes, fingers, and ears) tend to get coldest first. Take the appropriate steps to cover those areas by using gloves, moisture-wicking socks, and a winter cap to cover your head.

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13.11.1: Muscular Physiology

Muscles are highly specialized to contract forcefully. Muscles are powered by muscle cells, which contract individually within a muscle to generate force. This force is needed to create movement. There are over 600 muscles in the human body; they are responsible for every movement we make, from pumping blood through the heart and moving food through the digestive system, to blinking and chewing. Without muscle cells, we would be unable to stand, walk, talk, or perform everyday tasks.

Types of Muscle

There are three types of muscle:

- *Skeletal Muscle* - Responsible for body movement.
- *Cardiac Muscle* - Responsible for the contraction of the heart.
- *Smooth Muscle* - Responsible for many tasks, including movement of food along intestines, enlargement and contraction of blood vessels, size of pupils, and many other contractions.

Skeletal Muscle Structure and Function

Skeletal muscles are attached to the skeleton and are responsible for the movement of our limbs, torso, and head. They are under conscious control, which means that we can consciously choose to contract a muscle and can regulate how strong the contraction actually is. Skeletal muscles are made up of a number of **muscle fibers**. Each muscle fiber is an individual muscle cell and may be anywhere from 1 mm to 4 cm in length. When we choose to contract a muscle fiber—for instance we contract our bicep to bend our arm upwards—a signal is sent from our brain via the spinal cord to the muscle. This signals the muscle fibers to contract. Each nerve will control a certain number of muscle fibers. The nerve and the fibers it controls are called a **motor unit**. Only a small number of muscle fibers will contract to bend one of our limbs, but if we wish to lift a heavy weight then many more muscles fibers will be recruited to perform the action. This is called muscle **fiber recruitment**.

Each muscle fiber is surrounded by connective tissue called an **external lamina**. A group of muscle fibers are encased within more connective tissue called the **endomysium**. The group of muscle fibers and the endomysium are surrounded by more connective tissue called the **perimysium.** A group of muscle fibers surrounded by the perimysium is called a muscle **fasciculus**. A muscle is made up of many muscle fasciculi, which are surrounded by a thick collagenous layer of connective tissue called the **epimysium**. The epimysium covers the whole surface of the muscle.

Muscle fibers also contain many mitochondria, which are energy powerhouses that are responsible for the aerobic production of energy molecules, or**ATP molecules**. Muscle fibers also contain glycogen granules as a stored energy source, and **myofibrils**, which are threadlike structures running the length of the muscle fiber. Myofibrils are made up of two types of protein: 1) **Actin myofilaments**, and 2) **myosin myofilaments**. The actin and myosin filaments form the contractile part of the muscle, which is called
the **sarcomere**. Myosin filaments are thick and dark when compared with actin filaments, which are much thinner and lighter in appearance. The actin and myosin filaments lie on top of one another; it is this arrangement of the filaments that gives muscle its striated or striped appearance. When groups of actin and myosin filaments are bound together by connective tissue they make the myofibrils. When groups of myofibrils are bound together by connective tissue, they make up muscle fibers.

The ends of the muscle connect to bone through a tendon. The muscle is connected to two bones in order to allow movement to occur through a joint. When a muscle contracts, only one of these bones will move. The point where the muscle is attached to a bone that moves is called the **insertion**. The point where the muscle is attached to a bone that remains in a fixed position is called the **origin**.

How Muscles Contract

Muscles are believed to contract through a process called the **Sliding Filament Theory**. In this theory, the muscles contract when actin filaments slide over myosin filaments resulting in a shortening of the length of the sarcomeres, and hence, a shortening of the muscle fibers. During this process the actin and myosin filaments do not change length when muscles contract, but instead

they slide past each other.

During this process the muscle fiber becomes shorter and fatter in appearance. As a number of muscle fibers shorten at the same time, the whole muscle contracts and causes the tendon to pull on the bone it attaches to. This creates movement that occurs at the point of insertion.

For the muscle to return to normal (i.e., to lengthen), a force must be applied to the muscle to cause the muscle fibers to lengthen. This force can be due to gravity or due to the contraction of an opposing muscle group.

Skeletal muscles contract in response to an electric signal called an **action potential**. Action potentials are conducted along nerve cells before reaching the muscle fibers. The nerve cells regulate the function of skeletal muscles by controlling the number of action potentials that are produced. The action potentials trigger a series of chemical reactions that result in the contraction of a muscle.

When a nerve impulse stimulates a motor unit within a muscle, all of the muscle fibers controlled by that motor unit will contract. When stimulated, these muscle fibers contract on an all-or-nothing basis. The all- or-nothing principle means that muscle fibers either contract maximally along their length or not at all. Therefore, when stimulated, muscle fibers contract to their maximum level and when not stimulated there is no contraction. In this way, the force generated by a muscle is not regulated by the level of contraction by individual fibers, but rather it is due to the number of muscle fibers that are recruited to contract. This is called **muscle fiber recruitment**. When lifting a light object, such as a book, only a small number of muscle fibers will be recruited. However, those that are recruited will contract to their maximum level. When lifting a heavier weight, many more muscle fibers will be recruited to contract maximally.

When one muscle contracts, another opposing muscle will relax. In this way, muscles are arranged in pairs. An example is when you bend your arm at the elbow: you contract your bicep muscle and relax your tricep muscle. This is the same for every movement in the body. There will always be one contracting muscle and one relaxing muscle. If you take a moment to think about these simple movements, it will soon become obvious that unless the opposing muscle is relaxed, it will have a negative effect on the force generated by the contracting muscle.

A muscle that contracts, and is the main muscle group responsible for the movement, is called the **agonist** or **prime mover**. The muscle that relaxes is called the **antagonist**. One of the effects that regular strength training has is an improvement in the level of relaxation that occurs in the opposing muscle group. Although the agonist/antagonist relationship changes, depending on which muscle is responsible for the movement, every muscle group has an opposing muscle group.

Below are examples of agonist and antagonist muscle group pairings:

AGONIST (Prime Mover)	Antagonist
Latimus Dorsi (upper back)	**Deltoids** (shoulder)
Rectus Abdominus (stomach)	**Erector Spinae** (back muscles)
Quadricepts (top of thigh)	**Hamstrings** (back of thigh)
Gastrocnemius (calf)	**Tibialis Anterior** (front of lower leg)
Soleus (below calf)	**Tibialis Anterior** (front of lower leg)

Smaller muscles may also assist the agonist during a particular movement. The smaller muscle is called the **synergist**. An example of a synergist would be the deltoid (shoulder) muscle during a press-up. The front of the deltoid provides additional force during the press-up; however, most of the force is applied by the pectoralis major (chest). Other muscle groups may also assist

the movement by helping to maintain a fixed posture and prevent unwanted movement. These muscle groups are called **fixators**. An example of a fixator is the shoulder muscle during a bicep curl or tricep extension.

Types of Muscular Contraction

- *Isometric* - This is a static contraction where the length of the muscle, or the joint angle, does not change. An example is pushing against a stationary object such as a wall. This type of contraction is known to lead to rapid rises in blood pressure.
- *Isotonic* - This is a moving contraction, also known as **dynamic contraction**. During this contraction the muscle fattens, and there is movement at the joint.

Types of Isotonic Contraction

- *Concentric*
  This is when the muscle contracts and shortens against a resistance. This may be referred to as the lifting or positive phase. An example would be the lifting phase of the bicep curl.
- *Eccentric*
  This occurs when the muscle is still contracting and lengthening at the same time. This may be referred to as the lowering or negative phase.

Muscle Fiber Types

Not all muscle fibers are the same. In fact, there are two main types of muscle fiber:

- *Type I* - Often called slow-twitch or highly- oxidative muscle fibers
- *Type II* - Often called fast-twitch or low- oxidative muscle fibers

Additionally, Type II muscle fibers can be further split into **Type IIa** and **Type IIb**. Type IIb fibers are the truly fast twitch fibers, whereas Type IIa are in between slow and fast twitch. Surprisingly, the characteristics of Type IIa fibers can be strongly influenced by the type of training undertaken. Following a period of endurance training, they will start to strongly resemble Type I fibers, but following a period of strength training they will start to strongly resemble Type IIb fibers. In fact, following several years of endurance training they may end up being almost identical to slow-twitch muscle fibers.

Type I (Slow-Twitch Muscle Fibers)

Slow-twitch muscle fibers contain more**mitochondria**, the organelles that produce aerobic energy. They are also smaller, have better blood supply, contract more slowly, and are more fatigue resistant than their fast-twitch brothers. Slow-twitch muscle fibers produce energy, primarily, through aerobic metabolism of fats and carbohydrates. The accelerated rate of aerobic metabolism is enhanced by the large numbers of mitochondria and the enhanced blood supply. They also contain large amounts of **myoglobin**, a pigment similar to hemoglobin that also stores oxygen. The myoglobin provides an additional store of oxygen for when oxygen supply is limited. This extra oxygen, along with the slow-twitch muscle fibers' slow rate of contraction, increases their endurance capacity and enhances their fatigue resistance. Slow-twitch muscle fibers are recruited during continuous exercise at low to moderate levels.

Type IIb (Fast-Twitch Low-oxidative Muscle Fibers)

These fibers are larger in size, have a decreased blood supply, have smaller mitochondria and less of them, contract more rapidly, and are more adapted to produce energy **anaerobically** (without the need for oxygen) than slow-twitch muscle fibers. Their reduced rate of blood supply, together with their larger size and fewer mitochondria, makes them less able to produce energy aerobically, and are therefore, not well suited to prolonged exercise. However, their faster rate of contraction, greater levels of glycogen, and ability to produce much greater amounts of energy anaerobically make them much more suited to short bursts of energy. Because of their greater speed of contraction and reduced blood supply, they are far less fatigue resistant than slow-twitch fibers, and they tire quickly during exercise.

Numbers of Slow and Fast-Twitch Fibers

The number of slow and fast-twitch fibers contained in the body varies greatly between individuals and is determined by a person's genetics. People who do well at endurance sports tend to have a higher number of slow-twitch fibers, whereas people who are better at sprint events tend to have higher numbers of fast-twitch muscle fibers. Both the slow twitch and fast-twitch fibers can be influenced by training. It is possible through sprint training to improve the power generated by slow twitch fibers, and through endurance training, it is possible to increase the endurance level of fast-twitch fibers. The level of improvement varies, depending on the individual, and training can never make slow-twitch fibers as powerful as fast- twitch, nor can training make fast-twitch fibers as fatigue resistant as slow-twitch fibers.

Cardiac Muscle Structure and Function

Cardiac muscle cells are only found in the heart. They are elongated and contain actin and myosin filaments, which form**sarcomeres**; these join end to end to form**myofibrils**. The actin and myosin filaments give cardiac muscle a striated appearance. The striations are less numerous than in skeletal muscle. Cardiac muscles contain high numbers of mitochondria, which produce energy through aerobic metabolism. An extensive capillary network of tiny blood vessels supply oxygen to the cardiac muscle cells. Unlike the skeletal muscle cells, the cardiac cells all work as one unit, all contracting at the same time. In short, the sinoatrial node at the top of the heart sends an impulse to the atrioventricular node, which sends a wave of polarization that travels from one heart cell to another causing them all to contract at the same time.

Smooth Muscle Structure and Function

Smooth muscle cells are variable in function and perform numerous roles within the body. They are spindle shaped and smaller than skeletal muscle and contain fewer actin and myosin filaments. The actin and myosin filaments are not organized into sarcomeres, so smooth muscles do not have a striated appearance. Unlike other muscle types, smooth muscle can apply a constant tension. This is called **smooth muscle tone**. Smooth muscle cells have a similar metabolism to skeletal muscle, producing most of their energy aerobically. As such, they are not well adapted to producing energy anaerobically.[1]

For more information on muscle physiology, click on the links below:

Skeletal Muscle Physiology

Fast Twitch versus Slow Twitch Video

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Actin and Myosin: the Romeo and Juliet of Muscle Cells

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Skeletal Muscles

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

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13.11: MUSCULAR STRENGTH AND ENDURANCE

By Jonathan Howard

Learning Objectives

- Describe muscular structure and function
- Identify types of muscles
- Describe an effective resistance exercise program
- Assess your muscular strength and endurance
- Understand the dangers of supplements

Muscles are used for movement in the body. The largest portion of energy expenditure in the body happens in muscles while helping us perform daily activities with ease and improving our wellness. Muscular strength is the amount of force that a muscle can produce one time at a maximal effort, and muscular endurance is the ability to repeat a movement over an extended period of time. Resistance training is the method of developing muscular strength and muscular endurance, which in turns improves wellness. This chapter explores many ways to resistance train. However, achieving the best muscular performance requires the assistance of a trained professional.

13.11.1: Muscular Physiology

13.11.2: Resistance Exercise Programing

13.11.3: Supplements

13.11.4: Assessing your Muscular Strength and Endurance

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13.11.2: Resistance Exercise Programing

Designing a resistance exercise program can seem like a daunting task. However, the basics are very simple. The table below provides instructions for designing an effective resistance exercise program.

Resistance Exercise Program

F	Frequency of Exercise	How Often	Beginner	2–3 days per week Full-body workout of all 6 body areas 48–72 hours of rest in-between workouts	
			Intermediate to High	4–5 days per week; often perform split workouts (example: Monday and Thursday, work chest, shoulders, triceps, abdominals; Tuesday and Friday, work back, legs, biceps) 48–72 hours of rest in-between workouts	
I	Intensity of Exercise	How Hard	Beginner	60%–70% of maximum strength	
			Intermediate to High	70%–90% of maximum strength	
T	Time of Exercise	–How many reps –How many sets –How much time between sets	Beginner	1–3 Sets 8–12 repetitions	30 sec to 1 minute
			Intermediate to High	Endurance – 12–20+ Reps 2–3 Sets	30 sec to 1 minute
				Strength – 2–6 Reps 3–5 Sets	2 to 5 minutes
T	Type of Exercise	Which Exercises	Weight machines, free weights, resistance tubing, medicine ball, own body weight		

Note

Specificity Principle - you must work each muscle group to have strength gains in that particular part of the body

Recommendations for Resistance Training Exercise

- *Perform a minimum of 8 to 10 exercises that train the major muscle groups.*
  - Workouts should not be too long. Programs longer than one hour are associated with higher dropout rates.
  - Choose more compound, or multi-joint exercises, which involve more muscles with fewer exercises.
- *Perform one set of 8 to 12 repetitions to the point of volitional fatigue.*
  - More sets may elicit slightly greater strength gains, but additional improvement is relatively small.
- *Perform exercises at least 2 days per week.*
  - More frequent training may elicit slightly greater strength gains, but additional improvement is relatively small since progress is made during the recuperation between workouts.
- *Adhere as closely as possible to the specific exercise techniques.*
- *Perform exercises through a full range of motion.*
  - Elderly trainees should perform the exercises in the maximum range of motion that does not elicit pain or discomfort.

- *Perform exercises in a controlled manner.*
- *Maintain a normal breathing pattern.*
- *If possible, exercise with a training partner.*
  - Partners can provide feedback, assistance, and motivation.

Position Stand on Progression Models in Resistance Training for Healthy Adults[2]

- *Both concentric and eccentric muscle actions*
- *Both single and multiple joint exercises*
- *Exercise sequence*
  - Large before small muscle group exercises
  - Multiple-joint exercises before single-joint exercises
  - Higher intensity before lower intensity exercises
- *When training at a specific RM load*
  - 2-10% increase in load if one to two repetitions over the desired number
- *Training frequency*
  - 2-3 days per week for novice and intermediate training
  - 4-5 days per week for advanced training
- *Novice training*
  - 8-12 repetition maximum (RM)
- *Intermediate to advanced training*
  - 1-12 RM using periodization* (strategic implementation of specific training phases alternating between phases of stress and phases of rest)
  - Eventual emphasis on heavy loading (1-6 RM)
  - At least 3-min rest periods between sets
  - Moderate contraction velocity
  - 1-2 s concentric, 1-2 s eccentric

* For more information on using periodization for weight training, click on the link below:

Periodization for Weight Training

Details

- *Hypertrophy training*
  - 1-12 RM in periodized fashion, with emphasis on the 6-12 RM zone
  - 1- to 2-min rest periods between sets
  - Moderate contraction velocity
  - Higher volume, multiple-set programs
- *Power training* (two general loading strategies):
  - **Strength training**
    - Use of light loads
    - 30-60% of 1 RM
    - Fast contraction velocity
    - 2-3 min of rest between sets for multiple sets per exercise
    - Emphasize multiple-joint exercises especially those involving the total body
  - **Local muscular endurance training**
    - Light to moderate loads
    - 40-60% of 1 RM
    - High repetitions (> 15)
    - Short rest periods (< 90 seconds)

Recommendations should be viewed within the context of an individual's target goals, physical capacity, and training status.

Six Types of Resistance Training

Each type of resistance training benefits muscles in a different way. While these types of resistance training are not new, they could be unique sources of resistance that you have not considered in your quest to add muscle to your frame. Using these forms of resistance alone, in combination with one another, or in combination with the more traditional resistance apparatus, can enable

you to diversify your efforts to produce valuable and improved results.

In each type of training, you may use an apparatus to create an environment for resistance. The uniqueness of these sources is found in the way they are implemented. You might use a dumbbell for a particular exercise in some of these alternative resistance methods, but the way you use the resistance through a range of motion may be altogether different.

In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

- *Dynamic Constant Training*
  As the name suggests, the most distinctive feature of dynamic constant training (DCT) is that the resistance is constant. A good example of DCT occurs when you use free weights or machines that do not alter resistance, but redirect it instead. The emphasis shifts to different planes along the muscle group being worked. When you work on a shoulder-press machine, for example, the resistance remains constant over the entire range of motion. It is identical from the bottom of the movement to the top and back down again. Only the direction of the resistance varies. The resistance redirects itself through the arc and then redirects itself again when the shoulders let the weight come back down to the starting position.
- *Dynamic Progressive Training*
  In dynamic progressive training (DPT), resistance increases progressively as you continue to exercise. DPT is often used as a rehabilitative measure and offers the sort of resistance that builds gradually while remaining completely within the control of the person using it. Equipment includes rubber bands and tubing, springs, and an apparatus controlled by spring-loaded parts. They are low- cost items that are easily accessible and can be used anywhere. Though commonly employed for rehabilitation of torn ligaments, joints, muscles, and broken bones, it is also convenient for travelers on either vacation or business trips. When combined with traditional forms of resistance, this training creates a better-balanced program and provides the muscles with a welcome alternative from time to time.
- *Dynamic Variable Training*
  This form of resistance exercise takes up where dynamic constant training leaves off. Whereas DCT employs constant resistance, never varying to accommodate the body's mechanics, DVT can be adapted to the varying degrees of strength of a muscle group throughout a range of motion. Though very few machines succeed in this goal, a few have come close.

  Hammer Strength equipment emphasizes common fixed areas of resistance. However, the Strive line of equipment has been able to give the user much more choice in resistance levels during an exercise. Strive equipment uses the DVT principle most effectively because it allows the user to increase resistance at the beginning, middle or end of the range of motion. If your joints are stronger at the end of a movement (the top) or the beginning (the bottom), you can set the resistance accordingly. The Strive line is the most flexible yet of all gym equipment designed to adhere to the DVT principle. It lets you tailor-make your workouts based on your body's mechanics.

- *Isokinetic Training*
  In isokinetic training (IKT), the muscle is contracted at a constant tempo. Speed determines the nature of this resistance training, not the resistance itself; however, the training is based on movement carried out during a condition of resistance. IKT can be performed with the body's own weight.

  In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

- *Isometric Training*
  Familiar to most people, isometric training (IMT) is an excellent way to build strength with little adverse effect on joints and tendons commonly associated with strength training and lifting heavy weights. Though it appears simple in comparison to traditional resistance training, IMT should not be underrated in its effectiveness. IMT is a method in which the force of contraction is equal to the force of resistance. The muscle neither lengthens nor shortens. You may be wondering how any training occurs without lengthening and shortening the muscles. In IMT, the muscles act against each other or against an immovable object.

  Isometric training is what you see swimmers do when they press their hands against a solid wall, forcing all their bodyweight

into the wall. Another common IMT exercise is pressing the hands together to strengthen the pectorals and biceps. Pressing against the wall can involve muscles in the front deltoid, chest and biceps. Isometric training has been proven very effective for gaining strength, but this method usually strengthens only the muscles at the point of the isometric contraction. If the greatest resistance and force are acting upon the mid-portion of the biceps, that is where most of the benefit will occur. A comprehensive isometric routine can serve to increase strength in certain body parts.

- *Isotonic Training*
  This method demands constant tension, typically with free weights. Though this approach may sound a lot like dynamic constant training, it differs because it does not necessarily redirect the resistance through a range of motion, but rather, keeps tension constant as in the negative portion of an exercise. Complete immobility of the muscle being worked is required. For example, in the preacher curl, the biceps are fixed against the bench. They lift (positive), then release the weight slowly downward (negative), keeping the same tension on the muscles in both directions. This is one reason that free-weight exercise is considered the best form of isotonic training. Merely lifting a dumbbell or barbell, however, is not necessarily enough to qualify as isotonic. The true essence of isotonic training is keeping resistance constant in both the positive and negative portions of each repetition.

Exercise Order for Resistance Training

The general guidelines for exercise order when training all major muscle groups in a workout is as follows:

- Large muscle group exercises (i.e., squat) should be performed before smaller muscle group exercises (i.e., shoulder press).
- Multiple-joint exercises should be performed before single-joint exercises.
- For power training, total body exercises (from most to least complex) should be performed before basic strength exercises. For example, the most complex exercises are the snatch (because the bar must be moved the greatest distance) and related lifts, followed by cleans and presses. These take precedence over exercises such as the bench press and squat.
- Alternating between upper and lower body exercises or opposing (agonist–antagonist relationship) exercises can allow some muscles to rest while the opposite muscle groups are trained. This sequencing strategy is beneficial for maintaining high training intensities and targeting repetition numbers.
- Some exercises that target different muscle groups can be staggered between sets of other exercises to increase workout efficiency. For example, a trunk exercise can be performed between sets of the bench press. Because different muscle groups are stressed, no additional fatigue would be induced prior to performing the bench press. This is especially effective when long rest intervals are used.[3]

Resistance Training Conclusion

The most effective type of resistance- training routine employs a variety of techniques to create a workout program that is complete and runs the gamut, from basic to specialized. Learning different methods of training, different types of resistance, and the recommended order can help you acquire a balanced, complete physique. That does not mean that these training methods will help everybody to win competitions, but they will help you learn how to tune in to your body and understand its functions through resistance and movement. This knowledge and understanding develops a valuable skill, allowing you to become more adept at finding what works best for you on any given day.

For additional information on resistance exercises, click on the links below:

Exercise and Muscle Directory

Muscular Strength and Endurance Activity

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13.11.3: Supplements

Many active people use nutritional supplements and drugs in the quest for improved performance and appearance. Most of these substances are ineffective and expensive, and many are dangerous. A balanced diet should be your primary nutritional strategy.

Below are links that provide additional information about the use of supplements during exercise:

Benefits and Side Effects of Steroid Use

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Claims versus actual effects of performance aids

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3. Information is from the National Strength and Conditioning Association and LiveStrong.org

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13.11.4: Assessing your Muscular Strength and Endurance

Functional Leg Strength Tests

The following tests assess functional leg strength using squats. Most people do squats improperly, increasing their risk of knee and back pain. Before you add weight- bearing squats to your weight-training program, you should determine your functional leg strength, check your ability to squat properly, and give yourself a chance to master squatting movements. The following leg strength tests will help you in each of these areas.

These tests are progressively more difficult, so do not move on to the next test until you have scored at least a 3 on the current test. On each test, give yourself a rating of 0, 1, 3, or 5, as described in the instructions that follow the last test.

Chair Squat

Instructions

1. Sit up straight in a chair with your back resting against the backrest and your arms at your sides. Your feet should be placed more that shoulder-width apart so that you can get them under your body.
2. Begin the motion of rising out of the chair by flexing (bending) at the hips-not the back. Then squat up using a hip hinge movement (no spine movement). Stand without rocking forward, bending your back, or using external support, and keep your head in a neutral position.
3. Return to the sitting position while maintaining a straight back and keeping your weight centered over your feet. Your thighs should abduct (spread) as you sit back in the chair. Use your rear hip and thigh muscles as much as possible as you sit.

   Do five repetitions.
   Your rating _____

Un-weighted Squat

Instructions

1. Stand with your feet placed slightly more than shoulder-width apart, toes pointed out slightly, hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
2. Squat down, keeping your weight centered over your arches and actively flexing (bending) your hips until your legs break parallel. During the movement, keep your back straight, shoulders back, and chest out, and let your thighs part to the side so that you are squatting between your legs.
3. Push back up to the starting position, hinging at the hips and not with the spine, maximizing a straight back and neutral head position.

   Do five repetitions.
   Your rating _____

Single-Leg Lunge-Squat with Rear-Foot Support

Instructions

1. Stand about 3 feet in front of a bench (with your back to the bench).
2. Place the instep of your left foot on the bench, and put most of your weight on your right let (your left leg should be bent), with your hands at your sides.
3. Squat on your right leg until your thigh is parallel with the floor. Keep your back straight, chest up, shoulders back, and head neutral.
4. Return to the starting position. Do three repetitions for each leg. Your rating: _____

Rating Your Functional Leg Strength Test Results

- *5 POINTS*
  Performed the exercise properly with good back and thigh position, weight centered over the middle or rear of the foot,

chest out, and shoulders back; good use of hip muscles on the way down and on the way up, with head in a neutral position throughout the movement; maintained good form during all repetitions; abducted)spread) the thighs on the way down during chair squats and double-leg squats; for single-let exercises, showed good strength on both sides; for single-leg lunge-squat with rear-foot support, maintained straight back, and knees stayed behind toes.

- *3 POINTS:*
  Weight was forward on the toes, with some rounding of the back; used thigh muscles excessively, with little use of hip muscles; head and chest were too far forward; showed little abduction of the thighs during double-leg squats; when going down for single-leg exercises, one side was stronger than the other; form deteriorated with repetitions; for single-leg lunge-squat with rear-foot support and single-leg squat from a bench, could not reach parallel (thigh parallel with floor).
- *1 POINT*
  Had difficulty performing the movement, rocking forward and rounding back badly; used thigh muscles excessively, with little use of hip muscles on the way up or on the way down; chest and head were forward; on un-weighted squats, had difficulty reaching parallel; and showed little abduction of the thighs on single-leg exercises, one leg was markedly stronger than the other; could not perform multiple repetitions.
- *0 POINTS*
  Could not perform exercise.

Using Your Results

Are you at all surprised by your rating for muscular strength?

What factors , if any, influenced your ability to perform these assessments?

Are you satisfied with your current level of muscular strength as evidenced in your daily life? For example, are you happy with your ability to lift objects, climb stairs, and engage in sports and recreational activities?

Muscle Endurance Assessment

For best results, do not do any strenuous weight training within 48 hours of any test.

The 60-Second Sit-Up Test

- *Equipment*
  1. Stopwatch, clock, or watch with a second hand
  2. Partner

Warning

DO NOT TAKE THIS TEST IF YOU SUFFER FROM LOW-BACK PAIN.

To prepare, try a few sit-ups to get used to the proper technique and warm up your abdominal muscles.

1. Lie flat on your back on the floor with knees bent, feet flat on the floor, and your fingers interlocked behind your neck and your elbows wide. Your partner should hold your ankles firmly so that your feet stay on the floor as you do the sit-ups.
2. When your partner signals you to begin, raise your head and chest off the floor until your chest touches your knees or thighs, keeping your elbows wide, then return to the starting position. Keep your neck neutral. Do not force your neck forward, and stop if you feel any pain.
3. Perform as many sit-ups as you can in 60 seconds.

   Number of sit-ups: _____

To rank your results, please see the chart on page 16.

Ratings for 60-second Sit-up Test:

Number of Sit-Ups						
Men	*Very Poor*	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: Under 20	Below 36	36 - 40	41 -46	47 - 50	51 - 61	Above 61
20 - 29	Below 33	33 -37	38 - 41	42 - 46	47 - 54	Above 54
30 - 39	Below 30	30 - 34	35 - 38	39 - 42	43 - 50	Above 50
40 - 49	Below 24	24 - 28	29 - 33	34 - 38	39 - 46	Above 46
50 - 59	Below 19	19 - 23	24 - 27	28 - 34	35 - 42	Above 42
60 and over	Below 15	15 - 18	19 - 21	22 - 29	30 - 38	Above 38

Number of Sit-Ups						
Women	*Very Poor*	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: Under 20	Below 28	28 - 31	32 - 35	36 - 45	46 - 54	Above 54
20 - 29	Below 24	24 - 31	32 - 37	38 - 43	44 - 50	Above 50
30 - 39	Below 20	20 - 24	25 - 28	29 - 34	35 - 41	Above 41
40 - 49	Below 14	14 - 19	20 - 23	24 - 28	29 - 37	Above 37
50 - 59	Below 10	10 - 13	14 - 19	20 - 23	24 - 29	Above 29
60 and over	Below 3	3 - 5	6 - 10	11 - 16	17 - 27	Above 27

The Push-Up Test

- *Equipment*:
  Mat or towel (optional)

In this test, you will perform either standard push-ups, or modified push-ups, in which you support yourself with your knees. The Cooper Institute developed the ratings for this test with men performing push-ups and women performing modified push-ups. Biologically, males tend to be stronger than females; the modified technique reduces

the need for upper-body strength in a test of muscular endurance. Therefore, for an accurate assessment of upper-body endurance, men should perform standard push-ups and women should perform modified push-ups. (However, in using push-ups as part of a strength-training program, individuals should choose the technique most appropriate for increasing their level of strength and endurance, regardless of gender.)

Instructions

1. For push-ups: Start in the push-up position with your body supported by your hands and feet. For the modified push-ups: Start in the modified push-up position with your body supported by your hand and knees. For both positions, your arms and your back should be straight and your fingers pointed forward.
2. Lower your chest to the floor with your back straight, and then return to the starting position.
3. Perform as many push-ups as you can without stopping.

   Number of push-ups: _____

   Number of modified push-ups: _____

Rating Your Push-Up Test Result

Your score is the number of completed push-ups or modified push-ups. Refer to the appropriate portion of the table on page 19 for a rating of your upper-body endurance.

Record your rating below and in the chart at the end of this lab.

Rating: _____

Ratings for the Push-Up and Modified Push-Up Test:

Men	Number of Modified Push-Ups					
	Very Poor	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: 18 - 29	Below 22	22 - 28	29 - 36	37 - 46	47 - 61	Above 61
30 - 39	Below 17	17 - 23	24 - 29	30 - 38	39 - 51	Above 51
40 - 49	Below 11	11 - 17	18 - 23	24 - 29	30 - 39	Above 39
50 - 59	Below 9	9 - 12	13 - 18	19 - 24	25 - 38	Above 38
60 and over	Below 6	6 - 9	10 - 17	18 - 22	23 - 27	Above 27
Women	**Number of Modified Push-Ups**					
	Very Poor	*Poor*	*Fair*	*Good*	*Excellent*	*Superior*
Age: 18 - 29	Below 17	17 - 22	23 - 29	30 - 35	36 - 44	Above 44
30 - 39	Below 11	11 - 18	19 - 23	24 - 30	31 - 38	Above 38
40 - 49	Below 6	6 - 12	13 - 17	18 - 23	24 - 32	Above 32
50 - 59	Below 6	6 - 11	12 - 16	17 - 20	21 - 27	Above 27
60 and over	Below 2	2 - 4	5 - 11	12 - 14	15 - 19	Above 19

SOURCE: Based on norms from the Cooper Institute for Aerobic Research, Dallas, Texas; from the Physical Fitness Specialist Manual, Revised 2002.
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The Squat Endurance Test

Instructions

1. Stand with your feet placed slightly more than shoulder width apart, toes pointed out slightly, hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
2. Squat down, keeping your weight centered over your arches, until your thighs are parallel with the floor. Push back up to the starting position, maintaining a straight back and neutral head position.
3. Perform as many squats as you can without stopping.

Number of squats: _____

Rating your Squat Endurance Test Result

Your score is the number of completed squats. Refer to the appropriate portion of the table for a rating of your leg muscular endurance. Record your rating below and in the summary at the end of this lab.

Rating: _____

Ratings for the Squat-Endurance Test:

Number of Squats Performed

Men	*Very Poor*	*Poor*	*Below Average*	*Average*	*Above Average*	*Good*	*Excellent*
Age: 18-25	<25	25-30	31-34	35-38	39-43	44-49	>49
26-35	<22	22-28	29-30	31-34	35-39	40-45	>45
36-45	<17	178-22	23-26	27-29	30-34	35-41	>41
46-55	<9	13-17	18-21	22-24	25-38	29-35	>35
56-65	<9	9-12	13-16	187-20	21-24	25-31	>31
65 +	<7	7-10	11-14	15-18	19-21	22-28	>28
Women	*Very Poor*	*Poor*	*Below Average*	*Average*	*Above Average*	*Good*	*Excellent*
Age: 18-25	*<18*	*18-24*	*25-28*	*29-32*	*33-36*	*37-43*	*>43*
26-35	*<20*	*13-20*	*21-24*	*25-28*	*29-32*	*33-39*	*>39*
36-45	*<7*	*7-14*	*15-18*	*19-22*	*23-26*	*27-33*	*>33*
46-55	*<5*	*5-9*	*10-13*	*14-17*	*18-21*	*22-27*	*>27*
56-65	*<3*	*3-6*	*7-9*	*10-12*	*13-17*	*18-24*	*>24*
65 +	*<2*	*2-4*	*5-10*	*11-13*	*14-16*	*17-23*	*>23*

SOURCE: Top End Sports. www.topendsports.com/testing/tests/home-squat.htm

Summary of Results

Test	Number Performed	Rating
Sit-up Test		
Push-up Test		
Squat Endurance Test		

Using Your Results

1. Are you at all surprised by your ratings for muscular endurance?
2. What factors, if any, influenced your scores?
3. Are you satisfied with your current level of muscular endurance as evidenced in your daily life, for example, your ability to carry groceries or your books, hike, and do yard work?

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13.12: CARDIORESPIRATORY FITNESS

By Scott Flynn

Learning Objectives

- Define the cardiovascular and respiratory system
- Describe how the cardiorespiratory system works
- Identify the benefits of cardiorespiratory fitness
- What is the importance of this system?
- Identify methods for assessing and improving the CR system

13.12.1: What is the cardiovascular and respiratory system?

13.12.2: The Benefits of Good Cardiorespiratory Health

13.12.3: How the CR System Works

13.12.4: The CR System and Energy Production

13.12.5: Oxidative Energy System (Aerobic)

13.12.6: Immediate/Explosive Energy System

13.12.7: Immediate/Explosive Energy System

13.12.8: Non-Oxidative or Anaerobic Energy System

13.12.9: Energy Systems Combine

13.12.10: Changes in the CR System

13.12.11: Assessing CR Fitness

13.12.12: Creating a Plan to Develop CR Fitness

13.12.13: Measuring Heart Rate

13.12.14: Measuring Intensity

13.12.15: Cardiorespiratory Fitness Assessment

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13.12.1: What is the cardiovascular and respiratory system?

Imagine for a moment climbing to the top of Mt. Everest, a challenging feat very few have accomplished. In the process, you gradually ascend from base camp, which sits at about 17,500 feet above sea level, to the peak at over 29,000 feet. At this elevation, the pressure of oxygen is so low, you struggle to take in a satisfying breath. Although you strive to breathe deeply, you are unable to get enough air. Your heart rate increases and you might even develop nausea and a headache. Unless your body has a chance to acclimate itself to higher elevations or you gain access to supplemental oxygen, your symptoms will persist or worsen.

These are the sensations many people with cardiovascular or respiratory illnesses, such as asthma, chronic bronchitis, or mild cardiovascular disease, experience on a daily basis. Climbing up a flight of steps may leave them gasping for air, as would walking briskly or even breathing in cold air. Regardless of the cause, being unable to take in sufficient air can create a sense of panic and cause serious physical discomfort. The goal of this short narrative is to engender an appreciation for the simple act of breathing and the ensuing satisfaction that comes with each life-sustaining breath. For most people, unless they engage in strenuous physical activity, such as jogging or climbing a flight of stairs, their **cardiovascular and respiratory system** (heart, blood vessels, and lungs) operates efficiently enough to go unnoticed. However, does that mean their cardiorespiratory (CR) system is functioning at optimal capacity, or could it be operating at a minimum level and experiencing problems that go undetected? This chapter defines cardiorespiratory fitness, examines the benefits of a healthy CR system, and explores how to effectively assess and improve the CR system.

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13.12.2: The Benefits of Good Cardiorespiratory Health

The link below provides a list of specific benefits:

- List of Benefits

The article linked below describes how exercise protects against Cardiovascular Disease (CVD):

- Preventing CVD

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13.12.3: How the CR System Works

The cardiorespiratory system operates to obtain and circulate vital compounds throughout the body—specifically, oxygen and nutrients, such as food energy, vitamins, and minerals. Both oxygen and nutrients, which are imperative for cellular energy production, must be taken in from the lungs and digestive system. Because the heart and lungs are so interlocked in this process, the two systems are often labeled together as the cardiorespiratory system. Without a healthy respiratory system, the body would struggle to bring in enough oxygen, release **carbon dioxide** (the chemical waste product of cellular metabolism) and eliminate unwanted particles that enter the respiratory tract when inhaling. Without a healthy heart, transporting oxygen from the lungs and nutrients from the digestive system to the body's cells would be impossible. If the health of the CR system were compromised enough, survival would be impossible. Additionally, both must be healthy or the function of one or the other will be compromised.

Below are several videos explaining how the cardiovascular and respiratory systems operate and function together:

The CR System and Exercise

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

How the Cardiovascular System Works

YouTube Video

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View this YouTube Video online

Respiratory System Explained in Detail

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

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13.12.4: The CR System and Energy Production

Clearly the cardiovascular and respiratory systems function as one, but why is the CR system so important? What makes the distribution of oxygen throughout the body so vital to existence? The answer is simple: ENERGY. While oxygen in and of itself does not contain any energy (**calories**), it does combine with fuel extracted from food once it has been introduced into the cell to help produce **adenosine triphosphate** (ATP). ATP is the basic form of cellular energy found in the body. Because the body stores very little ATP, it must constantly be regenerated. For this reason, people must continue eating and breathing to live.

Within the context of fitness, the purpose of the cardiorespiratory system is not only to produce energy but to also adapt in a way so that energy production can be optimized. For example, a high school cross country runner wants to be fit enough to compete in the state cross country meet. Unfortunately, this athlete's current mile times are 6 minutes per mile. In other words, that is the maximum work rate possible for this athlete. However, the goal is to improve to 5 minutes per mile, or improve the maximum work rate. To do so, more energy must be produced. According to the principles of adaptation, it is possible for this athlete to become more efficient at producing energy, enabling him to run a mile in less time. An example of this adaptation comes from the world record mile time of 3 minutes and 43 seconds. The world record marathon time (26.2 miles) is 2 hours, 2 minutes, and 52 seconds. That equates to 4 minutes and 41 seconds per mile over the 26-mile course. That is some serious ATP production!

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13.12.5: Oxidative Energy System (Aerobic)

As oxygen and nutrients are delivered to the cells, they are utilized to produce ATP. The workhorses of the cell for oxidative metabolism are the **mitochondria**. This form of energy production is contingent on the ability of the CR system to deliver oxygen and nutrients and the cell's ability to process that oxygen. Because of the importance of oxygen in this particular energy-producing pathway, it is called the oxidative energy system, or **aerobic system**.

Oxidative energy production is the primary means of ATP production during rest and for activities that last for 2 minutes or longer. Although other forms of energy production assist in ATP production at any given time, long duration exercise sessions rely on this aerobic pathway. Also, in contrast to other forms of ATP production, the oxidative energy system uses both carbohydrates and fats for fuel sources.

To consider: What activities would emphasize development of this energy pathway?

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13.12.6: Immediate/Explosive Energy System

While the oxidative system is the primary source of ATP production, it does require a few minutes for the system to begin operating at full capacity during exercise. How then could the body immediately produce enough energy to perform a strenuous activity, such as sprinting 50 meters? Clearly, another energy system must drive ATP production. The immediate or explosive energy system utilizes the storage of **creatine phosphate** (CP) and the storage of **adenosine diphosphate**, which is stored in very small amounts, to generate ATP. When needed, this energy system provides enough ATP to sustain a short- duration, explosive activity, approximately 10–20 seconds or less. Once CP is depleted, other energy systems must assist in the ATP generating process.

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13.12.7: Immediate/Explosive Energy System

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13.12.8: Non-Oxidative or Anaerobic Energy System

As the name implies, the **non-oxidative energy system** does not require oxygen to generate ATP. Instead, the cells where the ATP is produced require **glucose**(carbohydrates that have been broken down) as the fuel source. Like the immediate energy system, this system is associated with high intensity and short duration movements. While it is possible for some elite athletes to maintain exercise at “anaerobic” levels for several minutes, even they will eventually fatigue as a result of the non-oxidative system’s ability to sustain ATP production for events lasting longer than approximately 2 minutes.

As glucose is processed to produce ATP, the natural byproduct of this process, lactic acid, also begins to accumulate. The result of excessive lactic acid accumulation contributes to muscle fatigue, making it impossible to continue exercise at a high intensity.

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13.12.9: Energy Systems Combine

It is important to understand that energy systems do not operate in a compartmental fashion, but rather operate simultaneously, each carrying some of the burden of ATP production. For example, a professional soccer player would spend most of the match “cruising” at a light/moderate intensity level, thus primarily utilizing the oxidative energy system. However, during the match, he or she may sprint for several hundred meters, utilizing the explosive and non-oxidative system, or he or she may jump, requiring use of the explosive system. Thus, both energy systems are utilized simultaneously throughout the match. To improve performance, this player would need to develop the energy system which is utilized the most during the match.

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13.12.10: Changes in the CR System

An improvement in CR functioning, or fitness level, requires adaptation of the system. Remember, the point is to more effectively generate ATP so more work can be accomplished. In order to process more oxygen and deliver more oxygenated blood to the cells, the overall system must undergo changes to make this possible. Here is a list of adaptations that occur to the CR system as a result of consistent aerobic exercise:

- Resting heart rate may decrease. The average resting heart rate hovers around 70–75 beats per minute. Elite athletes may have resting heart rates in the high 30s. Generally, resting heart rate may decrease by approximately 10 beats per minute with chronic exercise.
- Pulmonary adaptations, such as increased **tidal volume** (the amount of oxygen entering the lungs with each breath) and increased **diffusion capacity** (the amount of oxygen that enters the blood stream from the lungs). This allows for more oxygen to enter the pulmonary circulation en route to the left side of the heart.
- The heart muscles, specifically the left side of the heart, increase in size making it possible to contract more forcefully. As a result, more blood can be pumped with each beat meaning more oxygen can be routed to the systemic circulation.
- More oxygen is delivered and transported into the cells where ATP production can occur. This is called the **arterial-vein difference** (a-VO_{2diff})

These changes in the system are not permanent because of a process known as the **principle of reversibility**. Following a period of inactivity, the benefits from chronic aerobic exercise will be reversed.

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13.12.11: Assessing CR Fitness

To adequately prepare for starting a personal fitness program, it is important to first assess your current level of fitness. There are multiple methods for assessing a person's level of fitness. Each of the walking/jogging assessments discussed here attempts to estimate a key physiological marker of the heart's and lungs' functioning capacity and maximal oxygen consumption. **Maximal oxygen consumption**, or $VO_{2\ max}$, measures the body's maximum ability to take in and utilize oxygen, which directly correlates to overall health and fitness. A good estimate of $VO_{2\ max}$ provides a one- time glance at a person's health and fitness level and a baseline measurement for reassessment at future dates to gauge improvements.

Some of the most common walking/jogging assessments used to estimate $VO_{2\ max}$ include the 12-Minute Walk, 1.5-Mile Run/Walk Test, 3-Minute Step Test, and 1- Mile Walk Test. Unfortunately, these field assessments, although practical and inexpensive, only provide estimations. More accurate assessments require a lab- based VO_{2max} test using equipment that measures the volume of oxygen and carbon dioxide being moved in and out of the air passages during exercise. Although this test is more accurate, the expense and availability make it impractical for most. Unlike the lab test, the field assessments are relatively cost free, user-friendly and require very little expertise to conduct or perform. In addition, the key point of the assessment is measuring differences rather than absolute values, and the field tests accurately meet that objective.

Information on how to safely perform these assessments will be provided at the end of this chapter.

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13.12.12: Creating a Plan to Develop CR Fitness

Once the assessments have been completed, the next step is to develop a plan for maintaining or improving your current level of fitness. This fitness plan should include activities that are safe and adapted to meet your personal goals. Once these fitness goals have been identified, the principles of adaptation to change can be utilized to achieve those goals. These principles include **specificity**, targeting specific areas in a workout, and **overload,**the practice of increasing exertion as the body adapts to ensure continued gains in fitness levels. Specifically, you need to apply the FITT principle (**F**itness, **I**ntensity, **T**ime, and **T**ype) described in detail in the previous chapter, “Fitness Principles”:

- **Frequency**: 3–5 days per week for healthy adults.
- **Intensity**: moderate to vigorous intensity, which equals 40–85% of heart rate reserve, or 55–90% of percentage of max heart rate. (More information about intensity will be provided later.)
- **Time/duration**: 20–60 minutes per session or accumulation of 150 minutes per week. Sessions must be continuous for 10 minutes or more.
- **Type/mode**: Use large muscle groups and exercises specific to cardiorespiratory exercise.

Click on the link below for ACSM’s latest recommendations on the quantity and quality of exercise for adults:

ACSM's Official News Release

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- 7.4: The Calvin Cycle - Making Sugar from Carbon Dioxide has no license indicated.

13.12.13: Measuring Heart Rate

Those starting the VO2max assessments must first measure their heart rate, an important component used in the calculations.

Here is a video describing how to determine heart rate:

YouTube Video

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13.12.14: Measuring Intensity

Intensity may be the most important aspect of the FITT principle. Engaging in a “cardio” program that does not stress the CR system to the recommended levels will be ineffective. Engaging in a program that overstresses the system can lead to injury and pose unnecessary risks. So how do you know if you are in the right range?

Heart rate is one of the best ways to measure effort level. Walking and jogging increase a person’s heart rate. Based on the function of the heart, this is no surprise. The heart rate directly correlates with the amount of oxygen being taken in by the lungs. As activity increases in intensity, oxygen demands increase and so does heart rate.

Because of this relationship, heart rate can be used in the design of an effective walking and jogging program by creating target heart rate zones. Heart rate zones represent an intensity range—a low end heart rate and a high end rate—within which a person’s heart rate would fall during a walking or jogging session.

The first step in determining your **target heart rate (THR)**, is to determine your **maximum heart rate (MHR),** both measured in beats per minute (bpm). Generally, MHR is estimated to be your age subtracted from 220 beats per minute. In other words, your heart rate should theoretically stop increasing once it reaches the calculated maximum. While helpful, it is not uncommon to see variances in the laboratory tested maximum heart rate versus the calculated method.

The next step in calculating THR is to calculate a specific percentage of your MHR. This is done using two different methods. Keep in mind, finding the THR is the objective in both methods, even though slightly different numbers are used.

The first method, called Max Heart Rate Method, is more commonly used.

Max Heart Rate Method

1. Calculate MHR;
   MHR = 220 – age.
2. Calculate high and low THR by plugging in a percentage range. In this example, 60 and 80% are being used.
   MHR x .60 = THR_{Low}
   MHR x .80 =THR_{High}
3. The resulting low and high THR numbers represent the range, or target intensity.

The target intensity signifies an optimal training zone for that particular walking or jogging session. By keeping the heart rate within that range, you will drive adaptation specific to that intensity. By using real, but random numbers, and plugging them into the above equation this becomes apparent.

Female, aged 20:

1. MHR = 220 -20
   MHR = 200 bpm;
2. THR_{low} = 200 x .60
   THR_{low} = 120 bpm
   THR_{high} =200 x .80
   THR_{high} = 160 bpm
3. THR=120-160bpm

To achieve her self-established goals, the female in the example above will need to stay within the range of 120 and 160 bpm. If her efforts are intense enough that she begins to exceed 160 bpm during her session, or easy enough that her heart rate falls below 120 bpm, she would need to change her intensity mid-session to get the optimal results.

The Karvonen Formula or Heart Rate Reserve Method

1. Calculate MHR; MHR = 220 – age.

2. Determine your **resting heart rate (RHR)**.
3. Find the **heart rate reserve (HRR)**;

   HRR = MHR – RHR

4. Calculate high and low THR by plugging in a percentage range and then adding in the RHR. In this example, 60 and 80% are being used.

   THR_{low} = HRR x .60 + RHR

   THR_{high} = HRR x .80 + RHR

5. The resulting low and high THR numbers represent the range, or target intensity.

Clearly, the Karvonen formula requires a few more steps, specifically, the incorporation of the resting heart rate. Using the same female in the example above, along with a randomly selected RHR, the THR looks like this:

1. MHR=220–20
   MHR = 200
2. RHR = 72 bpm (randomly selected)
3. HRR=MHR–RHR
   HRR=200–72
   HRR = 128
4. THR_{low}=HRRx.60+RHR
   THR_{low}=128x.60+72
   THR_{low} = 149 bpm
   THR_{high} = HRR x .80 + RHR
   THR_{high}=128x.80+72
   THR_{high} = 174 bpm
5. THR=149–174bpm

A comparison of the two methods, reveals that the low and high end of the Karvonen formula is much higher than the Max Heart Rate method, even though the exact same percentages have been used. If the female in this example used the Karvonen Formula, she would find herself at a much higher intensity, especially at the low end of the range (120 vs. 149 bpm). How can this be? Aren't these formulas supposed to have the same objective?

While it is true that both equations are used to estimate a target heart rate range, only the Karvonen Formula takes into account the RHR, the lowest possible heart rate that can be measured for that individual. The Max Heart Rate method assumes the lowest heart rate possible is "0," a number to be avoided if at all possible! Because of the difference between 0 and the maximum heart rate, the calculated percentages result in a much lower number. In terms of accuracy, the Karvonen method is superior. It simply is a better representation of true target ranges.

Other Ways to Determine Intensity

Since not everyone owns a heart rate monitor, other methods of determining exercise intensity have been developed. One particular method, called the **rating of perceived exertion (RPE)**, uses subjective measurement to determine intensity. The method is as simple as asking the question, Overall, how hard do I feel I am working? The answer is given based on a scale of 6 to 20 with 6 being almost no effort and 20 being maximum effort. Studies have indicated that when subjects are asked to exercise at a moderate or heavy intensity level, subjects can accurately do so, even without seeing their heart rate. As a result, using the RPE scale can be an effective way of managing intensity.

The original RPE scale or **Borg Scale**, designed by Dr. Gunnar Borg, was developed to mimic generalized heart rate patterns. The starting and ending point of the scale are less intuitive than a typical scale of 1-10. By design, the 6 represents a resting heart rate of 60 bpm and the 20 an exercise heart rate of 200 bpm, a beat count someone might experience at maximum effort. Over time, a modified Borg Scale was developed using a simple 1– 10 scale, with 1 being resting effort and 10 being maximum effort. Even though the modified scale is more intuitive, the traditional scale is still used more frequently.

Walking and jogging not only benefit physical health, but many enjoy the social benefits realized by exercising with friends. When

walking or jogging with friends, intensity can easily be measured by monitoring your ability to carry on a conversation. With the **Talk Test**, if you are only able to say short phrases or give one word responses when attempting to converse during an exercise session, this would suggest you are working at a high enough intensity that your breathing rate makes conversation difficult. Certainly, if you can speak in full sentences without getting winded, the intensity would be very light. Just like RPE, the Talk Test is yet another way to subjectively measure intensity, which can then be correlated with heart rates.

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13.12.15: Cardiorespiratory Fitness Assessment

Follow the link below to the course lab in which you will be assessing your current level of cardiorespiratory fitness. You will be using the lab labeled:

Assessing Your Cardiorespiratory Fitness Level

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13.13.1: THE BENEFITS OF FLEXIBILITY AND STRETCHING

There are many benefits to regular stretching with the most important of those being simple: being flexible will help you move freely and complete activities with greater ease.

Healthy Joints and Pain Management

As many as 28 percent of all adults report pain and stiffness in joints. That number increases dramatically with age and women are more likely to develop joint symptoms. For adults, arthritis is one of the most common conditions with 54% of people 75 years and older having been diagnosed with arthritis. Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching increases joint mobility and function, and decreases joint stiffness and pain.

Pain can also be related to imbalances in the muscles. For example, if the front of your thighs and hips get too tight from a lack of flexibility, the tension will pull on the hips (where the muscles are attached). The result is the pelvis may be pulled forward and cause greater sway in your lower back. This affects your posture and can eventually lead to pain and stiffness in the neck, shoulders and lower back. Stretching regularly, for all major muscle groups/joint areas, promotes good alignment and balance.

Muscle Relaxation and Stress Relief

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots (also called trigger points). Regular stretching decreases anxiety, blood pressure, and breathing rate which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea (painful menstruation) and to relieve muscle cramps during participation of exercise/sports.

Other Benefits

In addition to the benefits listed above, several other benefits have been researched and characterized as good reasons maintain a regular routine of stretching:

- Increased blood flow- Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched which may help them recover from exercise faster.
- Reduction of Future Lower Back Pain-Most experts agree (while research is still inconclusive) that counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging with muscle fitness and stretching exercises can reduce your risk of developing lower- back pain.

Flexibility and Aging

For many young adults, the thought of long term flexibility can be taken for granted. For example, how hard is it to bend over and tie your shoes? How difficult is it to walk around campus with a backpack? As young adults, most of those activities are likely encountered with little pain or resistance. However, ROM declines with age. Simple things like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can be painful. Therefore, flexibility is critical to maintaining a high quality of life in older years.

The Inactivity-Mobility Cycle

If you have ever been injured to the point that required immobilization of a joint, you realize how important mobility is in relation to your overall health. Unfortunately, as joints ROM is restricted from arthritis or other injuries, activity declines. As activity declines, the ROM likely continues to suffer as a result of inactivity and the vicious cycle ensues. A simple stretching program can help alleviate this problem and help break out of the cycle.

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13.13.2: IMPROVING RANGE OF MOTION

Joint ROM results from a combination of factors which could be classified as internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include environmental temperature, gender, age, excess fat mass, muscle mass, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions such as muscular contractions and stretching are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

Joint Structure

A joint is a location on the body in which two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits the ROM. For example, the shoulder joint which is structurally a ball-in-socket joint, can rotate in multiple directions. In other words, it has a wide range of motion. However, the knee joint is a modified hinge joint which is limited to essentially a forward-backward direction of movement. Additionally, excessive fat mass surrounding a joint or even large muscle mass may limit the ROM for a particular joint. Although weight loss could affect amounts of fat mass surrounding a joint, or loss of muscle, joint structure cannot be altered. As a result, little can be done in this area to improve flexibility.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. In other words, you can't stretch your hamstring and expect your shoulders to improve. Likewise, you can be flexible in your shoulder but very "stiff" in your fingers or ankles. So, a complete stretching program must include multiple stretches for various joints.

Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. For example, the head of the humerus fits into a small cavity to create the shoulder joint. However, those bones can only remain in place as a result of the muscles, tendons, and ligaments that keep the joint tight an in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through it's normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed isn't well understood, it does appear to be related to the elastic and plastic properties of the connective tissue. Elasticity is defined as the ability to return to resting length after **passive stretching** (i.e. elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. Plasticity is the tendency to assume a greater length after passive stretching (i.e. plastic deformation). In other words, taking that stretchy spring and changing the resting position to a new longer length. The goal of a flexibility program, is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Several studies have suggested that a slow, sustained stretch of 30-90 seconds is necessary to produce chronic plastic deformation.

Neuromuscular System

Modern cars come equipped with a central computer and sensors throughout to troubleshoot problems with the vehicle. Sensors in the engine determine temperature. Sensors on the wheels determine tire pressure while sensors in the gas tank tell you when the gas tank is low in fuel. Much like car, our bodies are equipped with sensors, called proprioceptors, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These proprioceptors are called muscle spindles and Golgi tendon organs (GTO's).

Muscles spindles, lie parallel to the regular muscle and help determine the length of muscles when they are being stretched. When a muscle is stretched, they send signals to the central nervous system causing the stretched muscle to contract. In other words, there is some resistance to the stretch generated by the nervous system's reflexive stimulus sent to the stretching muscle. This

is called the myotatic or stretch reflex. Additionally, that same signal also causes the antagonist (the opposing) muscle to relax, called reciprocal inhibition. So, when you stretch your upper thigh (quadriceps) your hamstrings (antagonist to the quadriceps) are relaxed.

The GTOs are located near the musculotendon junction, the end points of the muscle, and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, these signals will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called autogenic inhibition or the inverse myotatic reflex. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, to effectively stretch, movements must be sustained for long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will not be overridden and lengthening cannot occur. Whether signaling the muscles to contract or relax, the neuromuscular system manipulates the stretched muscle, presumably as a protective mechanism to prevent injury.

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13.13.3: WAYS TO IMPROVE FLEXIBILITY

Stretching Techniques

Multiple stretching techniques have been researched with results showing they can be beneficial in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using two basic modes: active or passive. **Active stretching**, also called unassisted stretching, suggests that the actual stretch is done individually without an external stimulus.**Passive stretching**, or assisted stretching is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques mentioned below.

Static Stretching

The most commonly prescribed and most commonly used technique for improving flexibility is the static stretch. A static stretch involves slow, gradual and controlled movements. The muscle group is stretched toward the end of the joint ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a "static" position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be in Yoga routines or stretching after a workout or athletic event.

Some of the major advantages for static stretching is that it is generally considered safe (see Stretches to Avoid), it is simple to perform and effective at increasing ROM. The only major disadvantage comes from when it is done too much which can reduce strength and may make joints unstable. Of course this could apply to any of the techniques.

Ballistic Stretching

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch, and ballistic movements that can be forceful, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many athletic coaches feel ballistic stretching is unsafe. Also, many researchers feel it is less effective at improving ROM. Nonetheless, the ACSM still recommends ballistic as one method to effectively increase flexibility.

Synamic Stretching

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that don't involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is that it will target and improve dynamic flexibility which in turn may improve performance. A disadvantage comes from the type of movements which often require good balance and coordination. So, learning correct form and being able to perform dynamic stretches may take a little time to learn or may not be applicable to certain populations.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching

This type of exercise usually involves a partner. The partner will passively stretch the muscle, immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contrac- tion, also describing the sequence of movements involved but adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two things to happen, the stretch reflex and reciprocal inhibition (the antagonist muscle to relax). After 5 seconds, the GTO's then override the muscle

spindle's signals causing autogenic inhibition. Because the muscle is relaxed, it can more easily be stretched. In other words, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself to relax as a result of the contraction.

While many experts feel that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF is that it generally requires a knowledgeable partner, it's somewhat complicated, and can cause some soreness from the contractions.

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13.13.4: CREATING AN EFFECTIVE STRETCHING PROGRAM

The ACSM has made recommendations on how to design a flexibility program. However, before getting into the design, you should know your current flexibility status by assessing various joint's ROM. Specifically, performing the sit- and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

Set Goals

Once you learn where you are most and least flexible, you should make some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, "I want to increase my flexibility," you will want to state the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal may be, "I will improve my sit-and-reach score by 4 cm by the end of the semester." Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of actually achieving it.

Apply the FITT Principle

As mentioned previously, the ACSM has made recommendations for carrying out a flexibility program based on the FITT Principle (Frequency, Intensity, Time and Type). As you select the areas you want to stretch, keep in mind it is recommended that multiple stretching exercises should be performed to target all major joints including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles. (insert link to specific exercise here). After selecting your exercises, follow the below recommendations when performing your routine.

- ***Frequency***-Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.
- ***Intensity***-Stretch to the point of tightness or mild discomfort.
- ***Time (or duration of each stretch)***-a minimum of 10 seconds for very tight muscles with an emphasis to progress to 30-90 seconds. Two to four repetitions of each stretch should be done.
- ***Type (mode)***-Select from either of the above techniques mentions that best suit your circumstances (Static, Dynamic, Ballistic, or Proprioceptive Neuromuscular Facilitation).

When to Stretch

Although stretching can be done at any time of the day, the ACSM has traditionally recommended that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies have provided evidence against stretching before exercise session suggesting that stretching will compromise the force- producing capabilities of muscles. Therefore, it is recommended that stretching take place only after the body temperature and of the muscles has increased, i.e. after the warm up or after the workout. Additional confirming evidence of this concept has shown that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. As you can see, temperature also plays a significant role in muscle ROM.

http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance

Stretching Safely

In addition to warming the muscle before performing stretching exercises, there are other things that can be done to make your flexibility routine safe. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

In addition, some stretches are not recommended, or contraindicated. Researchers have determined that some stretching exercises may not be beneficial at all or may cause injury. A list of contraindicated stretches and alternative stretches can be

found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. It is important to understand personal limitations before or during a stretch exercise to avoid injury.

Contraindicated Stretches

https://www.unm.edu/~lkravitz/Teaching%20Aerobics/YoungExercise3.pdf

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13.13.5: ASSESSING YOUR FLEXIBILITY, LABORATORY EXERCISES

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below to understand how you can perform these assessements. Those that may be most helpful include sections 5.1, 5.2, and 5.3.

https://wpscms.pearsoncmg.com/bc_hopson_health_2/214/54825/14035385.cw/index.html

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Biomechanics of Stretching

medind.nic.in/jau/t06/jaut06p3.pdf

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13.13: FLEXIBILITY

One of the five health related components of fitness is flexibility. Flexibility relates to the ability to move a joint through it's full range of motion (ROM). To develop a complete fitness program, you should take time to emphasize this component in your routine by stretching. Unfortunately, "...most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention." (American Council on Exercise)

Flexibility is classified into two types: static and dynamic. **Static flexibility** is a measure of the limits of a joints overall range of motion. It's measured by stretching and holding a joint in the position of it's maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, passive forces are required (force generated from an external source). **Dynamic flexibility** is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production (your own muscles contracting). Because it's difficult to quantify "stiffness," dynamic flexibility is measured more subjectively. For example, how easy is it to swing a tennis racket, climb steps, or get in and out of a car? The target of any good stretching program is to improve static and dynamic flexibility so that normal ROM can be achieved. The term "normal" relates to population studies that have measured various areas of the body and established an average degree of movement for a particular joint.

13.13.1: THE BENEFITS OF FLEXIBILITY AND STRETCHING

13.13.2: IMPROVING RANGE OF MOTION

13.13.3: WAYS TO IMPROVE FLEXIBILITY

13.13.4: CREATING AN EFFECTIVE STRETCHING PROGRAM

13.13.5: ASSESSING YOUR FLEXIBILITY, LABORATORY EXERCISES

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14: WEIGHT MANAGEMENT

By Lisa Jellum

Learning Objectives

- Discuss how to manage weight through diet
- Provide steps for starting a weight loss plan
- Reinforce the importance of physical activity in weight management
- Explain how to keep the weight off

The majority of Americans are unhappy with their current weight. Almost everyone would like to lose at least 5 pounds. A growing percentage of Americans are carrying enough excess weight to put them at risk for many diseases and even death. Few people, however, know enough about their own bodies to successfully manage their weight. Anyone planning to start a weight loss program should begin by carefully considering the following factors:

- How many calories are being consumed daily?
- How many calories are being expended?
- How much fluids are being consumed?
- How well are electrolytes being managed?

14.1: Weight Management Through Diet

14.2: The Importance of Physical Activity in Maintaining a Healthy Weight

14.3: Keeping the Weight Off

14.4: Health Risks of Being Underweight

14.5: References

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14.1: Weight Management Through Diet

Achieving one's ideal weight can be a real challenge. But like most endeavors in life, knowledge is power. The more people know about their diet, the better equipped they will be to manage their weight. Most people focus on the number of calories consumed. However, it is also important for them to know how many macronutrients are in the foods they eat. The most effective way to do this is performing a 10-day nutritional intake analysis. These analyses are best done on consecutive days to account for the habitual ebb and flow of one's daily food intake.

Remaining healthy during any weight loss program is paramount. Fad diets that promise quick results do not consider the effects of rapid weight loss on the body. Restricting weight loss to 1 to 2 pounds a week is a far healthier approach. Slow weight also prevents the body from burning lean muscle since the body can only burn a certain amount of fat in a week. Dieters who experience steady declines in weight are more likely to keep the weight off. The term "diet" is often synonymous with strict routines that require drastic changes in one's eating habits. In reality, the term "diet" simply describes the intake of food.

To lose weight, dieters need a clear understanding of how weight loss occurs. One pound of fat loss is going to require a reduction in caloric intake of 3,500 calories. When viewed in terms of daily food intake, to lose a pound a week, a dieter needs to reduce their daily food intake by 500 calories a day: 3,500 calories/7 days= 500 calories per day. To successfully lose 2 pounds per week, that reduction would have to be doubled to 1,000 calories per day. Attempting to lose 2 pounds or more per week would require a calorie reduction too drastic to be maintained and too restrictive to be healthy. Thus the recommendation of combining diet and exercise is the most effective method for experiencing weight loss. Subtracting 500 calories of food intake and exerting 500 calories in exercise will provide that same 1000 calorie reduction, but in a manner that is far easier to maintain, and certainly more enjoyable.

No matter what your weight loss goal is, even a modest weight loss, such as 5 to 10 percent of your total body weight, is likely to produce health benefits, such as improvements in blood pressure, blood cholesterol, and blood sugars.[1]

Getting Started with Weight Loss

The Centers for Disease Control and Prevention (CDC) recommends following the step-by-step guide published on its website, on this page: Healthy Weight: Losing Weight. Getting Started. The same information is also reprinted below:

Step 1: Make a commitment

Making the decision to lose weight, change your lifestyle, and become healthier is a big step to take. Start simply by making a commitment to yourself. Many people find it helpful to sign a written contract committing to the process. This contract may include things like the amount of weight you want to lose, the date you would like to lose the weight by, the dietary changes you will make to establish healthy eating habits, and a plan for getting regular physical activity.
Writing down the reasons why you want to lose weight can also help. It might be because you have a family history of heart disease, or because you want to see your kids get married, or simply because you want to feel better in your clothes. Post these reasons where they serve as a daily reminder of why you want to make this change.

Step 2: Take stock of where you are

Consider talking to your health care provider. He or she can evaluate your height, weight, and explore other weight- related risk factors you may have. Ask for a follow-up appointment to monitor changes in your weight or any related health conditions.

Keep a "food diary" for a few days, in which you write down everything you eat. By doing this, you become more aware of what you are eating and when you are eating. This awareness can help you avoid mindless eating.

Next, examine your current lifestyle. Identify things that might pose challenges to your weight loss efforts. For example, does your work or travel schedule make it difficult to get enough physical activity? Do you find yourself eating sugary foods because that is what you buy for your kids? Do your coworkers frequently bring high- calorie items, such as doughnuts, to the workplace to share with everyone? Think through things you can do to help overcome these challenges.

Finally, think about aspects of your lifestyle that can help you lose weight. For example, is there an area near your workplace where you and some coworkers can take a walk at lunchtime? Is there a place in your community, such as a YMCA, with exercise facilities for you and child care for your kids?

Step 3: Set realistic goals

Set some short-term goals and reward your efforts along the way. If your long-term goal is to lose 40 pounds and to control your high blood pressure, some short-term eating and physical activity goals might be to start eating breakfast, taking a 15-minute walk in the evenings, or having a salad or vegetable with supper.

Focus on two or three goals at a time. Great, effective goals are —

- Specific
- Realistic
- Forgiving (less than perfect)

For example, "Exercise more" is not a specific goal. But if you say, "I will walk 15 minutes, 3 days a week for the first week," you are setting a specific and realistic goal for the first week.

Remember, small changes every day can lead to big results in the long run. Also, remember that realistic goals are achievable goals. By achieving your short- term goals day by day, you will feel good about your progress and be motivated to continue. Setting unrealistic goals, such as losing 20 pounds in 2 weeks, can leave you feeling defeated and frustrated.

Being realistic also means expecting occasional setbacks. Setbacks happen when you get away from your plan for whatever reason—maybe the holidays, longer work hours, or another life change. When setbacks happen, get back on track as quickly as possible. Also, take some time to think about what you would do differently if a similar situation happens, to prevent setbacks.

Keep in mind everyone is different—what works for someone else might not be right for you. Just because your neighbor lost weight by taking up running, doesn't mean running is the best option for you. Try a variety of activities: walking, swimming, tennis, or group exercise classes, to see what you enjoy most and can fit into your life. These activities will be easier to stick with over the long term.

Step 4: Identify resources for information and support

Find family members or friends who will support your weight loss efforts. Making lifestyle changes can feel easier when you have others you can talk to and rely on for support. You might have coworkers or neighbors with similar goals, and together you can share healthful recipes and plan group exercise. Joining a weight loss group or visiting a health care professional, such as a registered dietitian, can help.

Step 5: Continually "check in" with yourself to monitor your progress

Revisit the goals you set for yourself in Step 3, and evaluate your progress regularly. If you set a goal to walk each morning but are having trouble fitting it in before work, see if you can shift your work hours or if you can get your walk in at lunchtime or after work. Evaluate which parts of your plan are working well and which ones need tweaking. Then rewrite your goals and plan accordingly.

If you are consistently achieving a particular goal, add a new goal to help you continue on your pathway to success.

Reward yourself for your successes! Recognize when you are meeting your goals and be proud of your progress. Use non- food rewards, such as a bouquet of freshly picked flowers, a sports outing with friends, or a relaxing bath. Rewards help keep you motivated on the path to better health.[2]

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14.2: The Importance of Physical Activity in Maintaining a Healthy Weight

On its website, the CDC explains the importance of including physical activity as part of any weight loss program. You can find information about the benefits of physical activity, recommended levels of physical activity, and the number of calories burned during common activities by clicking on this link to webpage: Healthy Weight: Physical Activity for a Health Weight. That same information is reprinted below.

Why is physical activity important?

Regular physical activity is important for good health, and it is especially important if you are trying to lose weight or to maintain a healthy weight.

- When losing weight, more physical activity increases the number of calories your body uses for energy or "burns off." The burning of calories through physical activity, combined with reducing the number of calories you eat, creates a "calorie deficit" that results in weight loss.
- Most weight loss occurs because of decreased caloric intake. However, evidence shows the only way to maintain weight loss is to be engaged in regular physical activity.
- Most importantly, physical activity reduces risks of cardiovascular disease and diabetes beyond that produced by weight reduction alone.

Physical activity also helps to–

- Maintain weight.
- Reduce high blood pressure.
- Reduce risk for type 2 diabetes, heart attack, stroke, and several forms of cancer.
- Reduce arthritis pain and associated disability.
- Reduce risk for osteoporosis and falls.
- Reduce symptoms of depression and anxiety.

How much physical activity do I need?

When it comes to weight management, people vary greatly in how much physical activity they need. Here are some guidelines to follow:

To maintain your weight.

Work your way up to 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous- intensity aerobic activity, or an equivalent mix of the two each week. Strong scientific evidence shows that physical activity can help you maintain your weight over time. However, the exact amount of physical activity needed to do this is not clear since it varies greatly from person to person. It is possible that you may need to do more than the equivalent of 150 minutes of moderate-intensity activity a week to maintain your weight.

To lose weight and keep it off.

You will need a high amount of physical activity unless you also adjust your diet and reduce the amount of calories you are eating and drinking. Getting to and staying at a healthy weight requires both regular physical activity and a healthy eating plan.

What do moderate- and vigorous-intensity mean?

Moderate: While performing the physical activity, if your breathing and heart rate is noticeably faster but you can still carry on a conversation, it is probably moderately intense.

Examples include:

- Walking briskly (a 15-minute mile).
- Light yard work (raking/bagging leaves or using a lawn mower).
- Light snow shoveling.
- Actively playing with children.
- Biking at a casual pace.

Vigorous: If your heart rate is increased substantially, and you are breathing too hard and fast to have a conversation, it is probably vigorously intense.

Examples include:

- Jogging/running.
- Swimming laps.
- Rollerblading/inline skating at a brisk pace.
- Cross-country skiing.
- Most competitive sports (football, basketball, or soccer). • Jumping rope.[3]

The table below provides a list of common physical activities and the average calories expended during those activities.

Calories Used per Hour in Common Physical Activities		
Moderate Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person[1]	Approximate Calori
Hiking	185	370
Light gardening/yard work	165	330
Dancing	165	330
Golf (walking and carrying clubs)	165	330
Bicycling (<10 mph)	145	290
Walking (3.5 mph)	140	280
Weight lifting (general light workout)	110	220
Stretching	90	180

Vigorous Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person[1]	Approximate Calori
Running/jogging (5 mph)	295	590
Bicycling (>10 mph)	295	590
Swimming (slow freestyle laps)	255	510
Aerobics	240	480
Walking (4.5 mph)	230	460
Heavy yard work (chopping wood)	220	440
Weightlifting (vigorous effort)	220	440
Basketball (vigorous)	220	440

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh les

Source: Adapted from Dietary Guidelines for Americans 2005, page 16, Table 4.

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh less.

Source: Adapted from Dietary Guidelines for Americans 2005, page 16, Table 4.

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14.3: Keeping the Weight Off

On its website the CDC admonishes that permanent weight loss is a result of making changes to eating habits that become a long-term part of a healthier lifestyle. You may access that section on their website by clicking Healthy Weight: Improving Your Eating Habits. It is also reprinted below.

Reflect, Replace, Reinforce: A process for improving your eating habits

- Create a list of your eating habits. Keeping a food diary for a few days, in which you write down everything you eat and the time of day you ate it, will help you uncover your habits. For example, you might discover that you always seek a sweet snack to get you through the mid- afternoon energy slump. Use thisdiary to help. It's good to note how you were feeling when you decided to eat, especially if you were eating when not hungry. Were you tired? Stressed out?
- Highlight the habits on your list that may be leading you to overeat. Common eating habits that can lead to weight gain are:
  - Eating too fast
  - Always cleaning your plate
  - Eating when not hungry
  - Eating while standing up (may lead to eating mindlessly or too quickly)
  - Always eating dessert
  - Skipping meals (or maybe just breakfast)
- Look at the unhealthy eating habits you have highlighted. Be sure you have identified all the triggers that cause you to engage in those habits. Identify a few you would like to work on improving first. Don't forget to pat yourself on the back for the things you are doing right. Maybe you almost always eat fruit for dessert, or you drink low-fat or fat- free milk. These are good habits! Recognizing your successes will help encourage you to make more changes.
- Create a list of "cues" by reviewing your food diary to become more aware of when and where you are "triggered" to eat for reasons other than hunger. Note how you are typically feeling at those times. Often an environmental "cue," or a particular emotional state, is what encourages eating for non-hunger reasons.
- Common triggers for eating when not hungry are:
  - Opening up the cabinet and seeing your favorite snack food.
  - Sitting at home watching television.
  - Before or after a stressful meeting or situation at work.
  - Coming home after work and having no idea what's for dinner.
  - Having someone offer you a dish they made "just for you!"
  - Walking past a candy dish on the counter.
  - Sitting in the break room beside the vending machine.
  - Seeing a plate of doughnuts at the morning staff meeting.
  - Swinging through your favorite drive-through every morning.
  - Feeling bored or tired and thinking food might offer a pick-me-up.

Circle the "cues" on your list that you face on a daily or weekly basis. Going home for the Thanksgiving holiday may be a trigger for you to overeat, and eventually, you want to have a plan for as many eating cues as you can. But for now, focus on the ones you face more often.

Ask yourself these questions for each "cue" you have circled:

Is there anything I can do to avoid the cue or situation? This option works best for cues that don't involve others. For example, could you choose a different route to work to avoid stopping at a fast food restaurant on the way? Is there another place in the break room where you can sit so you are not next to the vending machine?

For things I cannot avoid, can I do something differently that would be healthier? Obviously, you cannot avoid all situations that trigger your unhealthy eating habits, like staff meetings at work. In these situations, evaluate your options. Could you suggest or bring healthier snacks or beverages? Could you offer to take notes to distract your attention? Could you sit farther away from the food so it won't be as easy to grab something? Could you plan ahead and eat a healthy snack before the meeting?

Replace unhealthy habits with new, healthy ones. For example, in reflecting upon your eating habits, you may realize that you eat

too fast when you eat alone. So, make a commitment to share a lunch each week with a colleague, or have a neighbor over for dinner one night a week. Other strategies might include putting your fork down between bites or minimizing other distractions (i.e., watching the news during dinner) that might keep you from paying attention to how quickly—and how much— you are eating.

Here are more ideas to help you replace unhealthy habits:

Eat more slowly. If you eat too quickly, you may "clean your plate" instead of paying attention to whether your hunger is satisfied.

Eat only when you are truly hungry instead of when you are tired, anxious, or feeling an emotion besides hunger. If you find yourself eating when you are experiencing an emotion besides hunger, such as boredom or anxiety, try to find a non-eating activity to do instead. You may find a quick walk or phone call with a friend helps you feel better.

Plan meals ahead of time to ensure that you eat a healthy well-balanced meal.

Reinforce your new, healthy habits and be patient with yourself. Habits take time to develop. It doesn't happen overnight. When you do find yourself engaging in an unhealthy habit, stop as quickly as possible and ask yourself: Why do I do this? When did I start doing this? What changes do I need to make?

Be careful not to berate yourself or think that one mistake "blows" a whole day's worth of healthy habits. You can do it! It just takes one day at a time![4]

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14.4: Health Risks of Being Underweight

The 2003–2006 National Health and Nutrition Examination Survey (NHANES) estimated that 1.8 percent of adults and 3.3 percent of children and adolescents in the United States are underweight. Centers for Disease Control and Prevention. “NCHS Health E-Stat. Prevalence of Underweight among Children and Adolescents: United States, 2003–2006.” Accessed October 8, 2011. http://www.cdc.gov/nchs/data/hestat/underweight/underweight_children.htm. Being underweight is linked to nutritional deficiencies, especially iron-deficiency anemia, and to other problems such as delayed wound healing, hormonal abnormalities, increased susceptibility to infection, and increased risk of some chronic diseases such as osteoporosis. In children, being underweight can stunt growth. The most common underlying cause of underweight in America is inadequate nutrition. Other causes are wasting diseases, such as cancer, multiple sclerosis, tuberculosis, and eating disorders. People with wasting diseases are encouraged to seek nutritional counseling, as a healthy diet greatly affects survival and improves responses to disease treatments. Eating disorders that result in underweight affect about eight million Americans (seven million women and one million men).

Anorexia Nervosa

Anorexia nervosa, more often referred to as “anorexia,” is a psychiatric illness in which a person obsesses about their weight and about food that they eat. Anorexia results in extreme nutrient inadequacy and eventually to organ malfunction. Anorexia is relatively rare—the National Institute of Mental Health (NIMH) reports that 0.9 percent of females and 0.3 percent of males will have anorexia at some point in their lifetime, The National Institute of Mental Health. “Eating Disorders among Adults: Anorexia Nervosa.” Accessed October 8, 2011. http://mentalhealth.gov/statistics/1EAT_ADULT_ANX.shtml. but it is an extreme example of how an unbalanced diet can affect health. Anorexia frequently manifests during adolescence and it has the highest rate of mortality of all mental illnesses. People with anorexia consume, on average, fewer than 1,000 kilocalories per day and exercise excessively. They are in a tremendous caloric imbalance. Moreover, some may participate in binge eating, self-induced vomiting, and purging with laxatives or enemas. The very first time a person starves him- or herself may trigger the onset of anorexia. The exact causes of anorexia are not completely known, but many things contribute to its development including economic status, as it is most prevalent in high-income families. It is a genetic disease and is often passed from one generation to the next. Pregnancy complications and abnormalities in the brain, endocrine system, and immune system may all contribute to the development of this illness.

The primary signs of anorexia are fear of being overweight, extreme dieting, an unusual perception of body image, and depression. The secondary signs and symptoms of anorexia are all related to the caloric and nutrient deficiencies of the unbalanced diet and include excessive weight loss, a multitude of skin abnormalities, diarrhea, cavities and tooth loss, osteoporosis, and liver, kidney, and heart failure. There is no physical test that can be used to diagnose anorexia and distinguish it from other mental illnesses. Therefore, a correct diagnosis involves eliminating other mental illnesses, hormonal imbalances, and nervous system abnormalities. Eliminating these other possibilities involves numerous blood tests, urine tests, and x-rays. Coexisting organ malfunction is also examined. Treatment of any mental illness involves not only the individual, but also family, friends, and a psychiatric counselor. Treating anorexia also involves a dietitian, who helps to provide dietary solutions that often have to be adjusted over time. The goals of treatment for anorexia are to restore a healthy body weight and significantly reduce the behaviors associated with causing the eating disorder. Relapse to an unbalanced diet is high. Many people do recover from anorexia, however most continue to have a lower-than-normal bodyweight for the rest of their lives (see Note 11.33 "Video 11.3").

What I Gained in Recovery from Anorexia

On a more positive note, watch this personal account of what can be gained from anorexia recovery.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Bulimia

Bulimia, like anorexia, is a psychiatric illness that can have severe health consequences. The NIMH reports that 0.5 percent of females and 0.1 percent of males will have bulimia at some point in their lifetime. The National Institute of Mental Health. "Eating Disorders among Adults: Bulimia Nervosa." Accessed October 8, 2011. http://mentalhealth.gov/statistics/1EAT_ADULT_RBUL.shtml. Bulimia is characterized by episodes of eating large amounts of food followed by purging, which is accomplished by vomiting and with the use of laxatives and diuretics. Unlike people with anorexia, those with bulimia often have a normal weight, making the disorder more difficult to detect and diagnose. The disorder is characterized by signs similar to anorexia such as fear of being overweight, extreme dieting, and bouts of excessive exercise. Secondary signs and symptoms include gastric reflux, severe erosion of tooth enamel, dehydration, electrolyte imbalances, lacerations in the mouth from vomiting, and peptic ulcers. Repeated damage to the esophagus puts people with bulimia at an increased risk for esophageal cancer. The disorder is also highly genetic, linked to depression and anxiety disorders, and most commonly occurs in adolescent girls and young women. Treatment often involves antidepressant medications and, like anorexia, has better results when both the family and the individual with the disorder participate in nutritional and psychiatric counseling.

Binge-Eating Disorder

Similar to those who experience anorexia and bulimia, people who have a binge-eating disorder have lost control over their eating. Binge-eating disorder is not currently diagnosed as a distinct psychiatric illness, although there is a proposal from the American Psychiatric Association to categorize it more specifically. People with binge-eating disorder will periodically overeat to the extreme, but their loss of control over eating is not followed by fasting, purging, or compulsive exercise. As a result, people with this disorder are often overweight or obese, and their chronic disease risks are those linked to having an abnormally high body weight such as hypertension, cardiovascular disease, and Type 2 diabetes. Additionally, they often experience guilt, shame, and depression. Binge-eating disorder is commonly associated with depression and anxiety disorders. According to the NIMH, binge-eating disorder is more prevalent than anorexia and bulimia, and affects 3.5 percent of females and 2.0 percent of males at some point during their lifetime. The National Institute of Mental Health. "Eating Disorders among Adults: Binge Eating Disorder." Accessed October 8, 2011. http://www.nimh.nih.gov/statistics/1EAT_ADULT_RB.shtml. Treatment often involves antidepressant medication as well as nutritional and psychiatric counseling.

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14.5: References

1. CDC on benefits of losing 5 to 10 percent of body weight. https://www.cdc.gov/healthyweight/losing_weight/index.html
2. CDC's step by step guide. https://www.cdc.gov/healthyweight/lo...g_started.html.
3. CDC's page on physical activity. https://www.cdc.gov/physicalactivity/index.html
4. CDC's page on improving your eating habits. https://www.cdc.gov/healthyweight/lo...ng_habits.html

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15: CARDIOVASCULAR HEALTH AND CANCER

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15.2: Cardiovascular Disease and Stroke

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15.7.6: Cancer Risk and Prevention

15.7.7: End-of-Chapter Material

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15.1: The Cardiovascular System

Activity: Your heart and breath

Before you begin this chapter, take a moment to feel your heart and your breathing.

- Take your pulse.
  - Count how many times your heart beats in one minute.
  - In your wrist:
    - hold out one of your hands, with your palm facing upwards
    - press the first (index) finger and middle finger of your other hand on the inside of your wrist, at the base of your thumb – don't use your thumb as it has its own pulse
    - press your skin lightly until you can feel your pulse – if you can't find it, try pressing a little harder or move your fingers around
  - In your neck:
    - press your first finger and middle finger to the side of your neck, just under your jaw and beside your windpipe – don't use your thumb
    - press your skin lightly to feel your pulse – if you can't find it, try pressing a bit harder or move your fingers around
- Measure your respiratory rate
  - Count how many times you inhale and exhale in one minute.
- Multiple your one minute pulse and your one minute count of breaths by 1,440 to see how many times your heart beats and how many times you inhale/exhale in one day

If your heart beats 75 times per minute, it would contract approximately 108,000 times in one day, more than 39 million times in one year, and nearly 3 billion times during a 75-year lifespan. Your heart is an amazing organ that works all day, everyday, to ensure all of the cells, tissues, and organs in your body get the oxygen and nutrients needed to survive, while also removing carbon dioxide and waste by pumping about 2,000 gallons of blood around your body. This is a lot of work for an organ about the size of your fist that weighs less than a pound.

The heart is the power, or the pumping force, behind the circulation of blood through the body. Every time your heart beats it is contracting in order to push blood, much like you would squeeze a plastic ketchup bottle and push out ketchup. The heart is just one part of the cardiovascular system, the other part are the vessels through which blood travels through the body. The heart and blood vessels are a closed-loop system, where blood moves in one direction to and from your heart.

The heart has two halves, each with atria and ventricles known as the right atrium, right ventricle, left atrium, and left ventricle. As a closed-loop system, blood moves through the heart in a precise pattern.

- Deoxygenated blood enters the heart through the largest vein of the body called the superior vena cava
- The deoxygenated blood first enter the heart through the right atrium.
- The blood is then pushed down into the right ventricle.
- The deoxygenated blood now leaves the heart to go to the lungs and pick up oxygen.
- Oxygenated blood then returns to the heart through the left atrium.
- The blood is pushed into the left ventricle.
- Lastly the oxygenated blood leaves the heart to go to the body through the largest artery of the body called the aorta.

Each side of the heart plays an important role in the circulation of blood. The right side of the heart is responsible for circulating the deoxygenated blood to the lungs to pick up oxygen, called pulmonary circulation, and the left side of the heart is responsible for circulating the blood to the rest of the body, called systemic circulation.

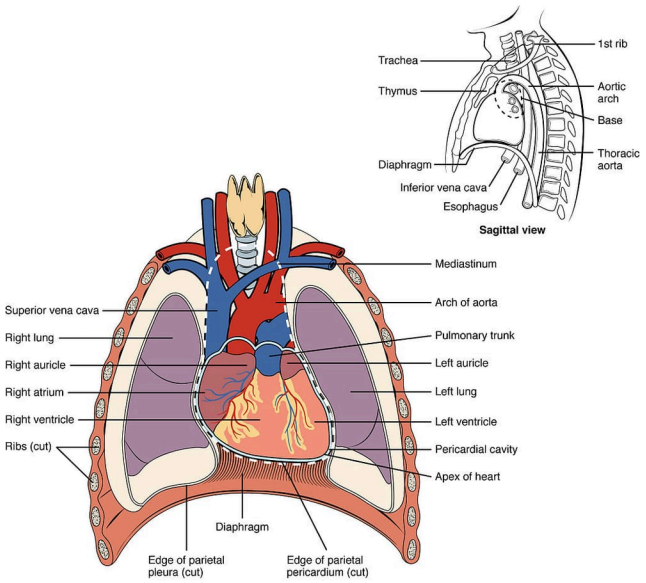


Figure 15.1.1: Position of the heart in the body

The three main types of blood vessels that transport blood throughout the body are the arteries, veins, and capillaries. In short, arteries are large blood vessels that carry blood away from the heart, veins are large blood vessels that carry blood to the heart, and capillaries are the small blood vessels that delivery oxygenated blood to organs and tissues and pick up deoxygenated blood from organs and tissues for the veins to take back to the heart. You might think of arteries and veins as big freeways or highways and the capillaries as the neighborhood streets, both working to provide a pathway to deliver food and take away waste.

In pictures of the circulatory system, arteries are typically represented by red blood vessels and veins are typically represented as blue blood vessels. Red is used for arteries because most arteries carry oxygenated blood, or red blood. Veins typically carry deoxygenated blood, or blue blood. The faster the heart beats, the more oxygen and nutrients are transported throughout the body.

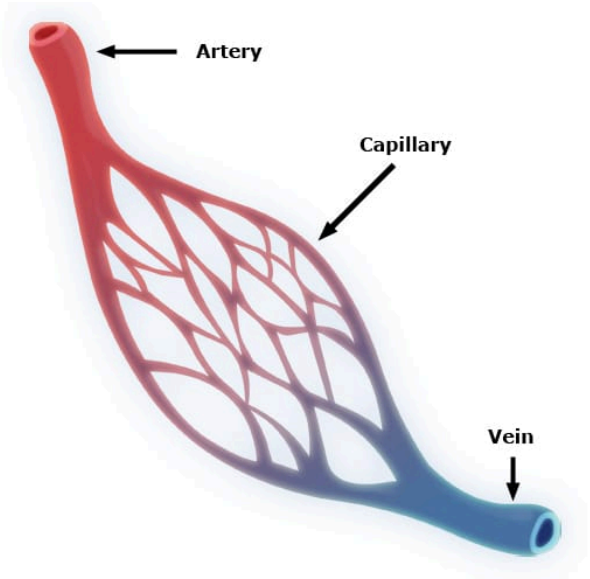


Figure 15.1.2: Arteries, capillaries, and veins

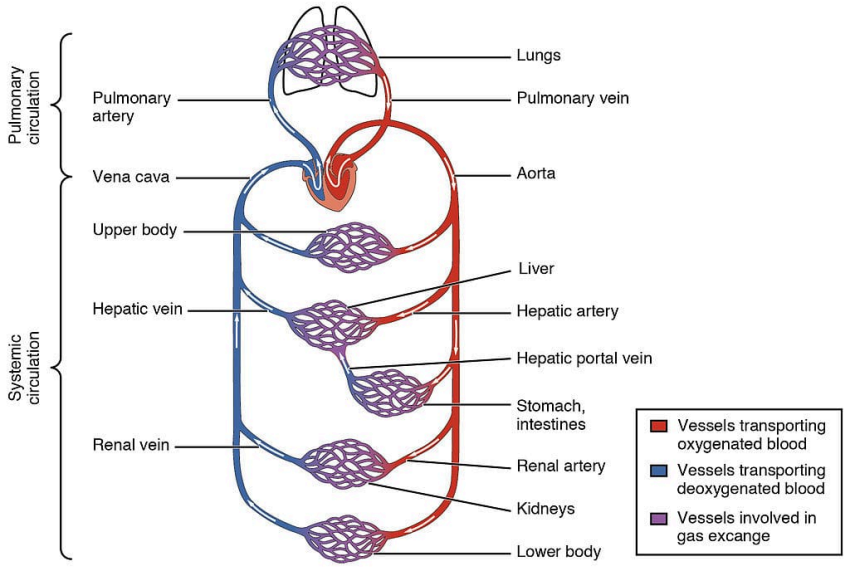


Figure 15.1.3: Blood flow through the heart

Each beat of the heart helps to keep the blood moving within the closed system, however the heart has an additional feature that helps to keep the blood moving in one direction and these are called heart valves. Heart valves ensure unidirectional blood flow through the heart. Valves operate link french doors that open when the heart contracts and close when the heart is at rest. The four valves in the heart are the tricuspid valve, pulmonary valve, bicuspid valve, and aortic valve.

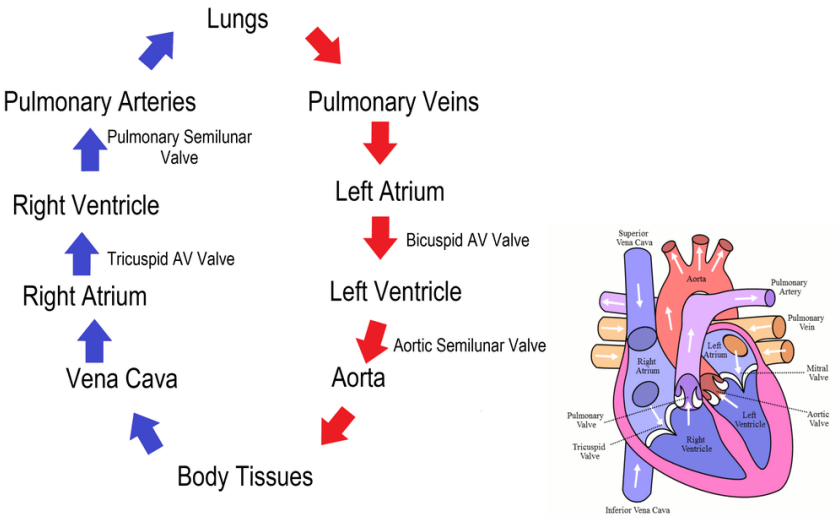


Figure 15.1.4: Circulation of blood through the heart

You do not tell you heart to beat, rather your heart beats automatically. For example, when your body needs more oxygen, such as when exercising, your bodies autonomic nervous system tells your heart to speed up to pump more blood throughout your body. The Autonomic nervous system specifically sends messages to a specialized group of cells located high in the right atrium, called the **Sinoatrial Node**, or SA node. The SA node is commonly referred to as the pacemaker of the heart and is responsible for normal cardiac rhythm by sending an electrical signal that makes the heart contract.

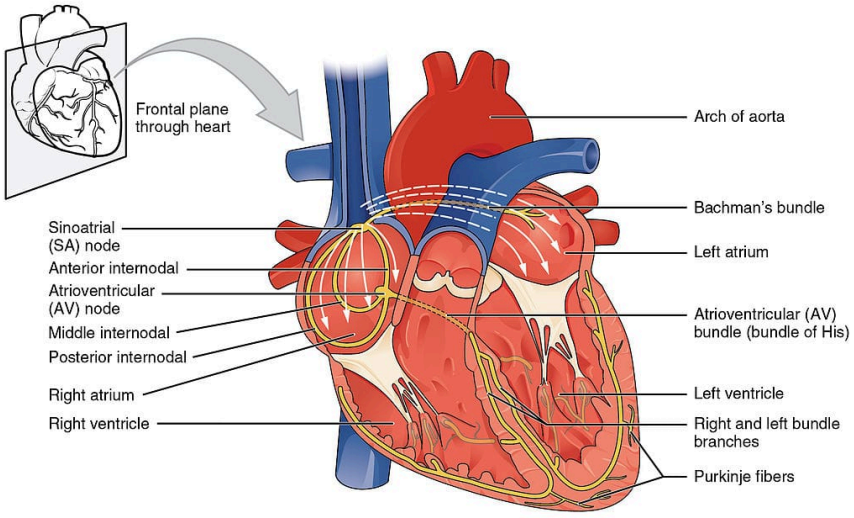


Figure 15.1.5: Conduction System of The Heart

The contraction of the heart is called **systole** and the relaxation of the heart is called **diastole**. Imagine clenching and relaxing your fist, when it is clenched that is representing systole and when it is relaxed that is diastole. When the heart contracts (systole) and pushes blood from the heart into the blood vessel (artery) it puts pressure on the blood vessel walls. When the heart relaxes (diastole) the pressure on the blood vessel walls lowers. By measuring the pressure in the blood vessel we can better understand the health of the heart and blood vessels. Measuring the pressure created in the blood vessel is known as your **blood pressure**. When you get your blood pressure tested they give you two numbers, the top number is the pressure created during systole and the bottom number is the pressure created during diastole. Thus, blood pressure readings are read as systolic over diastolic pressure. Average blood pressure is considered to be 120/80 (systolic/diastolic). If the pressure increases to 140/90 you are considered to have high blood pressure.

Manually pumping blood: CPR

If the heart stops beating, the blood can be manually pumped by using an emergency technique known as cardiopulmonary resuscitation (CPR). When performing CPR, repeated pressure is placed on the heart to push the blood through both the pulmonary and systemic circuits. This is particularly critical for the brain, as irreversible damage and death of neurons occur within minutes of loss of blood flow.

Trained first responders will perform both chest compressions and mouth-to-mouth breathing. However, bystanders should perform compression-only CPR.

1. Call 9-1-1 (or send someone to do that)
2. Push hard and fast in the center of the chest

Current standards call for compression of the chest at least 5 cm deep and at a rate of 100-120 compressions per minute, a rate equal to the beat in “Staying Alive,” recorded in 1977 by the Bee Gees.

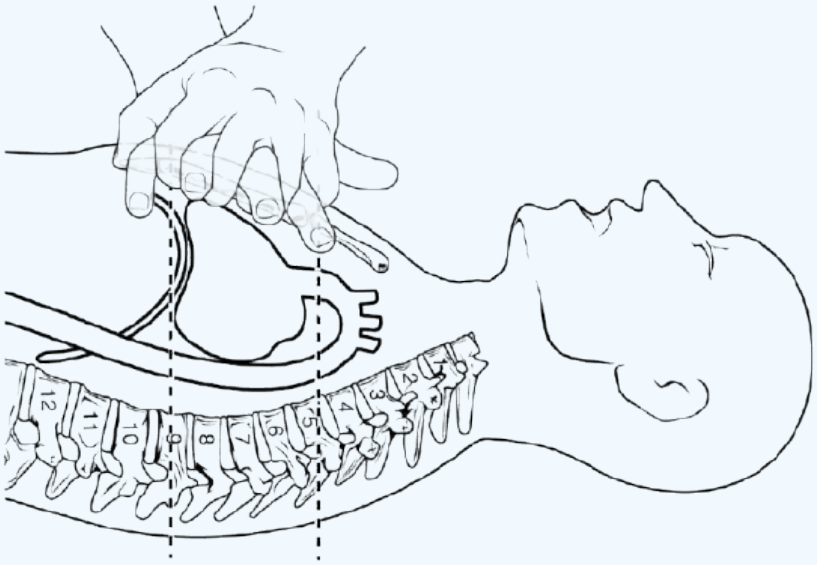


Figure 15.1.6: CPR Hand Placement

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15.2: CARDIOVASCULAR DISEASE AND STROKE

15.2.1: Heart Disease
15.2.2: Major Forms of CVD
15.2.3: What's Your Number?
15.2.4: Test Your Knowledge

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15.2.1: Heart Disease

What is Heart Disease?

Heart disease is the leading killer of Americans. Fortunately, the toll is much less — there are about 425,000 deaths each year from heart disease. In addition, the death rate from stroke, the third most common cause of death, has declined by about 75 percent since the early 1960s (NIH, 2017). While its root causes were unknown at that time, today, researchers can trace the problem to changes in the American lifestyle after World War II. Postwar prosperity led to more sedentary lifestyles and fattier diets. And cigarettes, which were introduced to soldiers during the war, became broadly popular. Researchers believe that the epidemic can be reversed if people eat healthier diets, exercise more, and stop smoking. (GPB, 2017)

https://gpb.pbslearningmedia.org/resource/envh10.health.heartdisease/heart-disease-americas-leading-cause-of-death/#.WQaEiVK-LR0

Things that lead to Cardiovascular Disease

These 4 things can be linked to cardiovascular disease that you cannot change:

1. **Age –** As a person ages there is higher risk for CVD. There is a strong correlation with CVD and age. Although, with males, the risk seems to be when they are younger and females seem to be at higher risk post-menopausal.
2. **Sex –** Males are higher risk for CVD, especially at younger ages. Women can be at high risk in later parts of their lives. To help with some of this risk women can look at this http://www.nhlbi.nih.gov/educational/hearttruth
3. **Race –** African Americans have the highest risk factor for CVD
4. **Family History/ Race –** This can be one of the strongest predictors of CVD, but also has the smallest correlation to CVD overall.

These 4 things can be linked to cardiovascular disease that you can change:

1. **Tobacco –** The strongest predictor of CVD is the use tobacco. The use of tobacco accounts for 30% of CVD risk. There is a significant reduction in risk for those who don't use tobacco.
2. **Obesity –** Those that have a BMI greater than 30 have a higher than normal risk than those that do not have a BMI greater than 30."The "obesity epidemic" experienced by the United States over the past several decades threatensto reverse important progress against heart disease. The NIH has undertaken several efforts to prevent or reduce obesity in children and young adults, including a set of randomized trials to identify effective approaches in individuals and a large project to evaluate community approaches to reduce obesity in children (NIH, 2017)"
3. **Diet –** CVD can be correlated to a high intake of saturated fat and cholesterol. Ris k of dietary cholesterol intake can be correlated to atherosclerosis .
4. **Diabetes –** This condition is viewed as seriously as any of the other controllable factors, such as smoking, high blood pressure, and high cholesterol. In fact, those with Type II diabetes, have the same level of risk for a heart attack as those who have already had a heart attack.

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15.2.2: Major Forms of CVD

The American Heart Association reports that nearly half of all U. S. adults have some type of cardiovascular disease. The most recent report said 121.5 million adults in the U.S. – 48 percent based on 2016 figures – have cardiovascular disease. Heart disease was the No. 1 cause of death in the U.S. and stroke was No. 5, the same ranking as in the previous year. That information and a link to the report can be found here: https://www.heart.org/en/news/2019/01/31/cardiovascular-diseases-affect-nearly-half-of-american-adults-statistics-show

Coronary heart disease—often simply called heart disease—is the main form of heart disease. It is a disorder of the blood vessels of the heart that can lead to heart attack. A heart attack happens when an artery becomes blocked, preventing oxygen and nutrients from getting to the heart. Heart disease is one of several cardiovascular diseases, which are diseases of the heart and blood vessel system. Other cardiovascular diseases include stroke, high blood pressure, angina (chest pain), and rheumatic heart disease. (NIH, 2017)

Arteriosclerosis

Arteriosclerosis is a form of cardiovascular disease that involves a thickening and hardening of the arteries. Arteries narrow from deposits of fat, cholesterol, and other substances. These deposits, called plaques, accumulate on arterial walls and can restrict blood flow. Coronary arteries, which supply the heart with blood, and cerebral arteries, which supply the brain with blood, are particularly susceptible to plaque build-up. The blockage of a coronary artery causes a heart attack and the blockage of a cerebral artery causes a stroke.

Heart Attack

A **Myocardial Infarction** is otherwise known as a heart attack. This MI can be seen with the symptoms of Angina Pectoris: crushing chest pains, profound shortness of breath, left arm pain, radiating jaw pain or middle back pain. These signs and symptoms of heart attack are very serious and should be recognized as soon as possible and should be taken care of ASAP.

What to do if you suspect someone having a heart attack. (Mayo Clinic)

- **Call 911 or your local medical emergency number.** Don't ignore or attempt to tough out the symptoms of a heart attack for more than five minutes. If you don't have access to emergency medical services, have a neighbor or a friend drive you to the nearest hospital. Drive yourself only as a last resort, and realize that it places you and others at risk when you drive under these circumstances.
- **Chew and swallow an aspirin.** If advised to do so by 911, unless you are allergic to aspirin or have been told by your doctor never to take aspirin. Seek emergency help first, such as calling 911.
- **Take nitroglycerin,** if prescribed. If you think you're having a heart attack and your doctor has previously prescribed nitroglycerin for you, take it as directed. Do not take anyone else's nitroglycerin, because that could put you in more danger.
- **Begin CPR if the person is unconscious.** If you're with a person who might be having a heart attack and he or she is unconscious, tell the 911 dispatcher or another emergency medical specialist. You may be advised to begin cardiopulmonary resuscitation (CPR). If you haven't received CPR training, doctors recommend skipping mouth-to-mouth rescue breathing and performing only chest compressions (about 100 per minute). The dispatcher can instruct you in the proper procedures until help arrives.
- **If an automated external defibrillator (AED) is available** and the person is unconscious, begin CPR while the device is retrieved and set up. Attach the device and follow instructions that will be provided by the AED after it has evaluated the person's condition.

Stroke

A stroke, also called a **cerebral vascular accident** (CVA), occurs when the blood supply to the brain is cut off. When brain cells are deprived of oxygen for more than a few minutes, they die. Depending on the area of the brain affected, a stroke may cause weakness or paralysis (often on only one side of the body), speech impairment, memory loss, and changes in behavior.

Most strokes are caused by a blockage in a blood vessel and are called an ischemic stroke. There are two types of ischemic strokes: 1) *thrombotic* – caused by a blood clot that forms in a cerebral or carotid artery; and 2) *embolic* – caused by an embolus, a clot that has formed elsewhere in the body and has been carried in the blood stream and becomes wedged in a cerebral artery.

Another type of stroke is a hemorrhagic stroke. A hemorrhagic stroke occurs when a blood vessel in the brain ruptures, leaking blood into the surrounding tissue. Brain cells are deprived of blood and accumulation of the blood from the burst vessel may put pressure on surrounding tissue, which can cause damage and even death. Only about 20% of strokes are hemorrhagic.

Using the Cincinnati Stroke Scale to identify early warning signs for stroke

F = Face: Is one side of the face drooping down?

A = Arm: Can the person raise both arms, or is one arm weak?

S = Speech: Is speech slurred or confusing?

T = Time: Time is critical!! Call 9-1-1 immediately!

High Blood Pressure

Blood pressure is the force of the blood exerted on the walls of the arteries, created by the pumping of the blood. It is expressed as two numbers – for example 120/80 – and measured in millimeters of mercury (mmHg). The first/higher number is the systolic pressure – the greatest pressure exerted as your heart beats. The second/lower number is the diastolic pressure, the lowest pressure when your heart relaxes between beats. Blood pressure is easily measured with a blood pressure cuff connected to a sphygmomanometer.

High blood pressure is a result of arterial resistance caused by the constriction of the smooth muscle surrounding the arteries or by arteriosclerosis. When someone has high blood pressure, the heart must work harder to force blood through the narrowed and/or stiffened arteries, straining both the heart and the arteries.

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15.2.3: What's Your Number?

Lipoprotein Profile

What: A blood test that measures total cholesterol, LDL "bad" cholesterol, HDL "good" cholesterol, and triglycerides (another form of fat in the blood). The test is given after a 9- to 12-hour fast.

Why: To find out if you have any of the following: high blood cholesterol (high total and LDL cholesterol), low HDL cholesterol, or high triglyceride levels. All affect your risk for heart disease.

When: All healthy adults should have a lipoprotein profile done at least once every 5 years. Depending on the results, your doctor may want to repeat the test more frequently.

Blood Pressure

What: A simple, painless test using an inflatable arm cuff.

Why: To find out if you have high blood pressure (also called hyper- tension) or prehypertension. Both are risk factors for heart disease.

When: At least every 2 years, or more often if you have high blood pressure or prehypertension.

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Fasting Plasma Glucose

What: The preferred test for diagnosing diabetes. After you have fasted overnight, you will be given a blood test the following morning.

Why: To find out if you have diabetes or are likely to develop the disease. Fasting plasma glucose levels of 126 mg/dL or higher in two tests on different days mean that you have diabetes. Levels between 100 and 125 mg/dL mean that you have an increased risk of developing diabetes and may have prediabetes. Diabetes is an important risk factor for heart disease and other medical disorders.

When: At least every 3 years, beginning at age 45. If you have risk factors for diabetes, you should be tested at a younger age and more often.

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15.2.4: Test Your Knowledge

1. The type of heart disease that can cause slurred speech, arm movement loss and facial drooping:

    a. Myocardial Infarction

    b. Cerebrovascular accident

    c. Sudden Cardiac Death

    d. Arrhythmia

2. What acronym is used to help identify if someone is having a stroke?

    a. SLOW

    b. JUMP

    c. FAST

    d. DOWN

3. Crushing chest pains are called:

    a. Angina Rhomboids

    b. Angina Femurous

    c. Angina Pectoris

    d. Angina Visceralis

4. Which of the following is not a factor that increases risk of CVD?

    a. Being Female

    b. Smoking

    c. Having family history of CVD

    d. Being older than 65

5. A fasting blood glucose level to be normal should be less than

    a. 100

    b. 110

    c. 125

    d. 150

Answers: 1.B, 2.C, 3.C, 4.A, 5.A

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15.3: Cardiovascular Diseases

The cardiovascular system is an intricate system and each part of the system plays an important role in ensuring your body receives the oxygen and nutrients it needs. Diseases of the cardiovascular includes diseases effecting the various elements of the heart and diseases impacting the ability of blood to move through the blood vessels.

The term “heart disease” refers to several types of heart conditions. The most common type of heart disease in the United States is coronary artery disease (CAD). The coronary artery is the artery that feeds oxygenated blood to the heart muscle itself. If the coronary artery is partially or fully blocked it affects the blood flow to the heart. When the heart muscle does not get oxygenated blood this is called a heart attack.

Sometimes heart disease may be “silent” and not diagnosed until a person experiences signs or symptoms of a heart attack, heart failure, or an arrhythmia. When these events happen, symptoms may include:

- Heart attack: Chest pain or discomfort, upper back or neck pain, indigestion, heartburn, nausea or vomiting, extreme fatigue, upper body discomfort, dizziness, and shortness of breath.
- Arrhythmia: Fluttering feelings in the chest (palpitations).
- Heart failure: Shortness of breath, fatigue, or swelling of the feet, ankles, legs, abdomen, or neck veins.

The risk factors for the majority of cardiovascular diseases are high blood pressure, high blood cholesterol, and smoking. About half of people in the United States (47%) have at least one of these three risk factors. Several other medical conditions and lifestyle choices can also put people at a higher risk for heart disease, including:

- Diabetes
- Overweight and obesity
- Unhealthy diet
- Physical inactivity
- Excessive alcohol use

Coronary Artery Disease

Coronary artery disease (CAD) is the leading cause of death worldwide and the most common type of heart disease in the United States. It is sometimes called coronary heart disease or ischemic heart disease. CAD is caused by plaque buildup in the walls of the arteries that supply blood to the heart and other parts of the body, this build up is called **Atherosclerosis**. As the coronary blood vessels become occluded, the flow of blood to the tissues will be restricted, a condition called ischemia that causes the cells to receive insufficient amounts of oxygen, called hypoxia. **Angina**, or chest pain and discomfort, is the most common symptom of CAD. Although angina is the most common symptom of CAD, for some people, the first sign of CAD is when they have a heart attack.

Over time, CAD can weaken the heart muscle. This may lead to heart failure, a serious condition where the heart can’t pump blood the way it should.

Arteriosclerosis and Atherosclerosis

Both atherosclerosis and arteriosclerosis negatively impact the ability of blood to flow freely throughout the body. Arteriosclerosis is known as the hardening of the artery and atherosclerosis is known as the thickening of the artery. Aging is a common factor in the hardening of the artery where the artery is losing elasticity and flexibility over time, however, lifestyle choices are a common factor in the thickening of the artery where plaques are building up in the artery.

Atherosclerosis is caused by an accumulation of plaque deposits of cholesterol and other substances in the artery. Plaque buildup causes the inside of the arteries to narrow over time, which can partially or totally block the blood flow. Atherosclerosis progresses slowly and often beginning in childhood and gradually progressing throughout life.

Well-documented risk factors include smoking, family history, hypertension, obesity, diabetes, high alcohol consumption, lack of exercise, stress, and hyperlipidemia or high circulating levels of lipids in the blood.

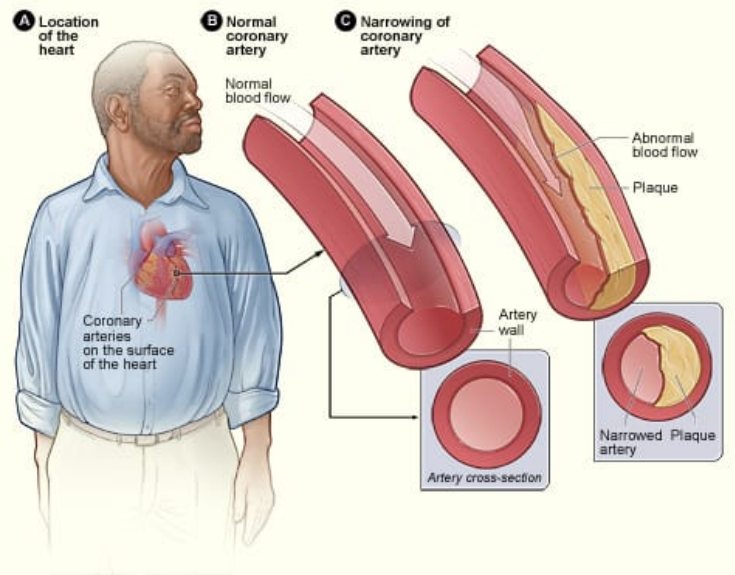


Figure 15.3.7: Atherosclerosis

Have you ever used a plunger

Take a moment to think about how the plumbing in a house or building works. When it works well, water comes into the house freely and waste from flushing the toilet or washing dishes flows out of the house. However, if the plumbing of a house get blocked by debris, then a backup occurs. Just like in a house, debris that blocks flow causes problems.

Angina

Angina, or chest pain and discomfort, is the most common symptom of CAD. Angina can happen when too much plaque builds up inside arteries, causing them to narrow. Narrowed arteries can cause chest pain because they can block blood flow to your heart muscle and the rest of your body.

Myocardial Infarction or “heart attack”

Myocardial infarction (MI) is the formal term for what is commonly referred to as a heart attack. It normally results from a lack of blood flow (ischemia) and oxygen (hypoxia) to a region of the heart, resulting in death of the cardiac muscle cells. An MI often occurs when a coronary artery is blocked by the buildup of atherosclerotic plaque. It can also occur when a portion of an unstable atherosclerotic plaque travels through the coronary arterial system and lodges in one of the smaller vessels. The resulting blockage restricts the flow of blood and oxygen to the myocardium and causes death of the tissue. MIs may be triggered by excessive exercise, in which the partially occluded artery is no longer able to pump sufficient quantities of blood, or severe stress, which may induce spasm of the smooth muscle in the walls of the vessel.

For many people, the first clue that they have CAD is a heart attack. Symptoms of heart attack include

- Chest pain or discomfort (angina)
- Weakness, light-headedness, nausea (feeling sick to your stomach), or a cold sweat
- Pain or discomfort in the arms or shoulder
- Shortness of breath

MIs may trigger cardiac arrest, but the two are not synonymous.

Cardiac Arrest and Arrhythmia

Cardiac arrest occurs when the heart suddenly and unexpectedly stops pumping. If this happens, blood stops flowing to the brain and other vital organs. The main cause of cardiac arrest is having an **arrhythmia**. An arrhythmia, or irregular heartbeat, is

a problem with the rate or rhythm of your heartbeat. When a person suffers from cardiac arrest, there are a number of things that could potentially be happening to their heart: they could have a rapid heart rhythm (tachycardia), a disorganized electrical rhythm that doesn't allow heart muscles to contract (fibrillation), or they could have no electrical current passing through their heart (asystole).

Nine out of 10 people who have a cardiac arrest outside of a hospital die — often within minutes.

Important risk factors include prior cardiac arrest, coronary heart disease, heart valve disease, congenital heart defects, and arrhythmias caused by faulty gene. However, half of cardiac arrests happen to people who did not know they had a heart problem.

"Clear"

Have you watched medical shows where a doctor grabs paddles, rubs them together, yells "clear," and then shocks or zaps the patient? They are using a machine called a defibrillator that sends an electrical shock to the heart to try to get the electrical signals in the heart to contract in their regular rhythm. Although you might believe the defibrillator is restarting the heart, it is actually stopping the heart in order to try to get the hearts electrical signal to reset and resumes beating in a normal rhythmic way.

Congenital Heart Defects

Congenital heart defects are problems with the heart that are present at birth. They are the most common type of major birth defect. Examples include abnormal heart valves or holes in the heart's walls that divide the heart's chambers. Congenital heart defects range from minor to severe.

Heart Valve Defects

Heart valves prevent the backward flow of blood. They are located between the chambers of the heart and where the blood leaves and returns to the heart. Healthy heart valves can fully open and close the valve during the heartbeat, but diseased valves might not fully open and close. If the heart valves are diseased, the heart can't effectively pump blood throughout the body and must work harder to pump, either while the blood is leaking back into the chamber or against a narrowed opening. This can lead to heart failure, sudden cardiac arrest (when the heart stops beating), heart palpitations (rapid, fluttering, or pounding), shortness of breath, or swelling in your legs and feet.

Valvular disorders are often caused by carditis, or inflammation of the heart. One common trigger for this inflammation is rheumatic fever, or scarlet fever, an autoimmune response to the presence of a bacterium, Streptococcus pyogenes, normally a disease of childhood.

Congestive Heart Failure

Heart failure is often called congestive heart failure because of fluid buildup in the lungs, liver, legs, and feet. Heart failure is a serious condition that occurs when the heart can't pump enough blood to meet the body's needs. It does not mean that the heart has stopped but that muscle is too weak to pump enough blood. Most of heart failure cases are chronic, or long-term heart failures.

The only cure for heart failure is a heart transplant. However, heart failure can be managed with medications or medical procedures.

Stroke or "brain attack"

A stroke is sometimes called a "brain attack" and is formally known as a Cerebrovascular Accident (CVA). Like a heart attack, a brain attack (stroke) occurs because oxygen cannot get to the brain. With a stroke, the oxygen may not be getting to the brain because of a blockage in the blood vessel (likely due to atherosclerosis) or due to a rupture of the blood vessel. In either case, parts of the brain become damaged or die. To work properly, your brain needs oxygen. Your arteries deliver oxygen-rich blood to all parts of your brain. If something happens to block the flow of blood, brain cells start to die **within minutes,** because they

can't get oxygen. This causes a stroke.

Time lost is brain lost. Every minute counts.

The brain controls our movements, stores our memories, and is the source of our thoughts, emotions, and language. The brain also controls many functions of the body, like breathing and digestion. The impact of a stroke is dependent on the part of the brain that is not getting the oxygen it needs. A stroke can cause lasting brain damage, long-term disability, or even death.

There are two types of stroke:

- Ischemic stroke
  - Most strokes are ischemic strokes. An ischemic stroke occurs when blood clots or other particles block the blood vessels to the brain. Fatty deposits called plaque can also cause blockages by building up in the blood vessels.
- Hemorrhagic stroke
  - A hemorrhagic stroke happens when an artery in the brain leaks blood or ruptures (breaks open). The leaked blood puts too much pressure on brain cells, which damages them. High blood pressure and aneurysms are examples of conditions that can cause a hemorrhagic stroke. Aneurysms are balloon-like bulges in an artery that can cause the artery to stretch and burst.

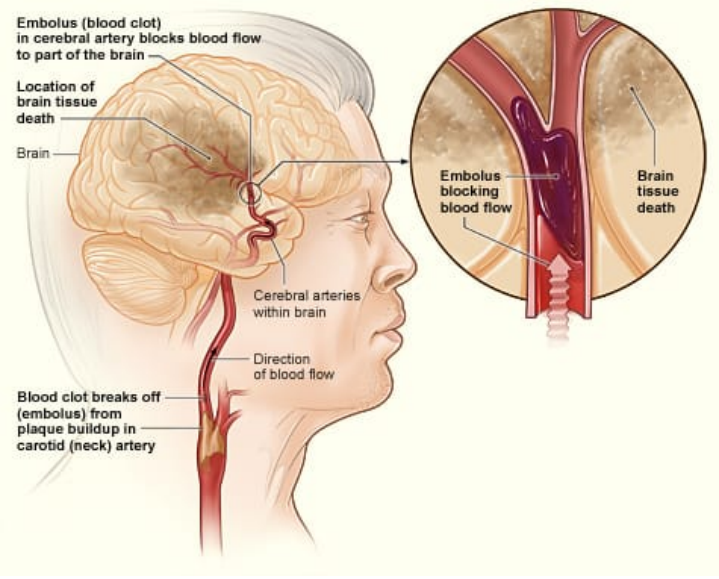


Figure 15.3.8: Ischemic Stroke

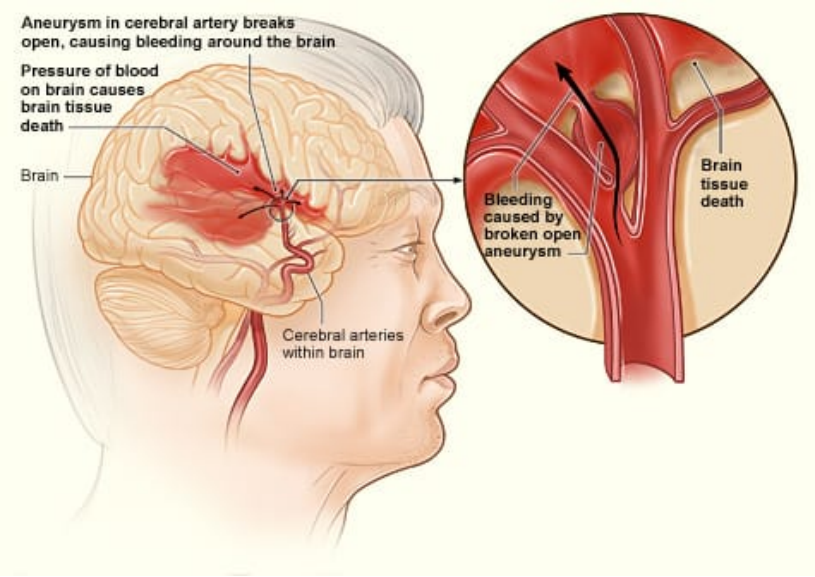


Figure 15.3.9: Hemorrhagic Stroke

A transient ischemic attack (TIA) is sometimes called a "mini-stroke" or a "warning stroke." It is different from the major types

of stroke, because blood flow to the brain is blocked for only a short time—usually no more than 5 minutes.

- A TIA is a warning sign of a future stroke.
- A TIA is a medical emergency, just like a major stroke.
- Strokes and TIAs require emergency care. **Call 9-1-1** right away if you feel signs of a stroke or see symptoms in someone around you.
- There is no way to know in the beginning whether symptoms are from a TIA or from a major type of stroke.
- Like ischemic strokes, blood clots often cause TIAs.
- More than a third of people who have a TIA and don't get treatment have a major stroke within 1 year. As many as 10% to 15% of people will have a major stroke within 3 months of a TIA.

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15.4: Risk Factors for Cardiovascular Disease

Metabolic syndrome is a group of conditions that together raise your risk of coronary heart disease, diabetes, stroke, and other serious health problems. Metabolic syndrome is common in the United States; About 1 in 3 adults have metabolic syndrome. The good news is that it is largely preventable.

You might have metabolic syndrome if you have three or more of the following conditions:

- A large waistline: This is also called abdominal obesity or “having an apple shape.” Extra fat in your stomach area is a bigger risk factor for heart disease than extra fat in other parts of your body.
- High blood pressure: If your blood pressure rises and stays high for a long time, it can damage your heart and blood vessels. High blood pressure can also cause plaque, a waxy substance, to build up in your arteries. Plaque can cause heart and blood vessel diseases such as heart attack or stroke.
- High blood sugar levels: This can damage your blood vessels and raise your risk of getting blood clots. Blood clots can cause heart and blood vessel diseases.
- High blood triglycerides: Triglycerides are a type of fat found in your blood. High levels of triglycerides can raise your levels of LDL cholesterol, sometimes called bad cholesterol. This raises your risk of heart disease.
- Low HDL cholesterol, sometimes called good cholesterol: Blood cholesterol levels are important for heart health. “Good” HDL cholesterol can help remove “bad” LDL cholesterol from your blood vessels. “Bad” LDL cholesterol can cause plaque buildup in your blood vessels.

Risk factors you can control include:

- Lifestyle habits:
  - Being inactive
  - Eating an unhealthy diet and large portion sizes
  - Not getting enough good quality sleep, which helps control how your body absorbs nutrients from the food you eat
  - Smoking and drinking a lot of alcohol
- Occupation: Shift workers have a higher risk of metabolic syndrome because they often have circadian clocks that are not aligned with the environment. This can cause problems with how your body absorbs nutrients from food.

Risk factors you cannot control include:

- Age: Your risk of metabolic syndrome increases as you get older.
- Environment: Low socioeconomic status can lead to an unhealthy diet and an inactive lifestyle, and can cause you not to get enough sleep (sleep deprivation).
- Family history and genetics: Your genes can affect your weight or how your body responds to insulin. You have a higher risk of metabolic syndrome if others in your family have had diabetes, metabolic syndrome, or any of its risk factors.
- Other medical conditions: The following medical conditions can raise your risk of metabolic syndrome.
  - Overweight and obesity are the main risk factors for metabolic syndrome because they can raise “bad” LDL cholesterol, blood triglycerides, and blood pressure, and lower “good” HDL cholesterol. Overweight and obesity during pregnancy can raise your child’s risk of metabolic syndrome. In infants, a low birth weight and rapid weight gain after birth can raise the risk of metabolic syndrome later in life.
  - Polycystic ovary syndrome (PCOS) is a condition that causes fluid-filled sacs called cysts to grow on the ovaries. The hormone changes that cause PCOS can also cause you to have a large waistline, high blood sugar levels, high triglyceride levels, and low levels of “good” HDL cholesterol.
  - Problems with your immune system can cause some skin diseases such as psoriasis, which raise your risk. Certain cancer treatments that affect your immune system also can raise your risk.
  - Sleep problems, including not getting enough sleep (sleep deprivation), circadian rhythm disorders, and sleep apnea, can raise your risk.
  - Some medicines used to treat allergies, bipolar disorder, depression, HIV, and schizophrenia also raise your risk.
- Sex: In older adults, women have a higher risk of metabolic syndrome than men. This is because changes in hormone levels after menopause can raise the risk of a large waistline, high blood sugar levels, and low levels of “good” HDL cholesterol.

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15.5: Treatment for Cardiovascular Diseases

The best treatment for cardiovascular diseases is prevention. By living a healthy lifestyle, you can help keep your blood pressure, cholesterol, and blood sugar levels normal and lower your risk for heart disease and heart attack.

Choose healthy habits:

- Choose healthy foods
- Maintain a healthy weight
- Exercise regularly
- Don't smoke

Understand your own health

- Have your Cholesterol levels checked regularly
- Measure your blood pressure regularly
- Manage your blood sugar levels and control diabetes
- Go to the doctor regularly. Many of the diseases of the cardiovascular system, like blood pressure, have no symptoms, so you will not know you have it without being tested.

If you suffer from cardiovascular diseases, there are several surgeries or procedures that me be required.

Medications

There are many types and combinations of drugs used to treat coronary artery disease (CAD), and your doctor or other health care provider will decide the best treatment combination for your situation. Some of the medications available include:

- Anticoagulants: Decrease the clotting (coagulating) ability of the blood. Sometimes called "blood thinners"
- Antiplatelet agents: Keep blood clots from forming by preventing blood platelets from sticking together.
- Angiotensin-Converting Enzyme (ACE) Inhibitors: Expand blood vessels and decreases resistance thus allowing blood to flow more easily and makes the heart's work easier or more efficient.
- Beta blockers: Decrease the heart rate and force of contraction, which lowers blood pressure and makes the heart beat more slowly and with less force.

Balloon Angioplasty

Angioplasty is a procedure to improve blood flow in coronary arteries that have become narrow or blocked by mechanically widening the artery with a balloon. A specialized catheter with an expandable tip is inserted into the blocked blood vessel. The balloon is inflated to compress the plaque material and to open the vessel to increase blood flow. Then, the balloon is deflated and retracted. A stent consisting of a specialized mesh is typically inserted at the site of occlusion to reinforce the weakened and damaged walls. Stent insertions have been routine in cardiology for more than 40 years.

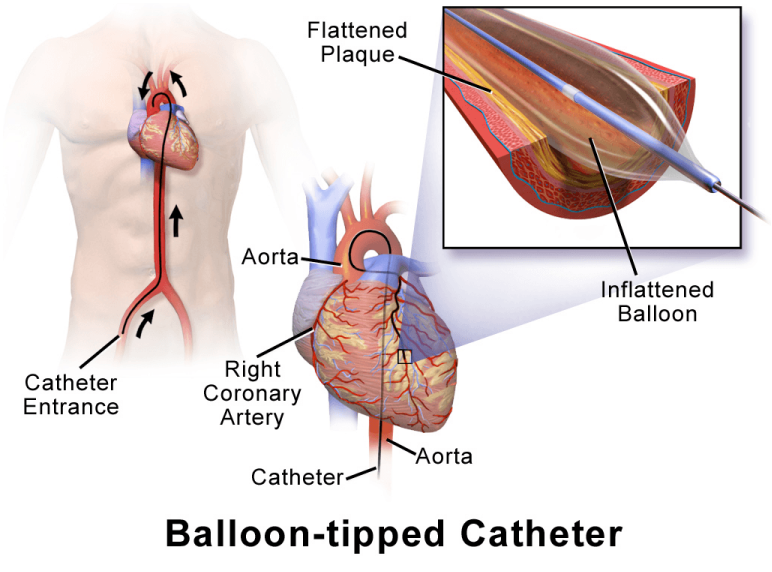


Figure 15.5.10: Balloon Angioplasty

Coronary Bypass Surgery

Sometimes arteries become so damaged that they cannot be healed or fixed. When this occurs, the only option is to create a new artery and bypass the damaged one, this is known as coronary bypass surgery. You might have heard of someone having a "quadruple bypass," what they are saying is that the surgeon had to create four new blood vessels to replace four coronary arteries that were blocked.

The surgery creates a new path for blood to flow to the heart. The surgeon takes a healthy piece of vein from the leg or artery from the chest or wrist. Then the surgeon attaches it to the coronary artery, just above and below the narrowed area or blockage. This allows blood to bypass (get around) the blockage.

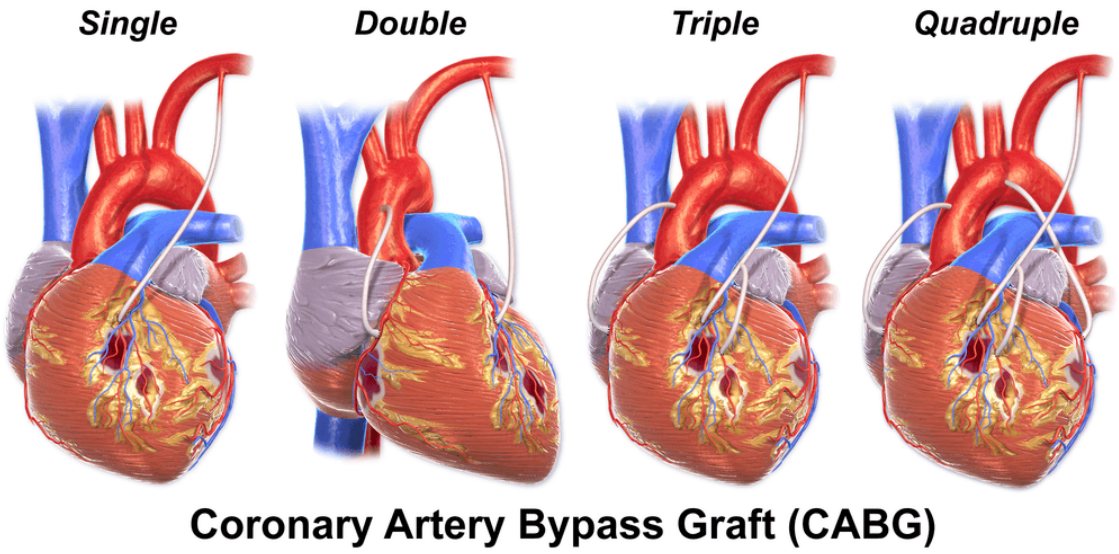


Figure 15.5.11: Coronary Bypass: single, double, triple, and quadruple

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15.6: End-of-Chapter Material

Key takeaways for this Chapter

- Cardiovascular disease is the leading cause of death.
- Cardiovascular disease includes diseases of the heart and blood vessels.
- The heart is the “pumping” force behind your blood flow.
- Arteries carry blood away from the heart to your organs and tissues
- Veins carry blood back to your heart from your organs and tissues.
- Blood pressure readings show your systolic pressure over your diastolic pressure, or the pressure during contraction over your pressure during relaxation.
- Both arteriosclerosis and atherosclerosis impact the ability of blood to flow freely in your blood vessels.
- A heart attack is the blockage in a coronary artery.
- A “brain attack” or stroke is the blockage or rupture of the artery that brings oxygenated blood to the brain.
- Everyone should know how to do CPR compressions to keep blood circulating when a person heart has stopped beating.
- Risks for cardiovascular disease are highly lifestyle dependent

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15.7: PREVENTING CANCER

Learning Objectives

By the end of this chapter you will be able to:

- Explain how cancer begins and spreads.
- Describe the difference between benign and malignant tumors.
- Compare incidence and risk factors for common types of cancer.
- Identify ways to prevent cancer

How does cancer start?

How does cancer spread through the body?

What are the most common types of cancer?

How do I know if I have cancer?

The human body is composed of trillions of cells and every cell has a specific purpose. Cells provide structure for the body, take in nutrients from food, convert those nutrients into energy, and carry out specialized functions. When cells become damaged or die, the body makes new cells to replace them. For example, the epidermis of our skin continually makes new skin cells and we shed off old dead skin cells. Unfortunately, sometimes the cells in our body change and they begin to grow and divide when they shouldn't, this is known as Cancer, all cancers begin with a change in just one microscopic cell.

Cancer is the 2nd leading cause of death in the U.S. after cardiovascular disease. In the United States in 2019, 1,752,735 new cancer cases were reported and 599,589 people died of cancer. For every 100,000 people, 439 new cancer cases were reported and 146 people died of cancer. In 2022 in the U.S., there will be an estimated 1,918,030 new cancer cases and 609,360 cancer deaths.

Cancer has a major impact on society in the United States and across the world. Thankfully, in the United States, the likelihood of dying from cancer has dropped steadily since the 1990s. Five-year survival rates for some cancers, such as breast, prostate, and thyroid cancers, now are 90 percent or better and the 5-year survival rate for all cancers combined is currently about 67 percent.

15.7.1: Cancer Overview

15.7.2: Understanding Cancer

15.7.3: Understanding Cancer

15.7.4: Types of Cancer

15.7.5: Cancer Screening and Symptoms

15.7.6: Cancer Risk and Prevention

15.7.7: End-of-Chapter Material

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- The National Cancer Institute
- The Center for Disease Control- Cancer

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15.7.1: Cancer Overview

What Is Cancer?

File:Lung cancer cell during cell division-NIH.jpg Cancer is the name given to a collection of related diseases. In all types of cancer, some of the body's cells begin to divide without stopping and spread into surrounding tissues.

Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place.

When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old or damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may form growths called tumors.

Cancerous tumors are malignant, which means they can spread into, or invade, nearby tissues. In addition, as these tumors grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumors far from the original tumor.

Unlike malignant tumors, benign tumors do not spread into, or invade, nearby tissues. Benign tumors can sometimes be quite large, however. When removed, they usually don't grow back, whereas malignant tumors sometimes do. Unlike most benign tumors elsewhere in the body, benign brain tumors can be life threatening.

How Cancer Arises

Cancer is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Genetic changes that cause cancer can be inherited from our parents. They can also arise during a person's lifetime as a result of errors that occur as cells divide or because of damage to DNA caused by certain environmental exposures. Cancer-causing environmental exposures include substances, such as the chemicals in tobacco smoke, and radiation, such as ultraviolet rays from the sun.

When Cancer Spreads

In metastasis, cancer cells break away from where they first formed (primary cancer), travel through the blood or lymph system, and form new tumors (metastatic tumors) in other parts of the body. The metastatic tumor is the same type of cancer as the primary tumor.

A cancer that has spread from the place where it first started to another place in the body is called metastatic cancer. **The process by which cancer cells spread to other parts of the body is called metastasis**.

Metastatic cancer has the same name and the same type of cancer cells as the original, or primary, cancer. For example, breast cancer that spreads to and forms a metastatic tumor in the lung is metastatic breast cancer, not lung cancer.

Under a microscope, metastatic cancer cells generally look the same as cells of the original cancer. Moreover, metastatic cancer cells and cells of the original cancer usually have some molecular features in common, such as the presence of specific chromosome changes.

Tissue Changes That Are Not Cancer

Not every change in the body's tissues is cancer. Some tissue changes may develop into cancer if they are not treated, however. Here are some examples of tissue changes that are not cancer but, in some cases, are monitored:

Hyperplasia occurs when cells within a tissue divide faster than normal and extra cells build up, or proliferate. However, the cells

and the way the tissue is organized look normal under a microscope. Hyperplasia can be caused by several factors or conditions, including chronic irritation.

Dysplasia is a more serious condition than hyperplasia. In dysplasia, there is also a buildup of extra cells. But the cells look abnormal and there are changes in how the tissue is organized. In general, the more abnormal the cells and tissue look, the greater the chance that cancer will form.

Some types of dysplasia may need to be monitored or treated. An example of dysplasia is an abnormal mole (called a dysplastic nevus) that forms on the skin. A dysplastic nevus can turn into melanoma, although most do not.

Normal cells may become cancer cells. Before cancer cells form in tissues of the body, the cells go through abnormal changes called hyperplasia and dysplasia. In hyperplasia, there is an increase in the number of cells in an organ or tissue that appear normal under a microscope. In dysplasia, the cells look abnormal under a microscope but are not cancer. Hyperplasia and dysplasia may or may not become cancer.
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15.7.2: Understanding Cancer

Cancer can start almost anywhere in the human body, when just one of the trillions of cells changes and begins to grow uncontrollably and spread to other parts of the body. Normally, human cells grow and multiply (through a process called cell division) to form new cells as the body needs them. When cells grow old or become damaged, they are supposed to die and new cells take their place, however sometimes abnormal or damaged cells grow and multiply when they shouldn't. These cells typically form tumors, which are lumps of tissue.

Normal Cells versus Cancer Cells

Cells group themselves together to make up the tissues and organs of our bodies and usually we have just the right number of each type of cell. This is because cells produce signals to control how much and how often the cells divide. For example, when the body is growing, such as from childhood to adulthood, the body will signal for more cells as the body tissues grow. Normal healthy cells also like each other, they know which other cells to join up with, and they stick together.

Normal cells:

- control their growth, reproducing when and where it's needed.
- stick together and remain in their intended location in the body.
- die when they become damaged or too old to maintain homeostasis.
- become specialized with specific functions.

Cancer cells:

- grow in the absence of signals telling them to grow (normal cells only grow when they receive such signals).
- ignore signals that normally tell cells to stop dividing or to die .
- invade into nearby areas and spread to other areas of the body.
- tell blood vessels to grow toward tumors.
- hide from or trick the the immune system. The immune system normally eliminates damaged or abnormal cells. Cancers cells can trick the immune system into helping cancer cells stay alive and grow.
- accumulate multiple changes in their chromosomes, such as duplications and deletions of chromosome parts. Some cancer cells have double the normal number of chromosomes.
- rely on different kinds of nutrients than normal cells. In addition, some cancer cells make energy from nutrients in a different way than most normal cells. This lets cancer cells grow more quickly.

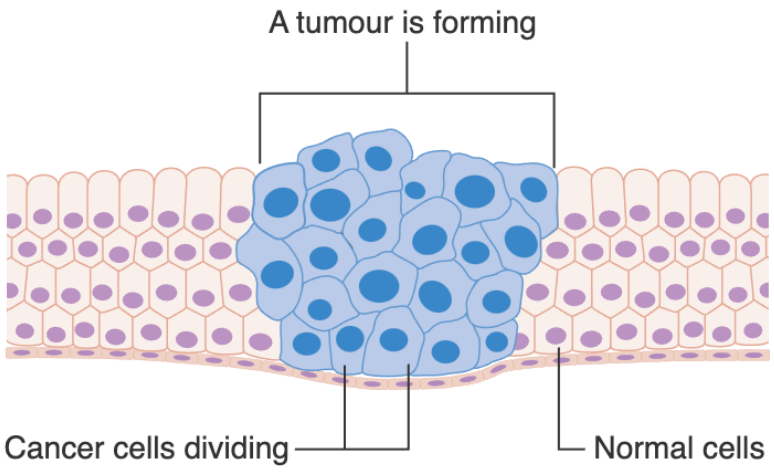
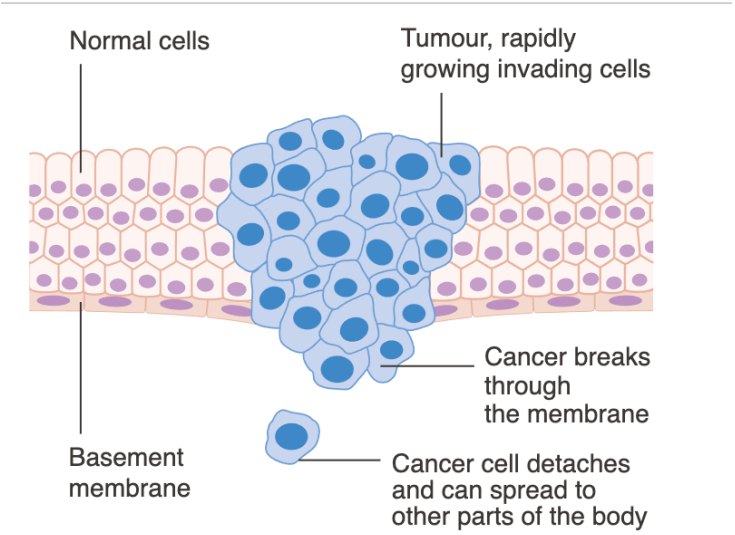


Figure 15.7.2.1: Diagram showing how



cancer cells keep on reproducing to form a tumor Figure 15.7.2.2: Diagram showing a tumor forcing its way through normal tissues

Benign versus Malignant Tumors

When cells grow and divide they may form tumors, which are a lump of tissue. These lumps might be benign or malignant. A benign tumor is not cancerous, a malignant tumor is cancerous. However, not all cancers form tumors, leukemia is a cancer of the blood cells that does not develop tumors, instead, the cancer cells build up in the blood and sometimes the bone marrow.

The big difference between a cancerous (malignant) tumor versus a non-cancerous (benign) tumor is the ability of the tumor to spread to other areas of the body, which is called **metastasis**. Benign tumors do not spread into, or invade, nearby tissues and are usually left in the body unless it is causing pain or is life threatening, such as benign tumors in the brain. Whereas, cancerous (malignant) tumors spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumors.

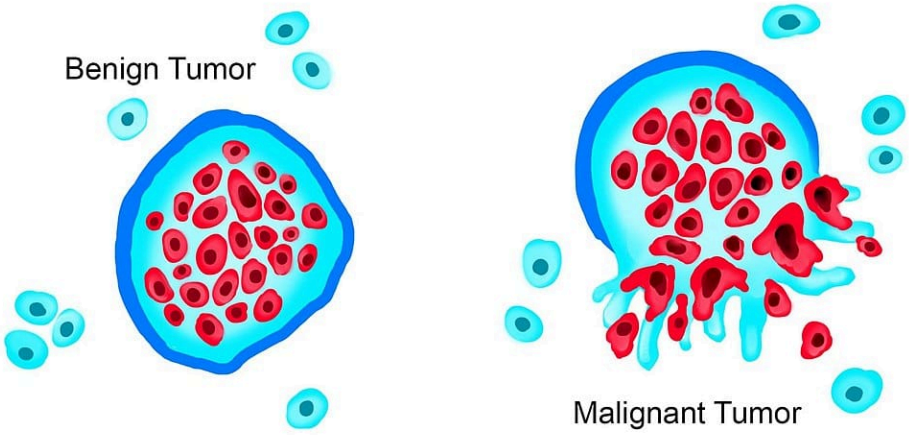


Figure 15.7.2.3: Benign Tumor versus Malignant Tumor

Benign tumors:

- usually grow quite slowly
- don't spread to other parts of the body

- usually have a covering made up of normal cells

Malignant tumors:

- usually grow faster than benign tumors
- spread into surrounding tissues and cause damage
- may spread to other parts of the body in the bloodstream or through the lymph system to form secondary tumors. This is called metastasis

Metastasis

Cancer cells don't like each other and do not stick together like normal cells. Rather, cancer cells leave their origin and spread to other parts of the body. The development of secondary malignant growths at a distance from a primary site of cancer is known as metastasis. When a cancer has spread to other parts of the body it is determined to be stage IV (4) cancer.

Cancer cells spread through the body in a series of steps:

1. Grow into, or invade, nearby normal tissue.
2. Move through the walls of nearby lymph nodes or blood vessels.
3. Travel through the lymphatic system and bloodstream to other parts of the body.
4. Stop in small blood vessels at a distant location, invading the blood vessel walls, and moving into the surrounding tissue.
5. Grow in this tissue until a tiny tumor forms.
6. Cause new blood vessels to grow, which creates a blood supply that allows the metastatic tumor to continue growing.

Cancer can metastasize to several places in the body, however it will be known by the primary site where the initial cancer cell began. For example, if a person has breast cancer that has spread to the lung, they will be determined to have stage IV breast cancer with lung metastases, not as lung cancer.

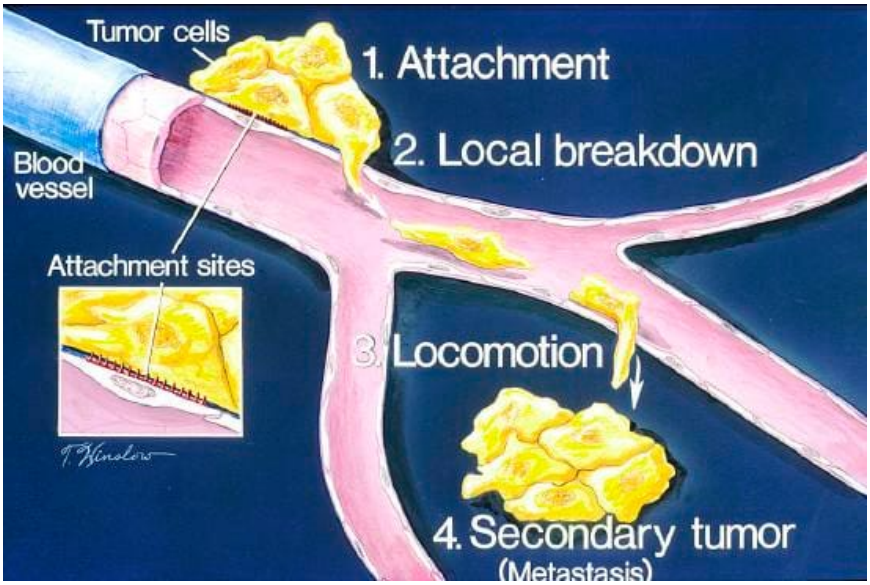


Figure 15.7.2.4: Cancer Metastasis

Table 15.7.2.1: Main Sites of Metastasis Based on Common Type of Cancer

Cancer Type	Main Sites of Metastasis or Secondary Tumors
Bladder	Bone, liver, lung
Breast	Bone, brain, liver, lung
Colon	Liver, lung, peritoneum
Kidney	Adrenal gland, bone, brain, liver, lung
Lung	Adrenal gland, bone, brain, liver, other lung

Cancer Type	Main Sites of Metastasis or Secondary Tumors
Melanoma	Bone, brain, liver, lung, skin, muscle
Ovary	Liver, lung, peritoneum
Pancreas	Liver, lung, peritoneum
Prostate	Adrenal gland, bone, liver, lung
Rectal	Liver, lung, peritoneum
Stomach	Liver, lung, peritoneum
Thyroid	Bone, liver, lung
Uterus	Bone, liver, lung, peritoneum, vagina

Cancer Stages

The cancer stage refers to the extent of your cancer, such as how large the tumor is, and if it has spread. A cancer is always referred to by the stage it was given at diagnosis, even if it gets worse or spreads. New information about how a cancer has changed over time gets added on to the original stage. So, the stage doesn't change, even though the cancer might.

Table 15.7.2.2*: Stages of Cancer*

Stage	What it means
Stage 0	Abnormal cells are present but have not spread to nearby tissue. Also called carcinoma in situ, or CIS. CIS is not cancer, but it may become cancer.
Stage I, Stage II, and Stage III	Cancer is present. The higher the number, the larger the cancer tumor and the more it has spread into nearby tissues.
Stage IV	The cancer has spread to distant parts of the body.

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15.7.3: Understanding Cancer

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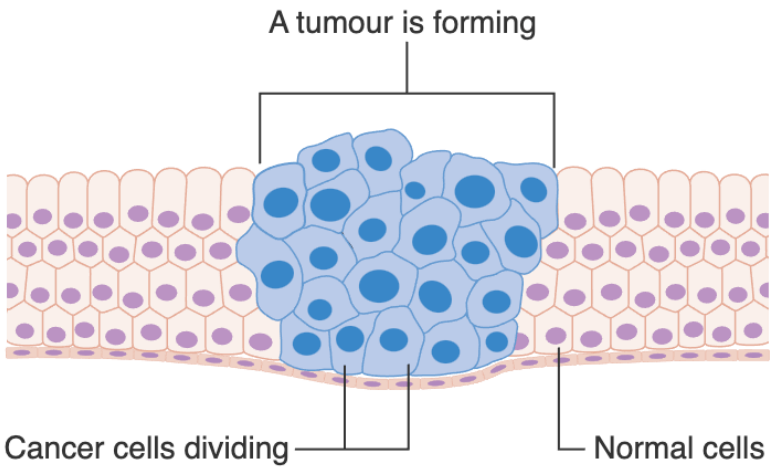
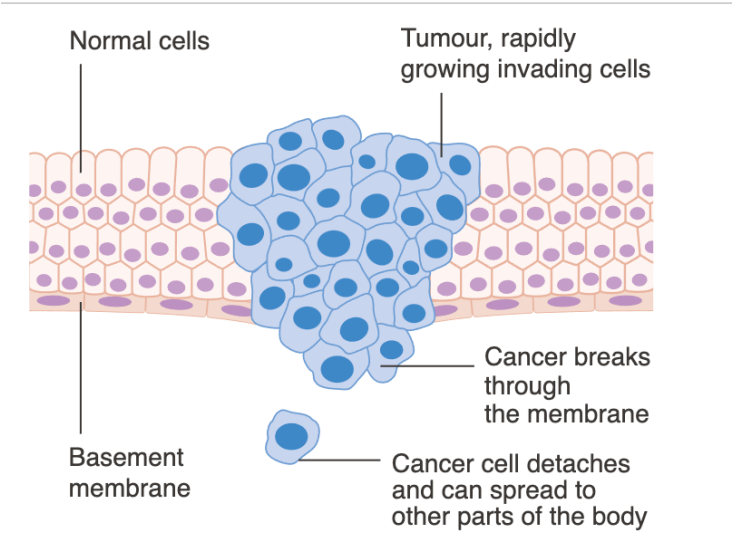


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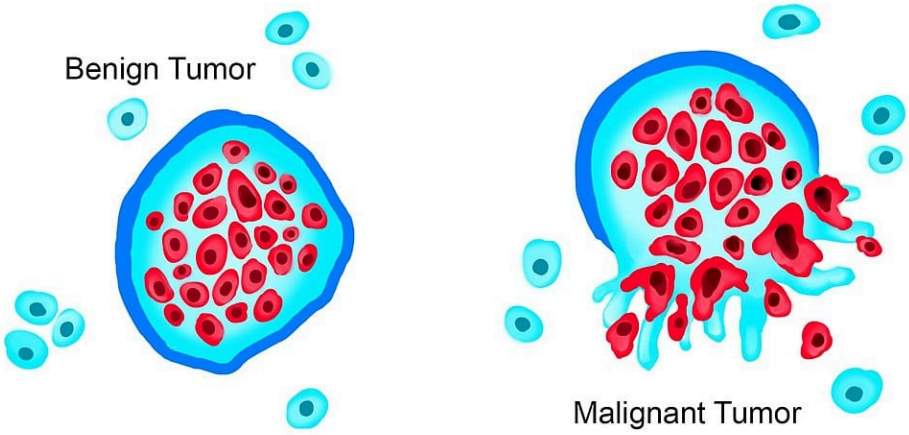


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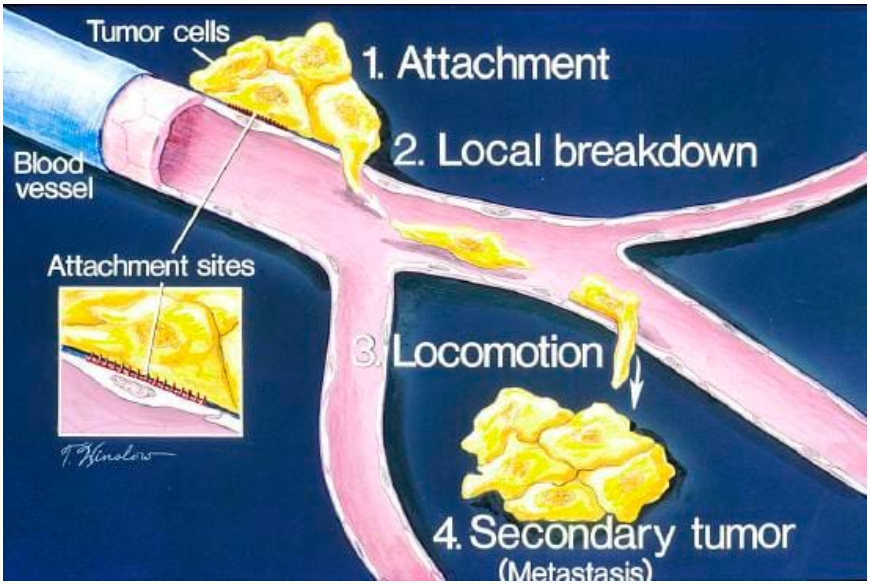


Figure 15.7.3.4: Cancer Metastasis

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15.7.4: Types of Cancer

There are more than 100 types of cancer. Types of cancer are usually named for the organs or tissues where the cancers form. For example, lung cancer starts in the lung, and brain cancer starts in the brain. Cancers also may be described by the type of cell that formed them, such as an epithelial cell or a squamous cell.

Common categories of cancers that begin in specific types of cells include carcinomas, sarcomas, leukemias, lymphoma, myeloma, and melanoma.

- Carcinoma
  - Carcinomas are the most common type of cancer. They are formed by epithelial cells, which are the cells that cover the inside and outside surfaces of the body.
- Sarcoma
  - Sarcomas are cancers that form in bone and soft tissues, including muscle, fat, blood vessels, lymph vessels, and fibrous tissue (such as tendons and ligaments).
- Leukemia
  - Cancers that begin in the blood-forming tissue of the bone marrow are called leukemias. These cancers do not form solid tumors. Instead, large numbers of abnormal white blood cells (leukemia cells and leukemic blast cells) build up in the blood and bone marrow, crowding out normal blood cells.
- Lymphoma
  - Lymphoma is cancer that begins in lymphocytes (T cells or B cells). These are disease-fighting white blood cells that are part of the immune system. In lymphoma, abnormal lymphocytes build up in lymph nodes and lymph vessels, as well as in other organs of the body.
- Multiple Myeloma
  - Multiple myeloma is cancer that begins in plasma cells, another type of immune cell. The abnormal plasma cells, called myeloma cells, build up in the bone marrow and form tumors in bones all through the body.
- Melanoma
  - Melanoma is cancer that begins in cells that become melanocytes, which are specialized cells that make melanin (the pigment that gives skin its color). Most melanomas form on the skin, but melanomas can also form in other pigmented tissues, such as the eye.
- Brain and Spinal Cord Tumors
  - There are different types of brain and spinal cord tumors. These tumors are named based on the type of cell in which they formed and where the tumor first formed in the central nervous system. For example, an astrocytic tumor begins in star-shaped brain cells called astrocytes, which help keep nerve cells healthy. Brain tumors can be benign (not cancer) or malignant (cancer).

Compare types of cancer

The National Cancer Institute provides in depth information into the types of cancers. One of the ways they provide the information covering about 100 types of cancer is by the location in the body. Take a moment to compare a few types of cancer for specific areas of the body to better understand the similarities and differences. You can compare the statistics, causes and prevention, treatment, and screening options.

Visit the National Cancer Institute's "Cancers by Location/System"

Cancers Rates

Cancer is the 2nd leading cause of death. Based on data from 2015-2017 it is estimated that about 39.5% of men and women will be diagnosed with cancer at some point in their lifetime. Cancer statistics provide data on the number of new cases and on the number of deaths. Comparing incident rate and death rate can be helpful for understanding the survival rate of various types of cancer. For example, estimations for 2022 show breast cancer incident as 290,560 with 43,780 deaths, however Lung cancer shows 236,740 incidents with 130,180 deaths. This data shows us that lung cancer has a much higher rate of mortality than breast cancer.

Table 15.7.4.3: National Cancer Society Estimated Cancer Incident and Death Rates for 2022 (listed by incident rate highest to lowest)
Source: American Cancer Society, 2022

Cancer Type	Estimated New Cases	Estimated Deaths
Breast	290,560	43,780
Prostate	268,490	34,500
Lung and bronchus	236,740	130,180
Colorectum	151,030	52,580
Melanoma of the skin	99,780	7,650
Urinary bladder	81,180	17,100
Non-Hodgkin lymphoma	80,470	20,250
Kidney and renal pelvis	79,000	13,920
Uterine corpus	65,950	12,550
Pancreas	62,210	49,830
Leukemia	60,650	24,000
Oral cavity and pharynx	54,000	11,230
Thyroid	43,800	2,230
Liver and intrahepatic bile duct	41,260	30,520
Myeloma	34,470	12,640
Stomach	26,380	11,090
Brain and other nervous system	25050	18280
Esophagus	20,640	16,410
Ovary	19,880	12,810
Cervix	14,100	42,80
Soft tissue (including heart)	13190	51,30
Larynx	12,470	3,820
Gallbladder and other biliary	12,130	4400
Small intestine	11,790	1,960
Testis	9,910	460
Anus, anal canal and anorectum	9,440	1,670
Vagina and other female genital	8,870	1,630
Hodgkin lymphoma	8,540	920
Vulva	6,330	1,560
Ureter and other urinary organs	4,010	970
Bones and joints	3,910	2,100
Eye and orbit	3,360	410
Penis and other male genital	2,070	470

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15.7.5: Cancer Screening and Symptoms

Before learning about the various cancer symptoms, it is important to note that many cancers have no symptoms, rather they are asymptomatic. It is important to get annual checkups and screenings to detect cancer. For example, women should get pap tests annually and mammograms after 40 (or earlier if breast cancer runs in their family. Men and women should get a colonoscopy every 10 years starting at 45.

Early detection is key for cancer survival!

The acronym CAUTION is a helpful reminder of the most common symptoms of cancer that you should watch out for. If you see any of the following symptoms please make an appointment with your primary care physician.

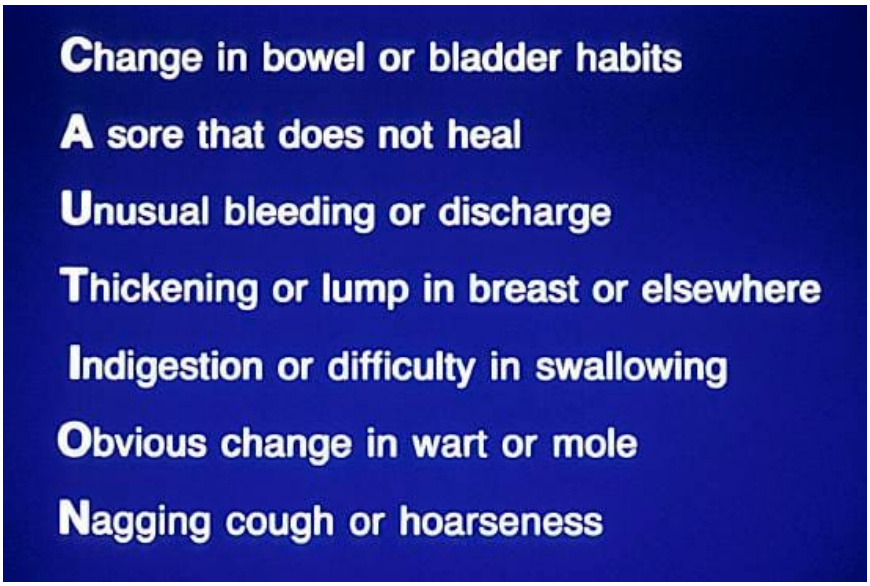


Figure 15.7.5.5: Cancer Warning Signs

Symptoms as related to type of cancer include:

Lung and bronchus

- Coughing that gets worse or doesn't go away.
- Chest pain.
- Shortness of breath.
- Wheezing.
- Coughing up blood.
- Feeling very tired all the time.
- Weight loss with no known cause.

Breast (female)

- New lump in the breast or underarm (armpit).
- Thickening or swelling of part of the breast.
- Irritation or dimpling of breast skin.
- Redness or flaky skin in the nipple area or the breast.
- Pulling in of the nipple or pain in the nipple area.
- Nipple discharge other than breast milk, including blood.
- Any change in the size or the shape of the breast.
- Pain in any area of the breast.

Prostate

- Difficulty starting urination.
- Weak or interrupted flow of urine.
- Frequent urination, especially at night.
- Difficulty emptying the bladder completely.
- Pain or burning during urination.
- Blood in the urine or semen.
- Pain in the back, hips, or pelvis that doesn't go away.
- Painful ejaculation.

Colorectal

- A change in bowel habits.
- Blood in or on your stool (bowel movement).
- Diarrhea, constipation, or feeling that the bowel does not empty all the way.
- Abdominal pain, aches, or cramps that don't go away.
- Weight loss and you don't know why.

Pancreas

- often asymptomatic
- jaundice
- Abdominal or back pain.
- nausea and vomiting.
- weight loss or poor appetite.

Liver

- Discomfort in the upper abdomen on the right side.
- A swollen abdomen.
- A hard lump on the right side just below the rib cage.
- Pain near the right shoulder blade or in the back.
- Jaundice (yellowing of the skin and whites of the eyes).
- Easy bruising or bleeding.
- Unusual tiredness.
- Nausea and vomiting.
- Loss of appetite.
- Weight loss for no known reason.

Ovary

- Vaginal bleeding (particularly if you are past menopause), or discharge from your vagina that is not normal for you.
- Pain or pressure in the pelvic area.
- Abdominal or back pain.
- Bloating.
- Feeling full too quickly, or difficulty eating.
- A change in your bathroom habits, such as more frequent or urgent need to urinate and/or constipation.

Leukemia

- Feeling tired (fatigue)
- Feeling weak
- Feeling cold
- Feeling dizzy or lightheaded

- Shortness of breath
- Paler skin

Non-Hodgkin lymphoma

- swollen lymph nodes, especially in the part of
- fever
- night sweats
- feeling tired
- weight loss.

Uterine

- Vaginal bleeding, or discharge from your vagina that is not normal for you.
- Pain or pressure in the pelvic area.

Brain and other nervous system

- Brain tumor symptoms can include:
  - Morning headache or headache that goes away after vomiting
  - Seizures
  - Vision, hearing, and speech problems
  - Loss of appetite
  - Frequent nausea and vomiting
  - Changes in personality, mood, ability to focus, or behavior
  - Weakness, loss of balance, and trouble walking
  - Unusual sleepiness
- Spinal cord tumor symptoms can include:
  - Back pain or pain that spreads from the back towards the arms or legs
  - A change in bowel habits or trouble urinating
  - Weakness or numbness in the arms or legs
  - Trouble walking

Urinary bladder

- Blood in the urine. This is the most common symptom.
- Having to urinate often.
- Pain while urinating.
- Back pain.
- Pelvic pain.

Esophagus

- Trouble swallowing
- Chest pain
- Weight loss
- Hoarseness
- Chronic cough
- Vomiting
- Bone pain (if cancer has spread to the bone)

Kidney and renal pelvis

- Blood in the urine.
- A lump or swelling in the kidney area or abdomen.

- Lower back pain or pain in the side that doesn't go away.
- Feeling tired often.
- Fever that keeps coming back.
- Not feeling like eating.
- Losing weight for no reason that you know of.
- Something blocking your bowels.
- A general feeling of poor health.

Myeloma

- Commonly asymptomatic
- Bone pain, especially in the back or ribs
- Bones that break easily
- Fever for no known reason;
- Frequent infections; bruising or bleeding easily
- Trouble breathing;
- Weakness of the arms or legs
- Feeling very tired.

Stomach

- Commonly asymptomatic
- Poor appetite
- Weight loss (without trying)
- Abdominal (belly) pain
- Vague discomfort in the abdomen, usually above the navel
- Feeling full after eating only a small meal
- Heartburn or indigestion
- Nausea
- Vomiting, with or without blood
- Swelling or fluid build-up in the abdomen
- Blood in the stool
- Feeling tired or weak, as a result of having too few red blood cells (anemia)
- Yellowing of the skin and eyes (jaundice), if the cancer spreads to the liver

Oral cavity and pharynx

- A white or red sore that does not heal on the gums, tongue, or lining of the mouth.
- Swelling in the jaw.
- Unusual bleeding or pain in the mouth.
- A lump or thickening.
- Problems with dentures.
- Trouble breathing or speaking.
- A lump or thickening.
- Trouble chewing or swallowing food.
- A feeling that something is caught in the throat.
- Pain in the throat that won't go away.
- Pain or ringing in the ears or trouble hearing.

Cervix

- Vaginal bleeding, or discharge from your vagina that is not normal for you.

Melanoma of the skin

- A-B-C-D-Es of melanoma
  - Asymmetrical: Does the mole or spot have an irregular shape with two parts that look very different?
  - Border: Is the border irregular or jagged?
  - Color: Is the color uneven?
  - Diameter: Is the mole or spot larger than the size of a pea?
  - Evolving: Has the mole or spot changed during the past few weeks or months?

Larynx

- Pain when swallowing.
- Ear pain.

Thyroid

- A lump or swelling on the side of the neck is the most common symptom.
- Having trouble breathing.
- Having trouble swallowing.
- Having a hoarse voice.

Testis

- A lump or enlargement in either testicle
- A feeling of heaviness in the scrotum
- A dull ache in the abdomen or groin
- A sudden collection of fluid in the scrotum
- Pain or discomfort in a testicle or the scrotum
- Enlargement or tenderness of the breasts
- Back pain

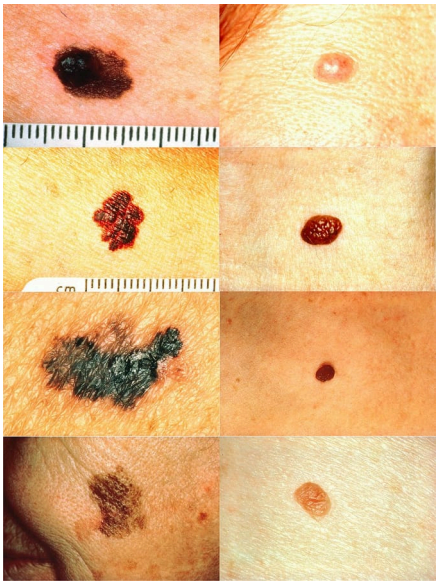


FIGURE 15.7.5.6: The ABCD'S of Skin Cancer Detection

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15.7.6: Cancer Risk and Prevention

Cancer prevention are actions you can take to lower the chance of getting cancer. It is usually not possible to know exactly why one person develops cancer and another doesn't. But research has shown that certain risk factors may increase a person's chances of developing cancer. Understanding the risk factors can help you to make lifestyle choices to try to prevent or lower your risk of cancer.

- Age
  - Advancing age is the most important risk factor for cancer overall and for many individual cancer types. The incidence rates for cancer overall climb steadily as age increases, from fewer than 25 cases per 100,000 people in age groups under age 20, to about 350 per 100,000 people among those aged 45–49, to more than 1,000 per 100,000 people in age groups 60 years and older.
- Alcohol
  - Drinking alcohol can increase your risk of cancer of the mouth, throat, esophagus, larynx (voice box), liver, and breast. The more you drink, the higher your risk. The risk of cancer is much higher for those who drink alcohol and also use tobacco.
- Environmental Carcinogens
  - People can avoid some cancer-causing exposures, such as tobacco smoke and the sun's rays. But other ones are harder to avoid, especially if they are in the air we breathe, the water we drink, the food we eat, or the materials we use to do our jobs. Being exposed to chemicals and other substances in the environment has been linked to some cancers. A few carcinogens in our environment include: Arsenic, formaldehyde, asbestos, radon, wood dust, mineral oils, and soot.
- Chronic Inflammation
  - In chronic inflammation, the inflammatory process may begin even if there is no injury, and it does not end when it should. Why the inflammation continues is not always known. Chronic inflammation may be caused by infections that don't go away, abnormal immune reactions to normal tissues, or conditions such as obesity. Over time, chronic inflammation can cause DNA damage and lead to cancer.
- Diet
  - Many studies have looked at the possibility that specific dietary components or nutrients are associated with increases or decreases in cancer risk, however results have been inconclusive or need further research. It is hard to study the effects of diet on cancer because a person's diet includes foods that may protect against cancer and foods that may increase the risk of cancer. Although the research is inconclusive, dietary relations to cancer have included:
    - Antioxidants may lower cancer risk by blocking the activity of free radicals that damage cells.
    - Artificial sweeteners have been shown to cause bladder cancer in animals.
    - Higher intakes of calcium and may reduce risks of colorectal cancer.
    - Charred meat increases exposure to chemicals that can cause cancer in animals.
    - Red meat is associated with an increased risk of colon and rectum cancer.
    - Cruciferous vegetables may have anticancer effects.
    - Fluoridated water helps decrease tooth decay, but may increase cancer risk.
    - Tea may lower cancer risk by blocking the activity of free radicals that damage cells.
    - Higher intakes of vitamin D or higher levels of vitamin D in the blood may be associated with a reduced risk of colorectal cancer.
- Hormones
  - Estrogens, a group of female sex hormones, are known human carcinogens. Although these hormones have essential physiological roles in both females and males, they have also been associated with an increased risk of certain cancers.
- Immunosuppression
  - Many people who receive organ transplants take medications to suppress the immune system so the body won't reject the organ. These "immunosuppressive" drugs make the immune system less able to detect and destroy cancer cells or fight off infections that cause cancer.
- Infectious Agents
  - Certain infectious agents, including viruses, bacteria, and parasites, can cause cancer or increase the risk that cancer will form.
- Obesity
  - People with obesity may have an increased risk of several types of cancer, including cancers of the breast (in women who have been through menopause), colon, rectum, endometrium (lining of the uterus), esophagus, kidney, pancreas,

and gallbladder.

- Radiation
  - Radiation of certain wavelengths, called ionizing radiation, has enough energy to damage DNA and cause cancer.
- Sunlight
  - The sun, sunlamps, and tanning booths all give off ultraviolet (UV) radiation. Exposure to UV radiation causes early aging of the skin and damage that can lead to skin cancer.
- Tobacco
  - Tobacco use is a leading cause of cancer and of death from cancer. Cigarette smoking is the number one risk factor for lung cancer. In the United States, cigarette smoking is linked to about 80% to 90% of lung cancer deaths. People who smoke cigarettes are 15 to 30 times more likely to get lung cancer or die from lung cancer than people who do not smoke.
- Physical activity
  - Studies show that people who are physically active have a lower risk of certain cancers than those who are not. It is not known if physical activity itself is the reason for this.
- Diabetes
  - Some studies show that having diabetes may slightly increase the risk of having several different types of cancer.

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15.7.7: End-of-Chapter Material

Key takeaways for this Chapter

- Cancer starts with the change in one cell in the body.
- Cancer cells do not like each other and break off from the other cells to spread throughout the body, called Metastasis.
- A cancerous tumor is called malignant, a non-cancerous tumor is called benign.
- Cancer is the 2nd leading cause of death.
- Many cancers are asymptomatic.
- The acronym CAUTION is helpful for remembering some common cancer symptoms.
- Lifestyle choices can impact your risk of getting cancer.

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16.1.1: AN INTRODUCTION TO MICROBIOMES

16.1.1.1: An Introduction to Microbiomes

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16.1.1.1: An Introduction to Microbiomes

An Introduction to Microbiomes

Microorganisms represent the fundamentals of life and interact with almost every facet of it. Yet, for the majority of their existence they have been largely ignored, or rather unseen by humans. The unraveling of the complex interactions between all life forms is an endless duty and seems to generate more questions than answers. However, the cracks in knowledge produced by peering into the unknown offers insight into our life and the world around us. These minute creatures have shaped Earth's evolution since their dawn almost three-and-a-half billion years ago, and continuously affect our environment and health. The importance of the planet's collection of microbes is realized more and more each day, and our unceasing investigation of them will surely unlock secrets of life we could never imagine.

The study of microbiomes is fairly novel in the context of understanding and applying their communal existence to ourselves and surroundings. Though scientists have recognized symbiotic relationships and traditionally focused on individual microbes and their interactions with human health, environmental impact, industrial applications, etc., their respective communities and influence as a whole in these areas have only just begun to be elucidated. That is in no small part due to the daunting task of cataloging the immense and complex interplay between the multitude of different microorganisms in a given environment, though rapid advances in technology have begun to ease analysis.

What is a microbiome?

A microbiome can be best described as a collective polymicrobial community, or 'microbiota', and its associated activity with genetic and physio-chemical constituents in a defined spaciotemporal habitat (Figure 1). These members of the microbiota include bacteria, archaea, algae, protozoa, fungi, and viruses (though the latter is somewhat debated since viruses and their derivatives aren't technically living). Within this symbiotic context with a particular eukaryotic host, the entire entity is termed a 'holobiont' and the aggregate of genetic material termed the 'hologenome'. Interactions between these partners may have long occurred, shaping the evolution of each, whereas others may be novel or transient, sometimes resulting in prompt change and infectious diseases. The change in the normal microbiota, or dysbiosis, can result in a variety of different diseases. As so, their study has been especially important in the fields of life sciences, human health, and medicine.

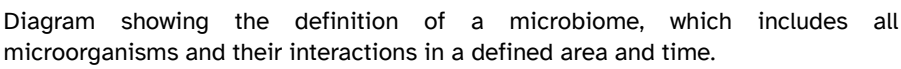


Figure 1. A schematic highlighting the composition of the term microbiome containing both the microbiota (community of microorganisms) and their "theatre of activity" (structural elements, metabolites/signal molecules, and the surrounding environmental conditions). (Berg et al., 2020 adapted by Dylan Parks).

Quick Quiz

Query 16.1.1.1.1

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Our fascination with microorganisms begun before we even fully understood them or were even able to see them. Their implications concerning human health were primarily explored during the 'golden age of microbiology' with the work of Louis Pasteur and Robert Koch. Their experiments and discoveries shed light on not only the ubiquitous nature of microbes, but their importance in our everyday lives. Other significant milestones and historical microbiological development can be viewed in Figure 2. Human health and infectious diseases were central to the field of microbiology, though food microbiology, industrial

applications, and microbial ecology became increasingly explored. Over the last couple centuries, a microbial catalog of knowledge has slowly grown, but much of these findings were limited to those organisms that could be cultured and measured. The advent of sequencing and 'multi-omics' technologies has since allowed researchers to document microorganisms that were previously missed or ignored with traditional techniques, and with further advances, larger microbial communities and symbioses can be better understood. The 'microbiome' was first defined in the late 1980s when a group of microbial ecologists were studying the rhizosphere, which provided context to better describe these polymicrobial communities (Whipps et al., 1988). Many other similar definitions have been published since then with varying specifics on genetic expression, symbioses, and ecological interactions (Lederberg & McCray, 2001, Marchesi & Ravel, 2015, Berg et al., 2020). The 'holobiont' concept stems from Adolf Meyer-Abich's 'theory of holobiosis' proposed in 1943 and was independently conceived and popularized in the early 1990s by Lynn Margulis, though it only described the host and a single symbiont (Margulis, 1991, Baedke et al., 2020). Since then has been expanded to include the entire microbiota in multiple symbiotic contexts (Simon et al., 2019). In recent decades there has been a steady increase in microbiome publications as the subject has grown in popularity. Along with that, there has been more analytical breakdown as certain microbiomes are being described with emphasis on specific members, such as the 'bacteriome', 'archaeome', 'mycobiome', 'protistome', and 'virome', and these terms are best used to refer to the distinct contribution of those particular microbes within the entire microbiome context. In general, though, most microbiomes are delineated by their specific host or type of environment, with the human microbiome being the most popular example.

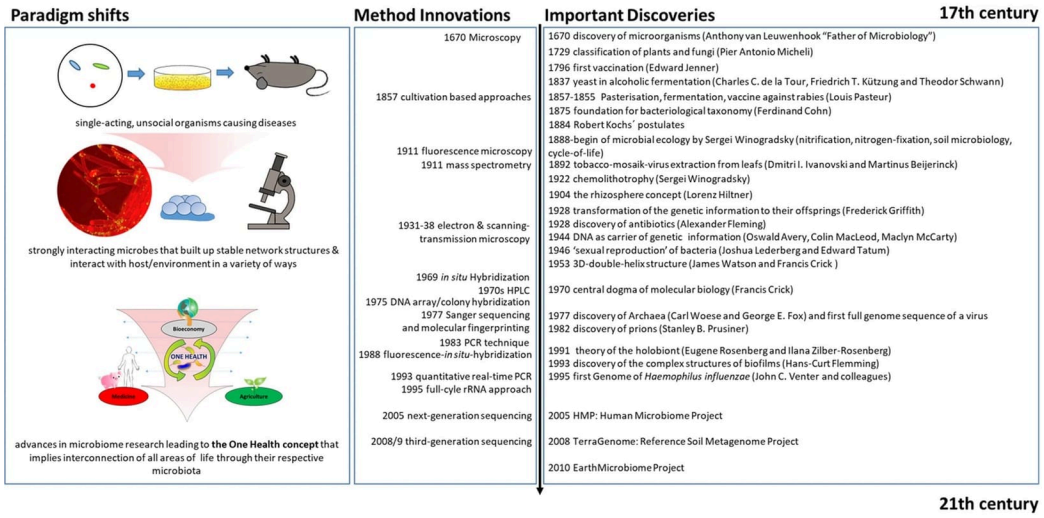


Figure 2. The history of microbiome research from seventieth century until our days, highlighting the shift of the paradigm from microbes as unsocial organisms causing diseases to the holistic view of microorganisms being the center of the One Health Concept: positively interconnecting all areas of our lives. (Berg et al., 2020).

The Human Microbiome

It was evident that the human microbiome and its involvement in a micro and macro scale needed to be characterized. The Human Microbiome Project (HMP) set out in 2007 with this as one of its primary goals (Turnbaugh et al., 2007). The program also set out with initiatives to develop a set of microbial genome sequences, explain the relationship between disease and microbiome changes and evaluate the data with multi-omics approaches, develop new tools and technology for computational analysis, establish a data analysis and coordinating center and research repositories, as well as address ethical, social, and legal implications of HMP research (Human Microbiome Project). The second phase of the HMP launched in 2014, called the Integrative Human Microbiome Project (iHMP), having the main mission to completely characterize the human microbiota with a key focus on human health and disease using three projects: pregnancy and preterm birth, onset of inflammatory bowel disease (IBD), and onset of type 2 diabetes (NIH Human Microbiome Project, The Integrative HMP (iHMP) Research Network Consortium, 2019). Aside from these, the human microbiome and disruption of the microbiota has been linked to several other important conditions and diseases including multiple sclerosis, diabetes (types 1 and 2), allergies, asthma, autism, and cancer (Backhed et al., 2012, Hsiao et al., 2013, Petersen and Round, 2014, Trompette et al., 2014, Garrett, 2015, Lloyd-Price et al., 2016).

It makes sense that the human microbiome can have such an impact on human health and behavior if you consider that we are essentially a collection of organisms forming a living entity. In a way, our symbionts may even actually define more of who we are than just our own unique biological makeup. For instance, the ratio of microbial cells associated with a human body could

equal, if not exceed (traditional estimates were tenfold), the number of human cells (Sender et al., 2016). Even more interesting is viewing our genetic makeup; the human genome contains about 20,000 genes, but its hologenome contains > 33 million genes brought by its microbiota (Huttenhower et al., 2012, Lloyd-Price et al., 2016, Simon et al., 2019). Furthermore, the composition and rate of change of each person's microbiota is distinctive from one individual to another since it is influenced by variables like age, lifestyle, diet, antibiotics, occupation, environment, etc. (Gilbert et al., 2018). The genetic wealth and member diversity contributed from the microbiota has roles in adaptation, survival, development, growth, and reproduction of the holobiont and can affect fitness in the short term as well as have long lasting effects concerning the evolution of both partners (Rosenberg, and Zilber-Rosenberg, 2011).

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Co-evolution of the host-microbiota symbiosis can be considered even more unique when viewing the microbial consortium at different locations or organs in the host, as their makeup is governed by and reflects specific physiological processes in those areas. For example, the bacteria found in the human gut microbiota are primarily from the phyla Bacteroides and Firmicutes, whereas Actinobacteria and Proteobacteria command the skin microbiome, though there is some overlap and it is important to note that there are differences depending on exact location (e.g. dry vs. moist areas of the skin) (Grice and Segre, 2011, Jandhyala et al. 2015). Though there are differences between various microbiota within a holobiont, they can still influence each other to some degree. In the case of the gut and skin microbiotas in humans, deemed the 'gut-skin axis', there are indications that both the health of the gastrointestinal (GI) tract and skin, as well as their response to stressors, are correlated (Levcovich et al., 2013, O'Neill et al., 2016, Salem et al. 2018). Even more interesting is the effects certain microbiota can have on germ-free organs like the brain. Studies on the 'gut-brain axis' show that the microbiota in the GI tract, and in some cases disruption of it, are associated with many mental illnesses and neurodegenerative disorders including depression, anxiety, autism, schizophrenia, Parkinson's disease, and Alzheimer's disease (Clapp et al. 2017, Foster et al. 2017, Cryan et al. 2019). A variety of different 'axes' which demonstrate interplay between microbiota, organs, and locations have been identified in the human body and much of what is known about their connections is novel and early in its research.

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Environmental Microbiomes

Not only can our microbiome regulate who we are, but those communities in the surrounding environment can affect us, our microbiome, and others. Environmental microbiomes can directly or indirectly affect our health through ecological interactions. For example, soil microbiomes in the rhizosphere of plant roots and plant microbiomes of economically important crops have implications in agriculture, human health, and ecology (Saleem et al., 2019, Hirt, 2020). Plant growth, health, soil nutrient cycling and availability, and defense against potential pathogens are dictated by their own symbionts as well as their microbial neighbors in the ground, which include a variety of bacteria, protists, viruses, and network of fungi known as mycorrhizae (Busby et al., 2017, Hannula et al., 2017, Pratama and van Elsas, 2018, Zhong et al., 2019,). By better understanding the functional interactions of all the players in these environmental microbiomes, it may be possible to address problems like agricultural soil fertility, plant disease, and pollution. Thus, harnessing better microbiomes either by specifically engineering a microbial consortia for a targeted area/specimen or transplanting a natural community could improve sustainable agricultural practices which are desperately

needed to feed the expanding population of humans while protecting the environment (Elhady et al., 2018, Arif et al., 2020, Hernandez-Alvarez et al., 2022).

Studying animal-microbiome systems can also give us information about our environment. For instance, how anthropogenic-induced changes have impacted things like climate-change and approaches to maintain homeostasis with various environmental factors. A promising reservoir of research is the microbiota of marine animals since most of the planet is covered in water. Corals, sponges, various fish, and marine mammals have all been investigated to document the response of their microbial symbionts to changing environmental factors (Apprill, 2017). Other animal microbiome models are being used in an analogous means to understand how the microbiota could potentially influence human health and fitness. The microbiomes of classic biomedical models such as the fruit fly, zebrafish, and nematode worm are being investigated since these organisms are well known and readily available to work with in many labs (Douglas, 2019). Though, it is important to consider a variety of animal host-microbiome models as each could contribute unique insights to beneficial microbial interactions within the human holobiont. For example, the gut microbiome of honeybees, the skin microbiome of freshwater polyps, and the individual interaction of *Vibro fischeri* and the Hawaiian bob-tailed squid have provided valuable information to understanding host-microbiome relationships (Douglas, 2019). Further research of these and other systems are needed for the pursuit of technological and medical advances or cultural/societal changes necessary for overall human and planetary benefit.

Microbiome Analysis

Traditionally, it has been difficult to characterize complete microbial communities, as most projects require substantial time and resources. Though, advancements in NGS and 'omics' technologies have begun to allow researchers to tackle microbiome analytics using a variety of approaches including metagenomics, metatranscriptomics, proteomics, metabolomics, culturomics, etc.(Integrative HMP (iHMP) Research Network Consortium, 2014, Bashiardes et al., 2016, Daliri et al., 2017, Janson and Hofmockel, 2018, Lin et al., 2019, Diakite et al., 2020,). Each technique is selected and applied depending on the experimental setup and what questions are being addressed. For instance, does the research care about the identification of members of the microbiome, how they are interacting with the host or each other, what macromolecules are present, what genes are being expressed, what is the functional potential, etc. These different types of investigations can then be integrated together in network analyses to establish linkages and correlations within the microbiome datasets, though statistical models and analytical tools must be carefully selected to avoid false outcomes and shortcomings (Jiang et al., 2019). Due to the particular limitations of these approaches and the unavoidably large datasets produced by microbiomic studies, it is paramount to continually develop novel technologies to unearth the knowledge buried in these microbiomes.

Considering the abundance of microbiomes that no doubt play role in human health, the extent to which microorganisms sway our lives is almost impossible to foresee, and the opportunities they present for improvement to industry, agriculture, environmental and human health is potentially unlimited.

Check Your Understanding

- What is the difference between a microbiome and microbiota?
- In what ways does a microbiome influence a holobiont?
- How can an environmental microbiome indirectly impact human health?

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16.1.2: ANALYZING MICROBIOMES

16.1.2.1: Analyzing Microbiomes
16.1.2.2: Environmental Metagenomics

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16.1.2.1: Analyzing Microbiomes

Analyzing Microbiomes

Choosing the correct approach when characterizing a microbiome is important when considering what questions are trying to be answered. Who are the players? What is the function? What genes are being expressed? How do they interact?

Even though when assessing a microbiome all members of the microbiota should be considered, some insight can be gained by viewing individual groups, such as the prokaryotic component, which can be further compartmentalized into the bacteriome and archaeome. In some cases, it is difficult to completely characterize all of the members due to inherent biological differences between these communities, and in other situations, certain groups may be absent or irrelevant to the study. In so, analyzing these individual pieces could help reveal their distinct importance and contribution to the overall big picture.

The type of analysis also depends on the research question. If the sole interest is to identify all the bacteria in a sample, then a metagenomic approach may work best. Whereas, if an interest lies in what the microorganisms are doing, then a metatranscriptomics or metaproteomics approach would be more appropriate. If there is an interest in one or a few particular members of the microbiome, culture-based techniques (culturomics) could be implemented, which can often catch rare microbes that are missed using sequencing techniques because of data filtering protocols (Lagier et al., 2012, Allaband et al., 2019). However, it is usually difficult to characterize an entire microbiome based on just a few microbes and achieving multiple isolations is extremely difficult as a 'one-size-fits-all' type media does not exist.

Sample Collection

Depending on the type of research questions and the particular microbiome of interest, there are different ways to collect microbial communities that will be subjected to analysis. That is, the approach to collecting microbes from the human gut is much different than getting a soil sample. Really, there is no perfect method for any one microbiome, though some may be more difficult to obtain than others, and will depend on a variety of factors such as feasibility, cost, patient acceptance, and downstream analytical methods (Allaband et al., 2019). It can also be very difficult to capture all microbes within a microbiome sample, as inevitably some will be missed or cannot be collected by a particular technique. For example, when analyzing the gut microbiome, stool collection is preferred due to its ease and frequent accessibility, but this method often misses microbes in the small intestine and others which are mucosally adherent as opposed to excreted (Eckburg et al., 2005, de Carcer et al., 2010, Allaband et al., 2019). Additionally, collection and storage materials, storage time, and transport options should be considered as these can compromise sample integrity and create problems for various analytical approaches (Costello et al., 2009, Caporaso et al., 2011, McDonald et al., 2018).

Approaches to Characterization

What is the Difference between Culture-Dependent and Independent Methods of Microbial Community Characterization?

-Excerpt taken from Findley and Grice, 2014 available under the Creative Commons CC0 public domain dedication:

Up until the 1980s, microbiologists routinely relied on culture-dependent methods for microbial isolation, identification, and characterization. Colony morphology, stains (i.e., Gram stain), biochemical characteristics (i.e., coagulase test), motility tests, antibiotic resistance profiles, and other characteristics guided bacterial and/or fungal identification and taxonomy. However, this approach has several limitations, including an inability to mimic in vivo conditions and selection against slow-growing and/or fastidious organisms. With recent advances in sequencing technologies and development of bioinformatics tools and reference databases, researchers are now better equipped to capture microbial diversity without the biases of culture-based approaches.

Culture-independent methods of microbial identification rely on a targeted amplicon strategy, which employs highly conserved microbe-specific molecular markers and does not rely on growing isolates in pure culture. The 16S ribosomal RNA (rRNA) gene is used for bacterial identification, while fungi and other microeukaryotes are identified using either the 18S rRNA gene or the Internal Transcribed Spacer (ITS) region. A complementary approach to amplicon-based surveys is whole genome shotgun metagenomics. With this approach, one can identify the microbiota present and gain insight into the functional potential of the microbiota in an untargeted manner.

Within the culture-independent targeted approach, PCR amplification techniques, like quantitative PCR (qPCR) and reverse transcriptase PCR (RT-PCR) can be implemented to detect and quantify specific organisms, genes, or expression values within the microbiome sample. Untargeted approaches typically give whole community characterization and include metagenomics, metatranscriptomics, metaproteomics, and metabolomics which have a variety of applications depending on the type of study.

Culturomics

Cultivating all the microorganisms within a certain microbiome can be quite challenging and time-consuming, but nonetheless can provide important information that would otherwise be missed with other approaches. Creating media that mimics the original environment can help to capture organisms that exist at lower concentrations than that of the detectable threshold of molecular tools (Lagier et al., 2012). The application of matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF MS) has enhanced culture-dependent studies by allowing fast and reliable identification of bacterial taxa in a cost-effective manner (Seng et al., 2009, Lagier et al., 2012). Even though there have been advances in culturomics, the approach still has certain biases based on the types of microbes that can be easily grown (e.g. aerobic microbes are much easier to grow than anaerobic ones in most cases), as well as the selection for those that grow more rapidly and outcompete the others in a sample (Allaband et al., 2019). Thusly, it is imperative to close the gap between microbial richness observed in nature versus what is cultivable in the lab in order to better understand *in vivo* microbial functioning within a microbiome (Sarhan et al., 2019).

Metagenomics and DNA sequencing

Next-generation sequencing (NGS), also known as high-throughput sequencing (HTS), allows the generation of thousands of sequencing reads in a cost-effective manner (Nkrumah-Elie, et al., 2018). These reads can then be bioinformatically processed and annotated to identify microbial taxa, genes, potential functions, etc. depending on the sample type and experimental conditions (Rivera-Pinto et al., 2018). However, differences in wet lab work, sequencing platforms, processing pipelines, and statistical approaches can affect data output, which make reproducibility come into question (Gloor et al., 2016). Usually, information about microbiome compositions are provided as relative abundances instead of the true abundances due to sequencing platform imitations. This data is considered an arbitrary sum and is referred to as compositional data (Jiang et al., 2019). As sequence generation and pipelines improve and become standardized, the development and accessibility for analytical tools can help to streamline and produce consistent and more accurate results while aggregating data for microbiome characterization and meta-analysis without advanced expertise (Markowitz et al., 2007, Dhariwal et al., 2017, Gonzalez et al., 2018, Chong et al., 2020, Mitchell et al., 2020, Bharti and Grimm, 2021, Chen et al., 2021).

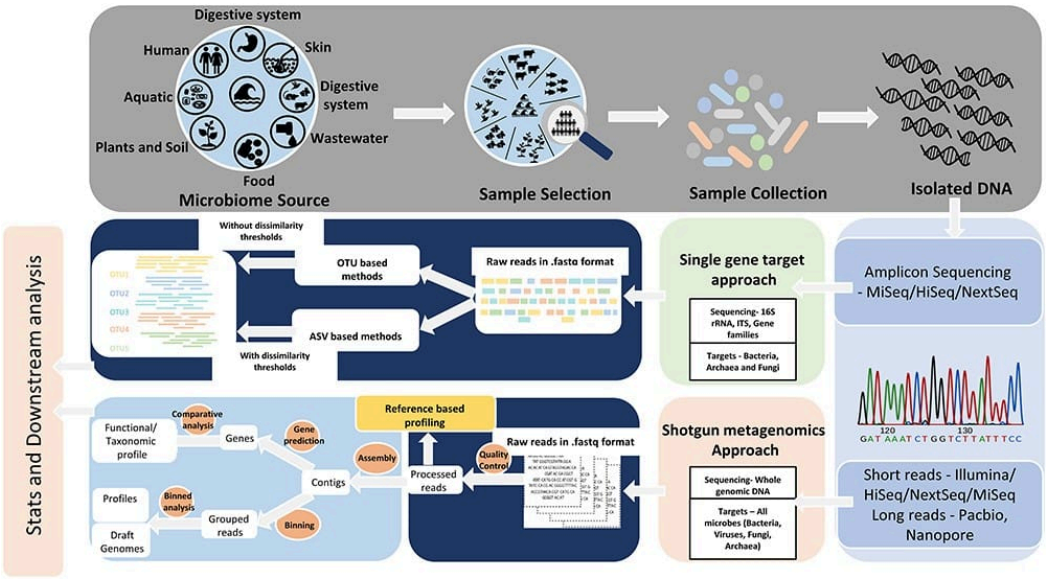


Figure 1. An illustration of targeted amplicon and metagenomic sequencing approaches. A schematic overview demonstrating diverse sample types along with commonly utilized sequencing platforms, as well as systematic and stepwise data processing steps. (Bharti and Grimm, 2021).

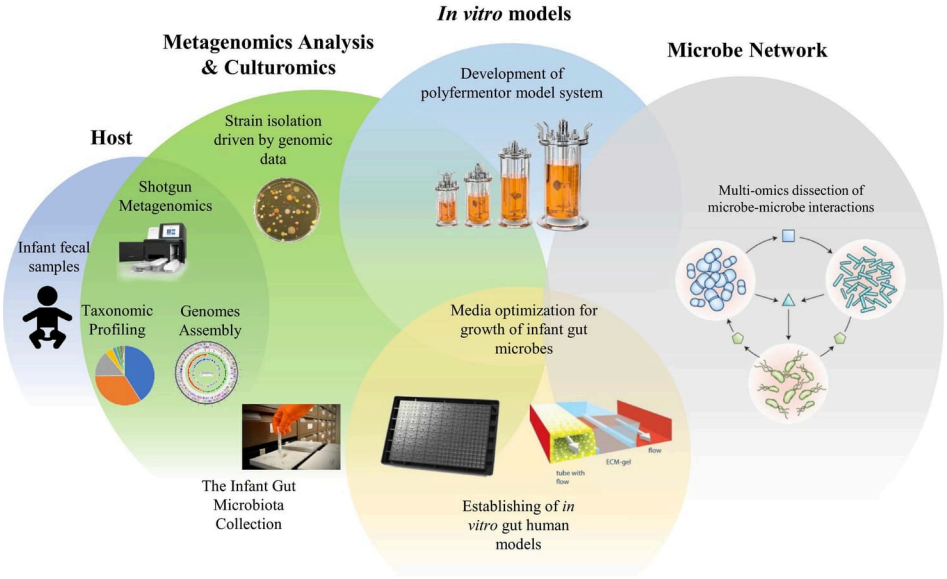


Figure 2. Schematic representations of the in vitro models used for underpinning the microbe–microbe and host–microbe cross talks.

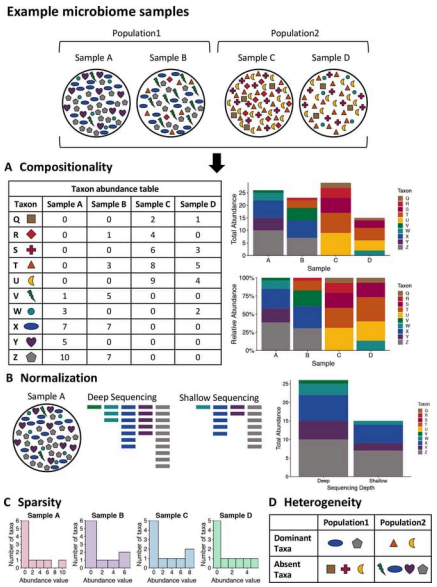


Figure 3. Visualizing the unique challenges of microbiome data. A mock set of bacterial samples from two populations where each colored shape is a bacterial taxon. (A) Compositionality. The taxon abundance table depicts the count of each observed taxon in each sample. When sequencing microbiome samples, the resulting counts of taxa are not representative of the actual taxa counts in the sample due to constraints of sequencing. Due to this, relative abundances are generally used in analysis of microbiome data. The bar plots illustrate the difference in community representation between raw counts (top) and relative abundances (bottom). (B) Normalization. Due to the constraints of sequencing, the overall sequencing depth of a sample can impact the results. For example, shallow sequencing may miss rare taxa such as the green taxon V in the example sample A that is present in low abundance in the community. (C) Sparsity. Microbiome data are often very sparse, where most observations are zero. This is illustrated by the histogram of taxa counts for each sample where most counts are zero and there are few taxa with high counts. This can also be seen in the table for part A, where many entries are zero. (D) Heterogeneity. The table summarizes the taxonomic heterogeneity in the mock dataset between the two populations. Each sample has a unique taxonomic composition, but there are also population specific signatures. The samples in each population are dominated by a few taxa, and these dominant taxa are different for the two populations. Additionally, there are taxa that are highly abundant in one sample and absent from the rest, such as the purple taxon Y in sample A.

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Metatranscriptomics and RNA sequencing

While metagenomic studies have been instrumental in identifying various microbes and genes in a given sample, it does not differentiate between viable cells or when those genes are being expressed (Gosalbes, et al., 2011, Bashiardes et al., 2016). Metatranscriptomic strategies of microbiome analysis allow researchers to capture gene activity which can delineate the functional dynamics of a particular community and it's interactions with its host or environment. These RNA-based approaches can complement metagenomics, as the extent of expression of those annotated genes can be measured (Franzosa et al., 2014). This is considerably important concerning certain disease states because the presence of a pathogen does not always produce deleterious conditions, but rather it is the functional activity of certain organisms.

RNA-seq experiments usually begin with isolation of total RNA in a sample, then selection is based upon whether it is prokaryotic or eukaryotic in origin, and mRNA must be isolated from other RNA species (i.e. rRNA and tRNA) (Bashiardes et al., 2016). cDNA is then synthesized from the mRNA, adapters are ligated to create a library, amplification and sequencing follows, and the generated reads are mapped to a reference genome where expression can be measured (Giannoukos et al., 2012, Bashiardes et al., 2016). These experiments can be difficult and sensitive, as care must be taken with sample collection, and avoiding contamination and degradation from ribonucleases is important to maintain integrity of the samples as well. Furthermore, metatranscriptomics may

not always give the whole picture of community expression due to the high complexity of organisms, the delicateness of RNA, the wide range of transcript expression, and various limitations with current technology (Shakya et al., 2019).

Metaproteomics

Metaproteomics gives a snapshot of the entire protein content of a microbiome sample under various conditions, which can further provide insight into gene activity and metabolic functions. This strategy identifies peptides by matching tandem mass spectrometry (MS/MS) data to protein sequence databases, which can be further assigned to functional groups via annotation databases (Sajulga et al., 2020). This approach can be convoluted though, as many peptides match to similar proteins produced by different organisms, and proteins can be multi-functional making it difficult for assignment to any one group. Additionally, bioinformatic analysis of metaproteomes isn't exactly standardized which makes reproducibility and comparison of studies problematic (Schiebenhoefer et al., 2019, Sajulga et al., 2020).

Metabolomics

Metabolomics analyzes the non-protein metabolites that are produced and/or regulated by a given microbiome, which adds another angle of characterization to community-host-environmental interaction and functional dynamics. By understanding how various microbes process metabolites like natural products, nutrients, and medications, we can better determine how they influence their ecosystem through molecular interactions. Researchers typically obtain these molecules through gas or liquid chromatography and subsequently analyze them by mass spectrometry (Allaband et al., 2019, Bauermeister et al., 2021). Metabolomics strategies can either be targeted or untargeted, where the former is more sensitive and compares metabolites to a pre-determined bank with reference standards, however, it cannot detect novel molecules. Since most metabolites produced by microbiomes are unknown, an untargeted approach using tandem mass spectrometry is useful in detecting many small molecules, though annotation of modified metabolites is challenging (Watrous et al., 2012, Wang et al., 2016, Allaband et al., 2019). As with other microbiome analytical approaches, various data analysis tools and pipelines of the metabolome need to be standardized to a degree to improve overall research context. Moreover, major advancements in the known inventory of microorganism-derived metabolites and their functions are required to enhance metabolomics studies (Lee-Sarwar et al., 2020, Bauermeister et al., 2021).

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Conclusion and Future Directions

While various approaches to characterizing a microbiome each have their advantages and drawbacks, network analyses integrating all the -omics (i.e. metagenomics, metatranscriptomics, metaproteomics, and metabolomics) could be best to gain a holistic view of compositional and functional dynamics (Bashiardes et al., 2016, Jiang et al., 2019). Novel and improved approaches to collect and analyze various microbiomes will help to minimize loss of information and provide a better picture of how these communities interact with and influence their host or environment. Also, the establishment of more comprehensive publicly available databases, and protocols for streamlining computational procedures will allow more consistent and reproducible research for upon which knowledge can be accumulated.

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Check your Understanding

- What is the difference between culture-dependent and independent methods of microbiome analysis?
- What is the importance of culturomics in the scope of microbiome analysis?
- How can inaccurate or inconsistent results be produced from different metagenomic approaches to microbiome analysis?
- When would a metatranscriptomic analysis be more appropriate than a metagenomic approach? How do these approaches complement each other?
- What are the benefits and limitations of metabolomic analysis?

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16.1.2.2: Environmental Metagenomics

Environmental Metagenomics

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Introduction

Metagenomics can be defined as the techniques and procedures that are used for the culture-independent analysis of the total genomic content of microorganisms living in a certain environment [2]. It has many useful applications with very promising potential in both medical and environmental microbiology. The most common use of metagenomics in environmental microbiology is studying the diversity of microbial communities in particular environments through the analysis of rRNA genes and how these communities change in response to changes in physical and chemical properties of these environments [3].

Metagenomics also provides an opportunity to obtain and identify novel enzymes with industrial applications from extreme environments where unculturable extremophiles live. In such circumstances, functional metagenomics enables the isolation of genes coding for extremozymes, enzymes that are capable of being catalytically active in extreme conditions, or genes that will allow for better understanding of the mechanisms that make such organisms resistant to extreme environmental conditions [4].

Metagenomics has special importance when it comes to studying soil microbiology. It is estimated that the number of distinct microorganisms in 1 gram of soil exceeds the number of microbial species cultured so far [5]. Therefore, metagenomics seems to be the ideal culture-independent technique for unraveling the biodiversity of soil microorganisms and to study how this biodiversity is affected with continuously changing conditions.

Sequencing technologies and metagenomics

Recently, taxonomic profiling, characterization, and analysis of microbial communities are being mostly performed using different next-generation sequencing (NGS) platforms. Metagenomic samples are high-throughput, short-read sequences, and the cost is relatively decreasing. In addition, these platforms are advantageous, avoiding the need for cloning of DNA fragments [6].

Recent advances in NGS technologies were developed to suit various numbers of applications, cost, and capabilities [7]. The most commonly used platforms are the 454 Life Sciences (Roche) and Illumina systems (Solexa) [8]. The 454 sequencing technology, which was the first commercially available next-generation technology, is based on the pyrosequencing technique. It provides high throughput and relatively cheap analysis [9]. During the sequencing reaction in this technique, nucleotide incorporation into the growing chain is detected by the capture of the released pyrophosphate, which is converted into a light through an enzymatic reaction. Different nucleotides are sequentially added into each nucleotide incorporation event; therefore the light signal can be attributed to a specific nucleotide. Finally, the light signals are converted into sequence information. In the 454 pyrosequencer, the DNA fragments are amplified after being fixed on beads in a water-oil emulsion [10]. Pyrosequencing has been employed widely in the analysis of microbial diversity in many environments including marine environments [11] and different soil environments [12, 13].

Illumina sequencing technology relies on the use of fluorescently labeled reversible terminator nucleotides. Instead of being chemically modified to prevent further DNA synthesis (dideoxynucleotides) which is the case with Sanger sequencing, the terminator nucleotides are attached with blocking group that can be removed from the nitrogen base in a single step. DNA synthesis takes place on a chip where primers are attached. After each cycle, the dyes attached to each nucleotide are excited by laser followed by scanning of the incorporated bases. In order for the next synthesis cycle to proceed, the blocking group and the dye are first removed by a chemical reaction. Illumina sequencing platform was successfully used to study microbial diversity in many environments [14, 15, 16].

In addition to the abovementioned technologies, recently developed sequencing technologies are available and being employed in metagenomic studies. These include SOLiD 5500 W Series developed by Applied Biosystems, single-molecule real-time (SMRT) DNA sequencing from Pacific Biosciences, and Ion Torrent semiconductor sequencing [8]. More innovative technologies are being developed that could be of great use for metagenomic studies in the near future. Strand sequencing technologies, currently being developed by Oxford Nanopore technologies, enable the sequencing of intact DNA strand that passes through a

protein nanopore [17]. Irys Technology, developed by BioNano Genomics, represents one of the very promising new technologies in genomics era [8].

The metagenomic approaches

Metagenomics research strategy starts with selecting a proper ecological or biological environment of interest that hosts a wide variety of microbial communities which may have potential biotechnological applications. Environments that attract metagenomic researchers are mainly those characterized with extreme conditions or unique environmental conditions. These include environments with highly acidic or alkaline pH; high metal concentrations, pressures, or radiation; and high salinity or extreme temperatures [4].

Metagenomic analysis starts with isolating genomic DNA that represents the whole community in the soil sample, constructing a DNA library from the isolated DNA, and screening the available library for a target gene. It is important here to select the DNA extraction method that will provide enough yield and DNA that represents the diversity of the whole microbial community in the target environment. This is still one of the most challenging steps of metagenomic analysis. The chemical and physical characteristics of soils are very wide and complex, depending on the type of the soil examined, that will make it difficult to develop a reference method for DNA extraction from soils. Besides, soils contain many substances that are co-extracted with genomic DNA and harbor inhibitory effects on the downstream processing of the extracted DNA. Examples include humic and fulvic acids [18]. Therefore, optimization and comparison between different extraction methods are usually required for each type of soil [19, 20, 21, 22].

A DNA library is then constructed from the genomic DNA isolated from the target environment. This is performed by fragmenting the isolated DNA into fragments with appropriate sizes that would allow for their cloning. This is performed by either using restriction enzyme digestion or mechanical shearing. DNA fragments obtained from such processes are cloned into the proper cloning vector. Plasmid vectors are used for small DNA fragments, and the libraries generated are called small-insert genomic libraries. Large inserts are cloning into cosmid or fosmid vectors which can hold inserts up to 40 kb in size or BAC vector which can carry inserts with sizes that exceed 40 Kb [23].

DNA libraries are usually constructed in a microorganism that is well-studied and is easy to manipulate inside the laboratory such as *Escherichia coli*. In case there is a need for expressing the genes within the DNA inserts in other microorganisms, shuttle vectors are used to transfer the libraries into a proper host [24].

Finally, a screening assay is applied to search for a gene of a particular function, and the gene product is functionally analyzed. There are two different metagenomic strategies that are commonly used in research. The first one is focused on the use of marker genes such as the ribosomal genes 16S rRNA [25] and 18S rRNA [26] to study the composition of the microbial community in a certain environment or specific protein-coding gene with medical or industrial importance [27, 28, 29]. Such a strategy is called targeted metagenomics. The second approach is the shotgun metagenomics, in which a wide coverage of genomic DNA sequences is achieved using high-throughput next-generation sequencing to assess the entire taxonomic structure or functional potential of microbial communities [30].

The most challenging aspect of the screening process in metagenomics is the analysis of a huge amount of sequence data that are generated from the constructed library. A wide range of bioinformatic tools has been developed over the years to help analyze the metagenomic data and compare it to available online databases.

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16.1.3: HUMAN HEALTH AND DISEASE

16.1.3.1: Human Health and Disease
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16.1.3.1: Human Health and Disease

Human Health and Disease

The human microbiome plays a vital role in maintaining homeostasis of various organ systems and protecting against infectious agents. It can be subcategorized into local or regional microbiomes throughout the body, such as the gut, oral, skin, lung, and vaginal microbiomes. These manicured microecosystems are highly organized and complex, with each person having their own distinct makeup and distribution of various microorganisms. Though, individual microbiomes are unique, there is still capacity to understand key role players in the community and their potential for adaptation to improve human health in general.

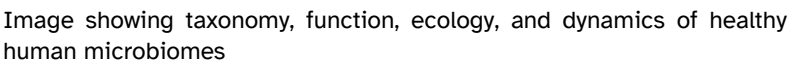


Figure 1. Possible definitions of a healthy microbiome: composition, function, dynamics, and ecology. a Early definitions of a "healthy" microbiome generally focused on sets of taxa that might be expected to be found prevalently in healthy people. While purely taxonomic cores of any type have remained elusive, even in relatively narrowly defined populations, each body-site habitat possesses strong phylogenetic enrichments. Typical genera (or families in the gut) in healthy populations at different sites are shown here. **b** Metagenomic measurements have allowed the functional potential of the microbiome at different sites to be assessed. These studies have yielded more consistently shared functional cores of body-wide and niche-specific pathways that are maintained in health. LPS lipopolysaccharide, PAMP pathogen-associated molecular pattern. **c** Ecological assembly patterns provide another possible definition of a healthy microbiome, because each host may draw from a "typical" meta-population of potential microbes through a mix of partially stochastic processes. These processes may include the order in which microbes colonize their respective human habitat (affected by geography and early exposures, for example), the prolonged availability of each microbe in the host's local environment, and host selection. **d** The healthy microbiome can also be characterized in terms of its dynamics, depicted here in a simplified model as a conceptual energy landscape. The infant microbiome (yellow point) starts out in an unstable state and gradually descends towards one of potentially several healthy adult attractor states. Perturbations (dashed red arrows) can either be resisted (green point) or can move the microbiome out of the healthy state, after which a resilient microbiome will return to a healthy state (not necessarily the original healthy state) or fall into an unhealthy state (red). (Lloyd-Price et al., 2016).

Disruption, or dysbiosis, of the microbiome can cause serious diseases and allow for opportunistic infections to occur. This disturbance can be caused by a variety of factors including changes in diet, exercise, geographical location, age, habits, as well as medical intervention like antimicrobial chemotherapy. This change in microbial composition subsequently leads to the development and exacerbation of a number of diseases impacting essentially every aspect of human physiology including the digestive, respiratory, integumentary, central nervous, and reproductive systems. Alternatively, dysbiosis may be the result of a particular disease, and in other cases disease-dysbiosis may be bidirectional (Silverman et al., 2019). The human microbiome can be influenced by many of the above mentioned factors, but also others like life partners, pet ownership, and occupation, which do not necessarily correlate with or contribute to dysbiosis (Kiecolt-Glaser et al., 2019, Kates et al., 2020).

A major driving feature of many of these elements is the host's genetics, which can also directly impact their microbiome (Tabrett and Horton, 2020). Part of the gut microbiome and even individual types of bacteria have been shown to be heritable (Kurilshikov et al., 2017), and it is likely that other areas of the human microbiome, like the skin microbiome, could be passed from parent to offspring as well (Si et al., 2015). The host genotype is intimately linked to its microbiome and has been shown to affect dysbiosis-induced diseases such as inflammatory bowel disease and atopic dermatitis (Knights et al., 2013, Dabrowska and Witkiewicz, 2016, Woo and Sibley, 2020). Host genetics and their microbiome can even indirectly affect one's susceptibility to other diseases. For example, the attractiveness of mosquitos to particular individuals is an heritable trait which is influenced by the many factors, including the skin microbiome; therefore altering the potential of contracting a mosquito-borne pathogen, such as a *Plasmodium* parasite which causes malaria (Martinez et al., 2020). It seems there is a combination between environmental factors, host genetics, behavior, and others that continually build and adapt the human microbiome, however, is worthy to note that the former may play a larger role in shaping particular microbiomes, such as the gut microbiome (Rothschild et al., 2018).

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16.1.3.2: The Gut Microbiome

The Gut Microbiome

The microbiome associated with the human gastrointestinal tract, termed the gut microbiome, may arguably be the most important component of the collective human microbiome. It has been shown to affect numerous other regions of the body and serves a role in many types of diseases throughout it. This is because many of the microbial products are absorbed in the alimentary canal and distributed throughout the body via the cardiovascular system.

Sample procurement to characterize the gut microbiome usually comes in the form of fecal matter, which readily available and less invasive. However, there are novel attempts to characterize gut microbiome constituents by sampling the mucosal-luminal interface (Yan et al., 2020). DNA and other features of interest can then be extracted from the microbes to provide information regarding gut microbiome composition and function.

Composition

The gut microbiome is quite versatile and its composition can vary widely among individuals with different ethnicities, across geographic locations, and with age (Yatsunenko et al., 2012, Gaulke and Sharpton, 2018). The host's genetics do play a role in the composition of the gut microbiome, as certain members are heritable, while other's abundances are the causal result of congenital diseases (Xu et al., 2020). Though diet, which is closely related to the aforementioned variables, may be the single strongest influencing factor when it comes to structuring this digestive community and alterations are reflected in both short-term and long-term dietary interventions (David et al., 2014, Xu and Knight, 2015). Indeed, the type of diet, such as a high-fat diet, will have a direct impact on the gut microbiome. More specifically, the unique macromolecules within the gut can modify microbial abundance and predicted functions. For example, a certain oil in the diet could result in higher microbial richness, however, this diversity may not alone be a predictor of better health outcomes (Abulizi et al., 2019). Dietary vitamin content and even receptors required for processing them are in part modulated by the microbiome. For example, vitamin D deficiency and downregulation of its affiliated receptor is associated with pathogenesis of various diseases and their restoration promotes healthy host-microbe homeostasis (Jin et al., 2015). It is also interesting to note that diet usually changes throughout the year as certain food items become available or absent depending on the season. An increased gut prevalence of Bacteroidetes, which can digest complex plant carbohydrates, could be explained by a diet consisting heavily of produce during a harvest season (Davenport et al., 2014). The composition and diversity of the gut microbiome can even be linked to personality traits. Those individuals with larger social networks have a more diverse gut microbiome, and those affected by stress and anxiety show an altered composition with reduced diversity (Johnson, 2020). The connection between the gut microbiome and mental states and behaviors will be discussed more in the section "Mental Health".

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Dysbiosis and Disease

The gastrointestinal mucosal immune system modulates and responds to the gut microbiome, where the resident members aid in its development and transient pathogens cause dysfunction, leading to various diseases (Shi et al., 2017). Inflammatory diseases such as systemic lupus erythematosus, rheumatoid arthritis, IBD, and ankylosing spondylitis are implicated in the impaired

interaction between the intestinal microbiota and mucosal immune system (Arbuckle et al., 2003, Mikuls et al., 2012, Costello et al., 2015). Microbial dysbiosis within these cases are marked by changes in composition and diversity of specific groups of organisms (Shi et al., 2017). So, the gut microbiome can not only serve as an indicator for such diseases, but may also eventually become a target for treatment, with maintaining proper homeostasis a major goal.

Gut microbiome dysbiosis, whether it causes a particular disease or manifests as a result of it, is quickly becoming the focus of many gastrointestinal illnesses. Specific members of the gut microbiome (e.g. bacteriome, mycobiome, virome) can even vary and be affected differently depending on the disease and its severity. For example, while much of the focus is usually on bacteria in the gut, it is important to not discount the contributions of other microorganisms like bacteriophages and fungi. The gut phageome can vary in diversity, complexion, and in so has been shown to contribute to diseases like IBD, malnutrition, and AIDS (Norman et al., 2015, Reyes et al., 2015, Monaco et al., 2016, Shkoporov and Hill, 2019). Similarly, the gut mycobiome has shown to have roles in IBD, colorectal cancer, and even neurological diseases (Forbes et al., 2019, Gu et al., 2019, Qin et al., 2021). Though, it is likely the complex interactions between all members of the gut microbiome with the host undoubtedly play a role in various degrees for the progression of gastrointestinal and other diseases.

Those with Inflammatory Bowel Disease (IBD) experience substantial fluctuations in the gut microbiome, which is implicated due to signs and symptoms of the disease state, diet, as well as increased medication during flare ups (Walters et al., 2014, Halfvarson et al., 2017). IBD is a blanket term for two disorders, ulcerative colitis and Crohn's disease, which are characterized by chronic inflammation of the gastrointestinal tract and commonly results in frequent diarrhea, abdominal pain, bloody stool, weight loss, and fatigue. It is likely that the gut microbiome plays both a role in the development of these conditions and is affected by the induced changes. The gut virome component responds to disease-induced environmental change of IBD patients by shifting from virulent to temperate bacteriophage core, which subsequently affects the bacteriome and dysbiosis condition (Clooney et al., 2019). A familial study of patients with Crohn's disease showed an increase in the number of pathogenic bacteria, and a decrease in beneficial bacteria. In particular, three potentially pathogenic biofilm-forming species from both the bacteriome (*Serratia marcescens* and *Escherichia coli*) and mycobiome (*Candida tropicalis*) interact with each other and impact the host immune system by increasing levels of proinflammatory cytokines and mucolytic enzymes which cause oxidative and tissue damage (Hoarau et al., 2016).

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Diabetes mellitus is another disease in which its progression is partially in response to gut microbiome dysbiosis. While there are other factors that play into diabetes such as culture, genetics, age, lifestyle, etc., this can be interlinked with an individual's microbiome. Studies over both type 1 and type 2 diabetes have shown that a change in the gastrointestinal microbial ecology is associated with diabetic subjects as compared with their healthy counterparts (Giongo et al., 2010, Larsen et al., 2010, Musso et al., 2011, Sohail et al., 2017). Type 1 diabetes stems from destruction of pancreatic beta cells, which results in decreased insulin production and elevated blood glucose levels. The gut microbiome may contribute to the disease by dysbiosis-associated immune regulation causing destruction of the beta cells and/or gut leakiness, endotoxemia, and chronic low-grade inflammation associated with certain enteric microbes (Cani et al., 2007, Lee et al., 2011, McDermott and Huffnagle, 2014, Sohail et al., 2017). Type 2 diabetes is characterized by the body's improper regulation and secretion of insulin and is associated by hyperglycemia. Physiological changes in the GI tract could be induced by dysbiosis in the gut microbiome leading to gut permeability and insulin resistance (Everard and Cani, 2013). In general, the gut microbiota composition is less in terms of diversity and richness for those with type 2 diabetes, though an increase in abundance of certain groups like *Bifidobacterium* could improve conditions associated with pathogenesis (Cani et al., 2007, Sohail et al., 2017). It seems that an alteration of the microbial gut profile has considerable effects on host metabolism, gastrointestinal physiology, gut fermentation capabilities, and immunity which can have many other downstream implications (Boulange et al., 2016).

Obesity is commonly associated with type 2 diabetes as well as other comorbidities that are linked to gut microbiome dysbiosis. As mentioned earlier, diet strongly affects the composition and function of the gut microbial community and subsequently impacts the host's metabolic capabilities. In fact, a high-fat/calorie or improper diet that results in dysbiosis is evident earlier than the signs of the host's metabolic abnormalities, and so gut microbiome dysbiosis may be the principle ingredient responsible

for the progression of obesity and type 2 diabetes (Nagpal et al., 2018). A high-sugar diet seems to promote an abundance of *Mollicutes*, a class within Firmicutes, which in turn suppresses Bacteroidetes (Turnbaugh et al., 2008), and this higher ratio of Firmicutes/Bacteroidetes has been proposed as a biomarker and hallmark indicator for obesity (de Bandt et al., 2011, Zou et al., 2020). However, it is important to consider other factors such as physical activity and medication that could cause a variation in diversity of the gut microbiome, as this ratio does not always definitively denote obesity (Magne et al., 2020). Though, there are similarities between many of the microbiome-linked contributing factors of pathogenesis progression for diet-induced diseases. For example, a high-fat diet induces increased gut permeability that allows exogenously produced bacterial compounds (e.g. lipopolysaccharides) to diffuse through the intestinal barrier, which then can interact with immune cells and lead to inflammation (Cani et al., 2007, Nagpal and Yadav, 2017). However, diet isn't the sole factor that can promote gut leakiness, and it seems that obesity in general causes an altered gastrointestinal state (Nagpal et al., 2018).

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Chemotherapeutic Intervention and C. diff

Medication and antimicrobial drugs can also have drastic effects on the gut microbiome that invoke risk of secondary infections, allergies, and other diseases like obesity (Becattini et al., 2016). Though many of these prescribed treatments are necessary to combat infectious diseases, the aftermath may have more serious consequences. Not only does antimicrobial therapy disrupt the resident microbiome, but misuse, suboptimal dosing, and patient noncompliance can create conditions conducive to fostering antimicrobial resistance through selective pressure.

Clostridioides difficile (commonly called C. diff) infections are directly associated with antibiotic-induced dysbiosis in the gastrointestinal tract. *C. difficile* is part of the normal microbiota, however, as an opportunistic pathogen it can invade or colonize empty niches brought about by dysbiosis and cause potentially fatal episodes of pseudomembranous colitis, which is associated with abdominal cramping, pain, sepsis, and bouts of diarrhea (Kho and Lal, 2018). Infection and transmission of this organism has been well known for its prevalence in hospital settings, primarily affecting the elderly and immunocompromised, however, community-associated infections have recently increased in what was once considered low-risk populations (Rouphael et al., 2008, Baker et al., 2010, Hensgens et al., 2012, Benson et al., 2015, Johanesen et al., 2015). It is also alarming that this organism has resistance mechanisms to many commonly prescribed antimicrobials, including β-lactams, aminoglycosides, lincomycin, tetracyclines, and erythromycin (George et al., 1978), and more recently 'hypervirulent' strains have developed resistance to fluoroquinolones (He et al., 2013, Johanesen et al., 2015). *C. difficile* infections have an enrichment of fungi that associate with the bacteriome and perhaps antifungal therapy could help improve treatment success if administered in conjunction with specific antibacterial drugs (Stewart et al., 2019). Though, these infections can have lingering impacts on the gut microbiome, as further antimicrobial therapy that is usually required can perpetuate the situation. The inflammation as a result of the disease induces the production of antimicrobial peptides by epithelial cells and neutrophils which inhibit the growth of the natural resident commensal microbes (Leber et al., 2015).

While many events of gut dysbiosis are directly linked to the chemotherapeutic effects on microbes since they are prescribed to target microbes responsible for the infection, some medications which are meant to address other diseases, like antidepressants for mental health, have undesired effects on the microbiome (Maier and Typas, 2017). In the cases of multi-drug combinations (e.g. non-steroidal anti-inflammatory drugs (NSAIDs), antidepressants, laxatives, proton-pump inhibitors (PPIs), etc.), it is not the number of drugs that affect gut microbiome diversity, but rather the types of drugs (Rogers and Aronoff, 2016). Though these scenarios become complicated as it is difficult to ascertain whether the alterations observed on the microbiome are from the drug's mechanism of action, a downstream side effect, or originate from the condition that is being treated, and it is likely a complex combination of all factors for each disease and medication (Rogers and Aronoff, 2016, Maier and Typas, 2017, Jackson et al., 2018).

Fecal Microbiota Transplant

Although pharmaceutical drugs are of dire importance to treat various diseases, whether they are infectious in nature or not, other avenues must be pursued for those that may benefit from restoration of the gut microbiome. Probiotics and fecal microbiota transplant (FMT) can serve as viable options for the prevention and treatment of gut microbiome dysbiosis. Probiotics are considered foodstuffs with microorganisms, usually bacteria (many being lactic acid bacteria) and yeast, and their byproducts that have a beneficial effect on human health when introduced into the body. Many probiotics are commercially available to consumers in the forms of products like yogurt, kefir, buttermilk, sauerkraut, pickles, premade vitamin supplements and many others (more information about probiotics and fermented foods can be found in the section "Food and Fermentation: Your Microbiome is What you Eat"). Specifically, probiotics can be used for the treatment and prevention of many of the aforementioned gut microbiome dysbiosis-associated diseases, especially those induced by antibiotics (Kim et al., 2019). The beneficial microbes outcompete pathogens for resources or prevent them from establishing a niche in which to grow (Ouwehand et al., 1999).

In more extreme cases of gut microbiome dysfunction and disease, like those from *C. difficile* infection (CDI) in which antibiotics are ineffective and can potentially exacerbate the problem, other measures must be taken. Fecal microbiota transplant therapy takes a stool sample containing the gut microbiome from a healthy donor and relocates it into the infected patient's colon. The introduced microbiota then helps move the gut microbiome towards homeostasis by restoring the structure of beneficial microbes and metabolites (Fujimoto et al., 2021). This procedure is usually reserved for those patients with recurrent CDI and has shown to be highly successful and is considered safer and more effective than prolonged antibiotic usage (Mattila et al., 2012, Cammarota et al., 2015), though is also being investigated for first-line treatment of CDI (Camacho-Ortiz et al., 2017). FMT has gained traction for its success and is being further considered as a therapeutic option in other treatment protocols, such as those for cancer patients undergoing cancer immunotherapy to help improve response or manage toxicity (McQuade et al., 2020), and individuals undergoing allogenic hematopoietic stem cell transplant for hematological disorders that experience graft-versus-host disease complications from it (Zhang et al., 2021). However, precautions must be taken for FMT, as the donor's sample could potentially harbor other pathogenic microbes, like multi-drug resistant *Escherichia coli*, that can result in pathogenesis, further complications, and even death for the recipient (DeFilipp et al., 2019, Martinez-Gili et al., 2020). More comprehensive research and FMT trials must be performed in order to optimize this procedure to better match donors with recipients and to further understand the exact mechanisms of microbiome rehabilitation.

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Conclusion

Gut microbiome intervention may be the key to future treatments of diseases associated with dysbiosis like IBD, diabetes, obesity, colorectal cancer, etc., and offers a viable alternative to many traditional pharmaceutical interventions. Though, the gut microbiome is plastic and continually changes with its host's environment and lifestyle, so stabilization is constant work. Additionally, creating an ideal 'cocktail' of microbes that will maintain homeostasis when implemented can be challenge. While there are general members of the gut microbiome that exist at a constant level and show some correlation to normal health, there

may not be a true 'standard' gut microbiome due to the vast differences between people across the world. So, this type of therapy may require a more unique and individualized approach that depends on the disease and characteristics of both the host and their microbiome.

Check Your Understanding

- What factors influence the composition of the gut microbiome?
- How is gut microbiome dysbiosis brought about?
- What diseases are associated with gut microbiome dysbiosis? Are features of pathogenesis always a cause or effect of these events? Explain.
- Explain the treatment options that are available for gut microbiome dysbiosis.

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16.1.3.3: The Oral Microbiome

The Oral Microbiome

The oral microbiome as with other site-specific microbiomes on and inside the human body is very distinct for each individual and its makeup and function is reflective of a variety of factors. Even within the context of the oral cavity, there are several unique niches with their own microbial ecosystem, including saliva, tongue, teeth, gingiva, throat, tonsils, and others. Each of these habitats exhibit diverse and complex interactions between bacteria, archaea, fungi, viruses, and protozoa, where dysfunction can lead to a number diseases, both rare and common (Wade, 2013, Sampaio-Maia et al., 2016).

Factors Affecting Composition

The composition of the oral microbiome and its respective niches is inherently dependent on host genetics, but other factors and habits such diet and smoking have a substantial effect on diversity. Members of the oral cavity demonstrate more heritability than the gut microbiome, and higher abundances of certain heritable organisms, such as *Prevotella pallens,* are associated with a lack of dental caries, while on the other hand, *Streptococcus mutans* and *Lactobacillus* species are linked to cavities (Davenport, 2017, Xiao et al., 2018). Detection of the specific groups of microbes has traditionally been difficult since many are fastidious and cannot be cultivated. So other techniques like metagenomics, metatranscriptomics, and proteomics have been implemented to better characterize the microorganisms present and their respective roles (Parahitiyawa et al., 2010, Grassl et al., 2016). These studies have found that the oral microbiota is quite different even between healthy individuals, and so it may be the microbial functionality that is more important in the progression of various diseases, such as the role of biofilm formation, plaque buildup, and sugar metabolism in the development of dental caries (Segata et al., 2012, Takahashi et al., 2010, Duran-Pinedo and Frias-Lopez, 2015, Sato et al., 2015, Davenport, 2017).

Dysbiosis and Disease

The oral cavity is such a dynamic location that constantly experiences a variety of different foods, drinks, oral hygiene products, and other environmental stimuli with each composed of a multitude of macromolecules, compounds, and potentially other microorganisms, and so it makes sense that its microbiome often fluctuates in diversity (Parahitiyawa et al., 2010). Though there are differences in composition between individuals, specific sites, and over periods of time, species such as *Streptococcus mitis* and *Granulicatella adiacens* are conserved and generally present throughout the oral microbiome, while the presence of other specific microbes are associated with a particular disease (Aas et al., 2005). However, diseases like Periodontitis, which is the chronic inflammation of the gums and tooth supporting structures and one of the most common oral diseases, has many organisms associated with the condition, so discerning which ones are primarily responsible is a complex task. There are a variety of viruses that cause oral-related conditions, such as the Human papilloma virus (HPV) which is known for causing lesions and warts in the mouth, as well as head and neck squamous cell carcinoma (Kumaraswamy and Vidhya, 2011). An increase of the protozoa *Entamoeba gingivalis* and *Trichomonas tenax* are observed in patients with gingival disease, but are not the causative agents, rather just taking advantage of the increased food sources (bacteria and food debris) from poor hygiene (Wantland et al., 1958). There is also a variety of fungi present in the oral cavity with *Candida* species being the most common, and many of the members in the oral mycobiome are responsible for chronic diseases, however correlation isn't exactly clear (Ghannoum et al., 2010). Archaea, primarily methanogens, are also present in the oral microbiome, and while there aren't technically any known pathogens in this domain, there is an increase in abundance observed in patients with periodontitis (Lepp et al., 2004, Mattarazo et al., 2011, Wade, 2013, Willis and Gabaldon, 2020).

Generally, the oral microbiome is linked with aspects oral health and has primary implications in dental and periodontal diseases, however it can contribute to vitality and diseases in other parts of the body such as cardiovascular disease, stroke, Alzheimer's disease, cystic fibrosis, rheumatoid arthritis, diabetes, pneumonia, and preterm birth (Seymour et al., 2007, Duran-Pinedo and Frias-Lopez, 2015, Kori et al., 2020, Willis and Gabaldon, 2020). Additionally, the oral microbiome is implicated in various forms of cancer including esophageal, pancreatic, gastric, liver, colorectal, and oral (Willis and Gabaldon, 2020, Bakhti et al., 2021, Mohammed et al., 2021). In many of these types of cancers the Gram-negative anaerobe, *Fusobacterium nucleatum,* is a primary culprit as it can promote cancer by activation of cell proliferation, promotion of cellular invasion, induction of chronic inflammation and immune evasion (Al-hebshi et al., 2017, McIlvanna et al., 2021). Another contributing factor to cancer development is the use of tobacco products which cause oral microbiome dysbiosis (Al-habshi et al., 2017, Gopinath et al., 2021, Sajid et al., 2021). As with other microbiomes, deviation from the normal composition can result in altered function and

progression of disease.

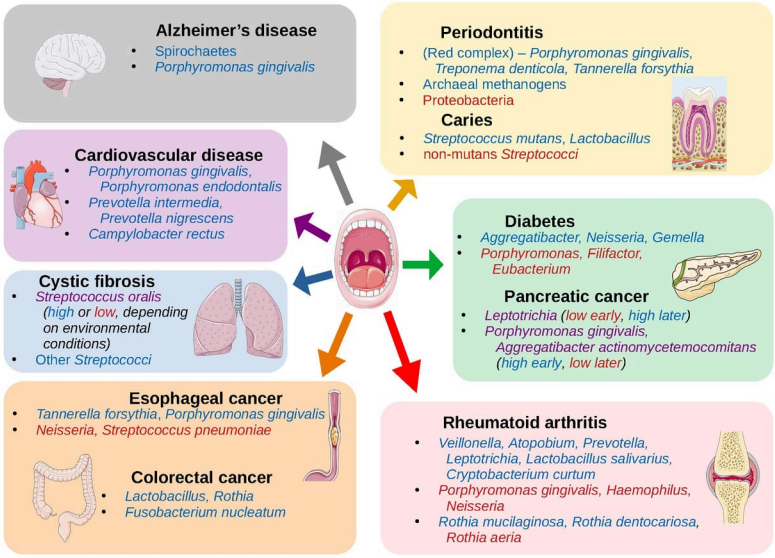


Figure 1. Oral and systemic diseases associated with the oral microbiome. A representation of the associations found between diseases with increases or decreases of the abundances of organisms in the oral cavity. Organisms listed in blue have been shown to be increased in abundance in the oral cavity in individuals presenting with the noted disease, and organisms listed in red have been shown to be decreased. Those in purple may be either increased or decreased depending on the conditions or progression of the disease. (Willis and Gabaldon, 2020).

Disease	Associated Organisms	Inhibited Organisms
Periodontitis	Phyla: Spirochaetes, Synergistetes and Bacteroidetes Classes: Clostridia, Negativicutes and Erysipelotrichia Genera: *Prevotella, Fusobacterium* Species: *Porphyromonas gingivalis, Treponema denticola, Tannerella forsythia, Filifactor alocis, Parvimonas micra, Aggregatibacter actinomycetemcomitans* Archaea: *Methanobrevibacter oralis, Methanobacterium curvum/congolense*, and *Methanosarcina mazeii*	Phyla: Proteobacteria Classes: Bacilli Genera: *Streptococcus, Actinomyces, Granulicatella*
Dental caries	Genera: *Neisseria, Selenomonas, Propionibacterium* Species: *Streptococcus mutans, Lactobacillus* spp. Fungi: *Candida albicans*	Species: non-mutans *Streptococci, Corynebacterium matruchotii, Capnocytophaga gingivalis, Eubacterium IR009, Campylobacter rectus, Lachnospiraceae sp. C1*
Oral cancer	Species: *Capnocytophaga gingivalis, Prevotella melaninogenica* and *Streptococcus mitis, Peptostreptococcus stomatis*, Streptococcus salivarius*, Streptococcus gordonii*, Gemella haemolysans*, Gemella morbillorum*, Johnsonella ignava* and Streptococcus parasanguinis I**	Species: *Granulicatella adiacens**
Esophageal cancer	Species: *Tannerella forsythia, Porphyromonas gingivalis*	Genera: *Neisseria* Species: *Streptococcus pneumoniae*

Figure 2. Examples of metagenomic studies of associations between the oral microbiome and oral diseases. The first column indicates a disease, the second indicates organisms that have been found at higher abundances in individuals presenting with the disease, and the third indicates organisms at lower abundances. (*) indicates taxa associated with oral cancer from a study in which samples were from tumor and non-tumor sites in the same patients and disease treatment is not specified. References: Matarazzo et al., 2011, Lepp et al., 2004, Vartoukian et al, 2009, Griffen et al., 2012, Costalonga and Herzberg, 2014, Liu et al., 2012, Jorth et al., 2014, Haubek, 2010, Koo and Bowen, 2014, Gross et al., 2010, Wang and Ganly, 2014, Pushalkar et al., 2012, Mager et al., 2005, Peters et al., 2017, Willis and Gabaldon, 2020.

Saliva

Saliva is an important component in maintaining homeostasis in the oral cavity, as it lubricates food, initiates the digestive process, and defends against bacteria. Disruption in secretion can lead to changes in the oral microbiome which promotes progression of oral and other diseases (Grassl et al., 2016). Since saliva contacts virtually all surfaces within the oral cavity it is involved with all other duties of the mouth, and adaptive and innate immune defense mechanisms can be considered the most important in terms of microbiological clinical relevance. The protein and gycoprotein content regulates the oral microbiome by

promoting the colonization of commensal microbiota while helping eliminate pathogenic microbes (Cross and Ruhl, 2018). These macromolecules aid in bacterial adhesion and biofilm formation so that they aren't dislodged by salivary flow and other oral physiological processes (Mandel, 1987). The establishment of beneficial microbes prevents pathogenic bacteria from gaining a foothold, and the agglutinins found in saliva aid in removal through binding and then swallowing (Scannapieco, 1994). The co-evolution of the microbiota and humans has cultivated the development of specific bacterial adhesins for colonization of the preferred microorganisms, thus establishing a mutualism, though pathogenic microbes are quick to adapt to changing binding motifs (Springer and Gagneux, 2013, Cross and Ruhl, 2018).

Saliva can harbor numerous microbes, with one milliliter containing approximately one hundred million microbial cells (Marsh et al., 2015) and over 600 different species (Dewhirst et al., 2020, Willis and Gabaldon, 2020). In one study, the prominent genera found across various types of saliva samples (i.e. spit, drool, and oral rinse) from healthy individuals were *Streptococcus* (17.5%), *Prevotella* (15.5%), *Veillonella* (15.3%), *Neisseria* (12.7%) and *Haemophilus* (10%) (Lim et al., 2017). Though it can be difficult to differentiate a core salivary microbiota from other specific oral niches since it coats the oral cavity.

For those suffering from various diseases, the relative abundance of certain microorganisms and general composition of the oral microbiota is altered as compared to healthy controls. For example, patients suffering from chronic obstructive pulmonary disease (COPD) and periodontitis have varying abundances of *Veillonella, Rothia, Actinomyces*, and *Fusobacterium* in saliva samples (Lin et al., 2020). Periodontitis and COPD are comorbid diseases that are commonly associated with other conditions like rheumatoid arthritis, diabetes mellitus, and cardiovascular diseases (Scher et al., 2014, Wang et al., 2014, Chrysanthakopoulos and Chrysanthakopoulos, 2014, Lin et al., 2020). Dysfunction of bacterial ecology in saliva is exacerbated by COPD and periodontitis, and so restoration of the salivary microbiota may treat or reduce the severity of these diseases and their comorbidities (Jeffcoat et al., 2014, Zhou et al., 2014, Lin et al., 2020).

Alterations of the salivary microbiome are also associated with certain human viral infections like the herpes virus, influenza, and SARS-CoV (Blostein et al., 2021, Miller et al., 2021). Saliva generally is beneficial to oral health, though changes in it's makeup could be detrimental and further aggravate disease. For instance, the saliva microbiota and their byproducts could be responsible for increased susceptibility of infection of gum tissues with herpes simplex virus 1, especially in individuals with periodontitis lesions (Zuo et al., 2019). Eukaryotic viruses can also directly interact with oral bacteria and affect disease severity, as is the case with streptococci and influenza which results in an increased viral load (Kamio et al., 2015). Similarly, among patients with COVID-19 there are differences in the salivary bacterial community based on SARS-CoV-2 viral load, though the exact dynamics and repercussions of the interaction isn't yet well understood. It is possible that COVID-19-induced inflammation could directly impact the oral microbiome and contribute to other diseases connected with dysbiosis (Miller et al., 2021).

Dysbiosis of the fungal component in the salivary microbiome also contributes to overall oral microbial community changes and detrimental effects to the human host. The mycobiome is an important constituent of the oral microbiome though its member's abundance is much less than that of the bacteriome. There are two main genera in the salivary mycobiome: *Candida* and *Malassezia*, where the former is associated with dental plaque bacteria, carbohydrate-rich microbial communities, and acidic pH conditions which contribute to dental caries (Hong et al., 2020). Other interactions between the mycobiome and bacteriome in saliva has been observed in the chronic inflammatory disease oral lichen planus (OLP). OLP causes swelling, discoloration, and open sores of the mucosal membranes in the oral cavity, primarily affecting the buccal region (cheek), but the lips, gingiva, and tongue may also be affected. Similar to plaque buildup and cavity formation, this disease is characterized by an increased abundance of genera *Candida,* but also *Aspergillus*, as well as a decrease in biodiversity (Li et al., 2019).

While diversity and abundance of specific groups within the salivary microbiome are associated with various diseases, it is important to consider other factors like diet, lifestyle habits, and genetics that can influence the progression of any particular disease.

Teeth, Plaque, and Cavities

Plaque formation occurs when a multispecies biofilm builds layers on the surface of teeth over time. This structure not only contains a variety of microbes, some of which are pathogenic, but proteins, carbohydrates, minerals, antimicrobial peptides and other compounds that dictate its structure and activity (Amerongen and Veerman, 2002, Flemmig and Beikler, 2011, Zarco et al., 2011). For normal healthy individuals, plaque biofilms are important in maintaining oral homeostasis and good tooth conditions as they can trap pathogens or prevent them from thriving due to competitive inhibition. However, regular detachment of these biofilms through oral hygiene and salivary flow are necessary to prevent pathogen establishment and their escape from immune responses and antimicrobial therapy (Avila et al., 2009, Filoche et al., 2009, Van Essche et al., 2010, Flemmig and Beikler, 2011, Zarco et al., 2011).

The persistence of oral biofilms contributes directly to cavity formation as carbohydrate-fermenting microbes within produce acidic byproducts which lower oral pH and damage tooth enamel (Selwitz et al., 2007, Ling et al., 2010). Cavities form once the surface layers of the tooth wear away and lesions form in the dentin, resulting in oral pain, tooth decay and loss (Selwitz et al., 2007, Zarco et al., 2011). Dental caries are the most prevalent disease for children worldwide, and dental care is the most common unmet need among children in the United States (Loesche and Grenier, 1976, Acs et al., 1999, Low et al., 1999, Peterson et al., 2013).

The fastidious nature of several members of plaque polymicrobial communities have made it traditionally difficult to characterize an exact consortium responsible for dental caries, however, recent studies using NGS technologies have detailed a few signature genera. *Streptococcus mutans* and *Lactobacilli* spp. are the primary culprits, but other genera such as *Fusobacterium*, *Bifidobacterium*, and *Actinomyces* are found in high abundance in people with cavities (Munson et al., 2004, Chhour et al., 2005, Corby et al., 2005, Peterson et al., 2013). The fungal yeast, *Candida albicans,* is also found regularly in children with severe early childhood caries (S-ECC) (Xiao et al., 2018). Interestingly, other members of *Streptococcus* including *S. parasanguinis, S. mitis, S. oralis*, and *S. sanguinis* are associated with individuals exhibiting good dental health (Corby et al., 2005, Peterson et al., 2013). Overall, during the progression of caries there is a reduction in species diversity in these communities (Peterson et al., 2013).

Gingivae and Periodontitis

Aside from dental caries, periodontitis, a.k.a. 'gum disease', is the other most common oral disease in humans, and it also results from alterations in oral microbial ecology. This inflammatory condition affects the supporting structures surrounding the teeth where the microbial communities that inhabit the subgingival area serve to trigger its onset (Hajishengallis and Lamont, 2012, Hong et al., 2015). Though progression of the disease comes in episodes, the continual breakdown of periodontium tissue (gingiva, periodontal ligament, cementum, and alveolar bone) leads to alveolar bone breakdown, formation of pocket lesions, and tooth loss (Listgarten, 1986). This condition is very difficult treat as specific antibiotics must be administered, though they are often unsuccessful as pathogens can hide in plaque, develop resistance, and quickly recolonize through reserves in the mucous membranes of the oral cavity. Once pockets form in the periodontium, periodontitis becomes irreversible, as the tissues are unable to reattach to the bone and the pathogens within cannot be completely eradicated or removed (Pihlstrom et al., 2005, Horz and Conrads, 2007, Van Essche et al., 2011, Zarco et al., 2011).

Culture-based studies have shown that periodontitis is associated with varying levels of abundance of three bacterial species: *Porphyromonas gingivalis*, *Tannerella forsythia* and *Treponema denticola,* which are collective referred to as the 'red complex' (Socransky et al., 1998, Rocas et al., 2001, Socransky and Hafajee, 2005, Teles et al., 2010). More recent genetic analysis has revealed other bacteria associated with the disease, including those from the classes Clostridia, Negativicutes, and Erysipelotrichia; the genera *Synergistes*, *Prevotella*, and *Fusobacterium*; and the species *Filifactor alocis* (Vartoukian et al, 2009, Griffen et al., 2012, Costalonga and Herzberg, 2014, Willis and Gabaldon, 2020). Some methanogenic archaeal species have even been implicated in the disease, and perhaps serve a metabolic role as a 'hydrogen sink' for secondary fermenters (Lepp et al., 2004, Matarazzo et al., 2011). Viruses, both eukaryotic and bacteriophages, are also thought to play a part in the etiology of periodontitis. While bacteriophages manage biofilm formation through bacterial predation, the role of eukaryotic viruses found in the oral cavity such as those in the Herpesvirus family, is more enigmatic (Martinez et al., 2021). The protist *Trichomonas tenax* is frequently found in patients with severe periodontitis, though it is not known if its presence is a cause or a result of the disease (Benabdelkader et al., 2019. It is generally thought that this condition arises from events of dysbiosis causing an increase in community diversity and richness which then alters antagonistic/synergistic relationships, metabolic functions, and the oral environment (Kolenbrander et al., 2006, Shi et al., 2015, Ng et al., 2021). Those bacteria that may be absent or inhibited during dysbiosis conditions, and are associated with good periodontal health include those from the phylum Proteobacteria and the Firmicutes, class Bacilli, and the genera *Streptococcus*, *Actinomyces*, and *Granulicatella* (Griffen et al., 2012, Liu et al., 2012, Willis and Gabaldon, 2020).

Periodontitis resulting from oral microbiome dysbiosis has been linked to other diseases like chronic kidney disease, as well as several types of cancers including oral, esophageal, gastric, lung, pancreatic, prostate, hematologic, and breast (Fitzpatrick and Katz, 2010, Ioanndiou and Swede, 2011, Michaud et al., 2017). These associations stemming from the oral cavity could be due to dysbiosis-induced microbiome changes and recruitment of disease causing pathogens, production of harmful microbial-derived byproducts, and/or modulation of the immune system causing an increase in proinflammatory cytokines (Abnet et al., 2005, Kurkivuori et al., 2007, Chalabi et al., 2008, Meurman, 2010, Willis and Gabaldon, 2020). In reality, there are likely a multitude of factors and interactions between microbial communities and the host that lead to the progression of these diseases, however, it is still important to determine certain organismal signatures or functions that could indicate a condition and perhaps aid in diagnosis or treatment.

YouTube Video

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Tongue

The tongue is another niche for a variety of microbial communities, and though it is a maneuverable oral centerpiece that comes into contact with the rest of the cavity, it has its own unique makeup of microbes. The tongue microbiome serves as an ideal model to analyze changing microbial consortia and understand microbial community dynamics. By employing a novel computational method known as oligotyping, which relies on identifying certain nucleotide content of genetic sequences, a better resolution of microbial taxonomic distribution can be achieved (Eren et al., 2014, Welch et al., 2014, Wilbert et al., 2020). As expected, the tongue experiences large fluctuations in relative abundance across taxa, but this isn't completely explained by obvious human behavior such as oral hygiene and food/liquid intake. The complex microbial organization that is observed is likely a combination of many factors, like other microbiomes, such as host immunity, physiology influenced by circadian rhythm, epithelial cell renewal, other microbial (e.g. bacteriophage) interactions, as well as certain host behaviors and lifestyles (Welch et al., 2014, Wilbert et al., 2020).

The changing microbiome of the tongue can also be linked to various diseases and conditions in both the oral cavity and throughout the rest of the body. Viewing the tongue for diagnosis isn't a novel approach either, as traditional Chinese medical practices have viewed tongue phenotypes to discern various illnesses for thousands of years, and currently physical aspects of the tongue are being connected with its microbiome composition to better diagnosis certain diseases like oral, liver, gastric, colorectal, and pancreatic head cancers (Jiang et al., 2012, Han et al., 2014, Mukherjee et al., 2017, Cui et al., 2019 Lu et al., 2019, Mohammed et al., 2021). It is also interesting that members of the tongue microbiome can help regulate blood pressure and cardiovascular health through metabolism of dietary nitrate, and oral hygiene (e.g. tongue cleaning) can help promote the growth of these beneficial organisms (Tribble et al., 2019). While good habits like proper oral hygiene can cultivate a healthy oral microbiome and improve overall health, bad habits like smoking negatively affect microbial communities which contributes to various diseases. For example, metagenomic analysis investigating bacterial species and their gene content showed significant differences of certain species, strains, and metabolic pathways within the tongue microbiome between smokers and never smokers (Sato et al., 2020). This further demonstrates the usefulness of tongue microbiome analysis as a reliable technique to explore and diagnosis certain diseases and conditions.

Conclusion

Though not as well characterized as the gut microbiome, the oral microbiome has a significant impact on human health. Within the oral cavity, specific niche microbiomes of saliva, teeth, gums, and tongue are each compositionally unique and implicated in various conditions and diseases. Moreover still, other oral niches like the buccal mucosa, palate, pharynx, and tonsils not detailed here are distinctive and have certain associated diseases initiated with respective microbiome dysbiosis (Gao et al., 2014, Fukui et al., 2018, van der Meulen et al., 2018). Areas within the oral microbiome may eventually become routine sites for medical observation since samples are easily acquired, especially saliva, and microbial analysis can serve as a fast and reliable option for diagnosis and potential treatment of oral disorders as well as other diseases.

As the oral cavity is the initial point of contact and entrance for foreign microbial loads into the body, oral disease and its associated microbial ecology appear to serve as a conduit for a multitude of other diseases. In a sense the oral microbiome can be considered a precursor to the gut and lung microbiomes, as microbes are undoubtedly mixed with food, drink, and air before being swallowed or inhaled and taken further into the respective system. It is therefore important to understand and better characterize the oral microbiome so that medical diagnosis and intervention can be improved. However, with vast differences in microbial community diversity and composition between humans across the word, this will be quite the challenge to determine normalized healthy consortia respective to people of various geographic regions, ages, lifestlyes, etc.

Hotspot Quiz

Query 16.1.3.3.1

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Check Your Understanding

- What aspects of the oral microbiome allow for the formation of unique niches?
- How does dysbiosis within the oral microbiome contribute to certain diseases? (What aspects of changes in microbial community diversity and richness could cause oral and other diseases?)
- Why may saliva sampling be considered a viable option for diagnosis of oral and other diseases?
- How do oral biofilms contribute to cavity formation and tooth decay?
- Why are microbial infections associated with periodontitis hard to treat?
- How do certain lifestyles influence various niches of the oral microbiome and lead to disease?

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16.1.3.4: The Skin Microbiome

The Skin Microbiome

The microorganisms that inhabit the largest human organ are important in a variety of ways in regard to host health. The skin microbiome defends against pathogens, educates the immune system, helps wound healing, and moderates progression of diseases, and in return receives nutrients and real estate for colonization, creating a symbiotic establishment (Byrd et al., 2018). As the primary external interface to the environment, the skin serves as the initial physical barrier against invasion of potential pathogens. The territory of the skin itself is harsh for most microbes; its cool, acidic, dry, and considered nutrient poor, and so only those organisms that have adapted to these conditions can successfully colonize it. A majority of these microbes rely on obtaining nutrients from sweat, sebum, and dead skin cells by using proteases and lipases to break apart various compounds to liberate usable resources (Byrd et al., 2018). Though, there are adverse conditions and a general lack of food for microbes on the skin, there is still quite a diverse community which is unique to certain individuals and body locations.

Better characterization of the skin microbiome and its site-specific diversity can allow for greater understanding of skin diseases such as atopic dermatitis, acne, rosacea, and psoriasis that are associated with dysbiosis (Grice and Segre, 2011). The role of resident and transient microorganisms are important in the onset and progression of these types of diseases, and their study may help in diagnosis and treatment protocols.

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Composition and Stability

Within a single square centimeter on the skin there can be up to one billion microorganisms, and this mixed community of bacteria, viruses, protozoa, fungi, and mites can be both good and bad for host health (Grice and Segre, 2011, Weyrich et al., 2015). Overall, there are four main bacterial phyla that constitute the human skin microbiome: Actinobacteria, Firmicutes, Proteobacteria, and Bacteroidetes (in descending order of abundance) (Grice et al., 2009). Microbial composition primarily depends on the specific location of skin site, and particularly whether it is dry, moist, or sebaceous (i.e. oily). Moist areas like the bend of the elbow or the feet harbor bacteria like *Staphylococcus* or *Corynebacterium* species and tend to have higher species diversity, while sebaceous locations promote the growth of *Propionibacterium* species and are lower in diversity (Grice et al., 2009, Oh et al., 2016, Byrd et al., 2018).

The composition of fungi on the skin also depends on location and physiological properties. Fungal members of the skin microbiome primarily consist of species from the genus *Malassezia*, with some from *Penicillium* and *Aspergillus,* and less of a few other genera. Specifically, the community of fungi on the feet have a high amount of diversity and it tends to change more over time as compared with other locations on the body. This may be due to environmental exposure, sock and shoe usage, or the fact that specific sites like plantar heels, toe webs and toenails are commonly infected by fungal pathogens, which can be difficult to treat. (Findley et al., 2013).

Small arthropods less than half a millimeter also colonize the skin and makeup part of the microbiota. Two species of mites from the genus *Demodex* utilize lipids produced in the sebaceous regions of the skin; the larger species *D. folliculorum* tends to cluster around hair follicles while the smaller *D. brevis* situated near the eyelid rim is more antisocial (Schommer and Gallo, 2013). These lipid-eating mites normally have a symbiotic relationship with humans, however, they could potentially serve as mechanical vectors for transport of pathogenic bacteria, and their population buildup and/or associated events of dysbiosis could promote inflammatory reactions (Lacey et al., 2009, Lacey et al., 2011).

Eukaryotic viruses on the skin are primarily transient, exhibit lower site-specific affinity, and the most different from person to person. This is likely due to the fact that they are obligate intracellular pathogens with special constraints. Also, maybe as expected, various bacteriophage abundance in certain sites is dependent on the corresponding bacterial genera (Oh et al., 2016).

Microbial communities on the skin remain stable despite the constantly changing external environment that humans bring about. Over both short- and long-term time intervals, sebaceous sites are the most stable, and moist areas like the feet are the least stable. Interestingly, dry sites with high environmental contact and disruption, like the palms of hands, exhibit community stability over time (Oh et al., 2016). Though, variability and stability may be dependent on individual host habits and lifestyles. At an early age, however, there are drastic changes in the skin microbiome until it becomes established. At birth, the baby transitions from an essentially sterile environment in the womb, to open air and constant microbial exposure where initial colonization of the skin begins. The method of delivery also affects initial community composition on the skin. When a baby is born conventionally through the vaginal canal, the members of the skin microbiome reflect the vaginal microbiome, and if born via cesarean section, the infant's skin community more closely resembles that of the mother's skin (Dominguez-Bello et al., 2010). In the initial few months, the skin community predominately consists of *Streptococci* and *Staphylococci* bacteria, but as aging ensues the abundance of these genera decrease and diversity and numbers of others begins to increase and level out (Capone et al., 2011). This has long-term effects on health, as the evolution of an infant's skin microbiome helps to regulate and mature both the skin and immune system.

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Immune System Interaction

Exposure to potentially pathogenic microorganisms at a young age can help educate the immune system. Immediately after childbirth, initial skin colonization by microorganisms is allowed without the classical inflammatory response, though shortly after this period, these microbes promote the development of distinct components of the immune system for future pathogen encounters (PrabhuDas et al., 2011, Naik et al., 2012, Naik et al., 2015, Belkaid and Harrison, 2017). This has been observed in infant's skin microbiome and an early colonization of *Staphylococcus aureus* being associated with a lower risk of developing atopic dermatitis, as the immune system is prepared for this organism that can exacerbate and perpetuate the disease (Kennedy et al., 2017, Blicharz et al., 2019). S. *aureus* can further modulate the immune system through toxin production and colonization, which initiates leukocyte responses and stimulates the adaptive and innate immune systems (Niebuhr, et al., 2011, Nakamura et al., 2013, Nakatsuji et al., 2016). Skin colonization of *Staphylococcus epidermidis* elicits similar immune responses, and a pre-association with this microbe could help defend against certain fungal and parasitic skin infections (Naik et al., 2012, Naik et al., 2015). Further investigation of microbe and immune system interactions will help uncover exact molecular functions and relationships, which could have future implications in therapy and treatment of skin diseases (Byrd et al., 2018).

Pathogens, Dysbiosis, and Skin Diseases

The skin microbiome also contributes to human health and combating infectious diseases in a preventative measure. In addition to educating the immune system, the commensal microorganisms that call the epidermis home help to prevent pathogen invasion by physically taking up niches and secreting certain antimicrobial compounds. For example, S. *epidermidis,* which is a part of the normal microbial flora of the skin, produces antimicrobial peptides and proteases that selectively targets and inhibits growth of pathogens such as S. *aureus* (Cogen et al., 2010, Iwase et al., 2010, Schommer and Gallo, 2013).

Though many commensal microorganisms on the skin can help to prevent pathogen colonization, these microbes themselves may be opportunistic pathogens and can cause an infection when certain conditions arise. For example, S. *epidermidis* is a common cause of infections when transmitted from the skin into the body, usually through a medical procedure like catheterization (Otto,

2012). Staphylococci are known for their ability to form biofilms on medical devices, which make them more difficult to treat (Otto, 2009). The fungi, *Candida albicans*, is another normal skin resident that can cause opportunistic infections. It is though that disruption of the normal skin flora, such as antibiotic therapy, could induce virulence factor production by the yeast, resulting in penetration of epidermal tissue and a subsequent case of candidiasis (Kuhbacher et al., 2017). Other skin diseases associated with dysbiosis, or various skin pathogens, include atopic dermatitis, acne, rosacea, psoriasis, and chronic wound healing.

Atopic dermatitis (AD), the most common form of eczema, is a chronic inflammatory condition of the skin that is caused by a mutation in several genes, including the fillagrin gene responsible for encoding a protein that helps maintain epidermal health (Bierber, 2008). AD is characterized by itchy, dry rashes that become vulnerable to infection when the skin barrier is breached by constant scratching, and occurs more frequently in areas with low microbial diversity, such as the inside of the elbow or back of the knee (Weyrich et al., 2015). *S. aureus* colonization is directly related to disease severity of AD, as it produces virulence factors that disrupt the integrity of the skin barrier. There is also an increase in abundance of *S. epidermidis*, and *Clostridium* and *Serratia* species, and this increase of select species suggests that a lower amount of microbial diversity plays a role in the progression of AD (Kong et al., 2012, Oh et al., 2013, Williams and Gallo, 2015). Selectively targeting pathogens such as *S. aureus* for treatment of AD proves to be difficult as the normal microbiota also suffers resulting in dysbiosis.

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Psoriasis is similar to AD in that the disease results in inflamed, scaly skin plaques that are itchy and painful. This condition is also associated with altered microbial diversity, and there is an association with the development of psoriasis and oral streptococcal infections, though the connection is not exactly known (Norlind, 1955, Owen et al., 2000). Within psoriatic lesions, there is an increase Proteobacteria and Firmicutes, a decrease in Actinobacteria, and specifically a decrease within the genera *Propionibacterium* (Gao et al., 2008, Fahlen et al., 2012, Statnikov et al., 2013). Though there is a decrease in general of microbial diversity in psoriatic lesions, there hasn't been any specific microbial causative agent identified for the disease.

Rosacea is a common chronic dermatosis which primarily manifests as persisting erythema (redness), telangiectasia (dilated or broken blood vessels), bulging, swelling, and/or raised patches in superficial facial skin (Picardo and Ottaviani, 2014). Like other cutaneous diseases, development of rosacea is linked with skin microbiome composition, and how those communities influence skin immune responses. In particular, an increase in *Demodex* mite abundance and density is observed in those with rosacea. They potentially contribute to the disease state through immune system activation, damaging epithelial tissue, and/or the exposure of antigenic proteins of bacteria released from their digestive tract (Forton and Seys, 1993, Georgala et al., 2001, Lacey et al., 2007, Koller et al., 2011, Casas et al., 2012, Forton, 2012,). The induced reactions from microbiome shifts, genetics, and environmental factors then likely invoke other inflammatory triggers, which includes overgrowth of certain bacteria like *S. epidermidis* (Schommer and Gallo, 2013).

Acne (acne vulgaris) is a skin condition that results from hair follicles and sebaceous glands that are clogged with oil, bacteria, and dead skin cells, which creates whiteheads and blackheads. *Propionibacterium acnes* is a primary etiological agent in acne; it's secretion of lipases, proteases, and hyaluronidases damage skin pores and induce inflammatory responses (McKelvey et al., 2012). Although this species of microbe is part of the normal skin microbiota, there are differences in certain strains of *P. acnes* that may explain differential virulence. Some disease-associated strains also have genes for antibiotic resistance, making treatment options other than chemotherapy a necessity (Fitz-Gibbon et al., 2013). Other commensal microorganisms, like *S. epidermidis*, could interact with *P. acnes* and be implicated in acne formation also, further demonstrating that residents can become pathogenic when opportunistic conditions arise (Bek-Thomsen et al., 2008, Weyrich et al., 2015, Dreno et al., 2017).

Chronic skin wounds (duration longer than three months) and their capacity to heal are also affected by the skin microbiome, especially in those individuals who are elderly, obese, immunocompromised, or diabetic (Weyrich et al., 2015, Byrd et al., 2018). Though the lesions or ulcers may not be initially caused by a microorganism, their presence, infection, and polymicrobial biofilm formation can be deleterious to the healing process and cause further complications (McKelvey et al., 2012, Wolcott et al., 2013). Analysis of skin wound microbiomes have shown a compilation of a diverse array of genera, but that microbial diversity is lower as compared with healthy skin (Gardiner et al., 2017, Kalan et al., 2019). Perhaps a higher microbial diversity allows for easier

elimination of potential pathogens from the wound and promotes faster healing. An increase in facultative anaerobes, specifically the genus *Enterobacter*, are significant indicators in the persistence of chronic wounds and their lack of healing, possibly due to their versatile metabolism (Verbanic et al., 2020). Antibiotic therapy is an option to eliminate certain bacterial pathogens for chronic wounds, however, the resulting changes in the microbiome and addressing fungal and viral constituents may necessitate multiple different treatment approaches (Price et al., 2009). Further studies are needed in order to see whether individual therapy and targeted therapeutic intervention would promote faster healing in cases with chronic wounds (Kong, 2011, Weyrich et al., 2015, Verbanic et al., 2020).

It is likely that changes in microbial community composition and the elicited immune response work in combination with host genetics and other environmental factors to cause various cutaneous disorders (Weyrich et al., 2015). This makes treatment of these complex conditions difficult, and targeting a few potential pathogens is rarely successful, especially if it is not known whether their presence is a cause or effect. So, future therapeutic efforts may focus on a similar approach to treating gut dysbiosis with FMT, and as so, use healthy skin microbiota transplants to repair and stabilize the skin microbiome for patients inflicted with skin diseases (Williams and Gallo, 2015).

Conclusion

The skin microbiome is incredibly complex, resilient, and has a strong influence on health and disease. Characterization and defining a normal skin microbiome could help in future diagnosis and treatment of disease, although factors like differences in host genetics, lifestyles, and particular skin locations must be accounted for. As research and medical technologies advance, it may be possible to utilize these microbial neighbors on the skin in efforts to promote better overall health.

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Check Your Understanding

- What features of human skin affect the composition and stability of its microbiome?
- How is the skin microbiome influenced in early life, and what implications does this have in human health?
- What diseases are associated with dysbiosis of the skin microbiome? How do these come about and what particular microorganisms are associated with each?
- How do certain members of the skin microbiome impede the healing process of chronic wounds?

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16.1.3.5: The Respiratory Microbiome

The Respiratory Microbiome

The respiratory microbiome (specifically the lower portions) was once thought to be nonexistent, as many considered healthy lungs to be a sterile environment. Like other microbiomes though, the upper and lower respiratory system are environments rich with bacteria, fungi, archaea, and viruses, and because of the novelty of study many of the members in these groups have not been identified. However, it is known that many of such organisms are not only responsible for or exacerbate a number of pulmonary diseases, but that the respiratory microbiome can help to mitigate infection and influence treatment of certain illnesses (Unger and Bogaert, 2017, Watson et al., 2019).

The human respiratory system begins with the upper respiratory system; starting with the nose and nostrils, then proceeds to the nasal cavity, pharynx, and larynx. The lower respiratory system then starts with the trachea, moves to the bronchi and bronchioles, and ends with the lungs. Each of these structures and areas have their own microbial niche which serve various roles in maintaining health, but also have the potential to be compromised. The respiratory system is similar to the oral and digestive system, in that they interact intimately with external stimuli and bring in foreign matter and microbes during regular biological processes, like inhalation. These systems also have overlapping parts (e.g. oral cavity and pharynx), where their respective microbiomes serve similar roles such as resistance to disruptive environmental factors and host defense (Dickson et al., 2014, Zaura et al., 2014, Hakansson et al., 2018). The mucosal surfaces of the respiratory tract also have a natural healthy biofilm where the resident microbiota reside to maintain homeostatic functions, however, as an extension of dysbiosis, these biofilms can become altered and obtain pathogenic microbes which contribute to respiratory diseases (Hamilos, 2019).

Composition

Immediately after birth the respiratory microbiome becomes colonized, though the collection of microbes found here during infancy is not much different than other locations in the body, and generally reflect the mode of delivery (Dominguez-Bello et al., 2010). The respiratory microbiome, as well as others, become differentiated over time when the different species of microbes adapt and outcompete each other based on their niche, host genetics, and environmental factors (Bosch et al., 2016). Colonization additionally depends on microbial immigration, microbial elimination, and relative reproduction rates of its members (Figure 1) (Dickson and Huffnagle, 2015). With age, the respiratory microbiome of each particular individual reflects the aforementioned factors as well as other lifestyle habits, and so they can be vastly different between people. Although these respiratory microbiomes are unique, a core set of microbes can be defined, with most of them being aerobic or facultatively anaerobic (Stearns et al., 2015, Hakansson et al., 2018).

Microbial composition also depends on the specific structure or niche within the respiratory system. The nasal microbiome largely consists of *Staphylococci*, *Corynebacteria*, and *Streptococci*, which is most likely due to its similarity and proximity to the skin (Mika et al., 2015, Shilts et al., 2016). Communities within the paranasal sinuses are highly diverse and include lactic-acid producing bacteria such as *Lactobacilli*, *Enterococcus*, and *Pediococcus,* and once in the nasopharynx the collection of microbes becomes more complex and favors oxygen-utilizing groups (Abreu et al., 2012, Biesbroek et. al, 2014, Teo et al., 2015). In the lower respiratory system, the microbiome resembles a bit of a mix from both the nasal and oral cavities, with a majority of bacteria from the genera *Streptococcus*, *Fusobacteria*, *Pseudomonas*, *Veillonella*, and *Prevotella* (Cui et al., 2014, Beck et al., 2015, Dickson and Huffnagle, 2015, Hakansson et al., 2018).

While much focus of the respiratory microbiome has been on bacteria (like many other microbiomes), study of the mycobiome and virome components have revealed their importance in pulmonary health and disease. Fungal spores are commonly inhaled, especially in high numbers during peak seasons, and depending on the particular organism and host immune health, they can cause infection and respiratory complications (Pashley et al., 2012, Denning et al., 2014, Nguyen et al., 2015). For healthy people, the respiratory mycobiome is predominated by environmental fungi including *Aspergillus, Cladosporium*, and *Penicillium* species (Charlson et al., 2012, van Woerden et al., 2012, Underhill and Iliev, 2014). However, members from these genera and other more well-known fungal pathogens, like *Candida albicans,* can be implicated in respiratory illnesses due to microbial community changes (Nguyen et al., 2015). The respiratory virome can also modulate various pulmonary diseases through respective bacterial interactions and host immune response. For bacteriophage composition, there are observed differences between healthy individuals and patients suffering from diseases associated with respective bacterial infections (Wilner et al., 2009). There is a diverse range of eukaryotic viruses that make up the normal human and respiratory virome, with the majority

consisting of adenoviruses, herpesviruses and human papillomaviruses (HPVs), though these may only be transient and quickly cleared by the immune system or via the mucociliary escalator (Wilner et al., 2009, Popgeorgiev et al., 2013). More research needs to be conducted over the normal respiratory virome to determine its functionality and importance, though usually more focus is catered to those viruses directly involved in pathogenesis and dysbiosis.

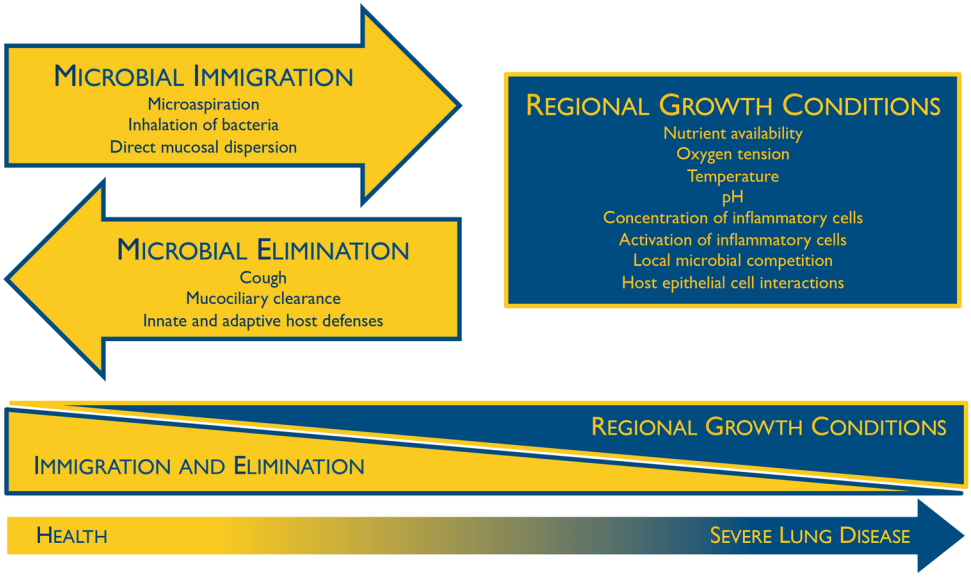


Figure 1. Ecological determinants of the respiratory microbiome. The constitution of the respiratory microbiome is determined by three factors: microbial immigration, microbial elimination, and the relative reproduction rates of its members. In health, community membership is primarily determined by immigration and elimination; in advanced lung disease, membership is primarily determined by regional growth conditions. Adapted from Dickson et al., 2014.

Dysbiosis and Disease

The normal matrix of organisms in the respiratory system maintain homeostasis through their complex interactive network with each other and their host. Pathogens like *Streptococcus pneumoniae* and *Haemophilus influenzae* are actually part of the resident respiratory microbiome and interact with commensal microbes, however, they can incite infection when they are not kept in check due to community perturbation (de Steenhuijsen et al., 2015). During events of dysbiosis, pathogens and opportunistic pathogens can contribute to and exacerbate several respiratory diseases including asthma, chronic obstructive pulmonary disease (COPD), cystic fibrosis, pneumonia, otitis media, and other acute infections like influenza.

Asthma is a chronic lung disease that usually develops at an early age, and its complex etiology makes it difficult to treat. People with asthma experience inflammation and tightening of their airways and a production of extra mucus impairs breathing, talking, and being active. The prevalence of asthma has increased in recent decades, and a decrease in microbe exposure during youth could be partially responsible (Ober and Yao, 2011, Prescott, 2013). Proper development of the immune system is reliant on contact with microbes, and those individuals who are regularly subjected to a diverse variety of microorganisms at an early age have a reduced risk of developing asthma (Ownby et al., 2002, Fujimura et al., 2010, Fall et al., 2015). Aside from grooming the immune system, the intake of microbes influences the composition of the mucosal microbiota that lines the air passageways, which could directly affect asthma development (Durack et al., 2016). Indeed epidemiologic studies have shown that the disruption of the microbiome, such as in the case of antibiotic use during childhood, create a predisposition for this allergic disease (Khalkhali et al., 2014). Specifically, the increased presence of genus *Haemophilus* and other *Proteobacteria,* as well as the fungus *Aspergillus fumigatus* in the respiratory system are signature of asthma patients (Hilty et al., 2010, Teo et al., 2015, Urb et al., 2015). These pathogens would normally be cleared by the immune system or stifled by the resident microbiota, however, early childhood dysbiosis resulting in hampered immune functions and/or a discontent microbial consortium in the respiratory system contribute to the development of this condition.

Chronic obstructive pulmonary disease (COPD) is another chronic inflammatory lung disease that causes obstructed airflow to the lungs and is exacerbated by microbial dysbiosis. Emphysema, a condition where the alveoli are damaged due to cigarette smoke and other irritants, and chronic bronchitis, a condition characterized by inflammation of the lining of the airways, are the most common contributors to COPD. An alteration of the lower respiratory microbiome causing reduced diversity or the presence of specific organisms can further aggravate COPD causing a worsening of symptoms (Huang et al., 2014). Viral infections, like

those caused by the rhinovirus, are commonly detected (in about half the patients) during COPD exacerbations (Seemungal et al., 2001, Rohde et al., 2003, Mallia et al., 2011). Also during these bouts, there is an increase in pathogens from the bacterial genera *Haemophilus*, *Pseudomonas*, and *Moraxella* and a general shift towards the phylum Proteobacteria in the respiratory microbiome (Huang et al., 2014, Millares et al., 2014). Additionally, patients with COPD exhibit a decline or absence of certain normal lung organisms that could contribute to mucosal homeostasis and prevention of pathogen overgrowth, such as Firmicutes *(Streptococcus spp.*), as well as Bacteroidetes (*Prevotella spp.*) (Fukata and Arditi, 2014, Sze et al., 2015, Hakansson et al., 2018). These compositional changes are at least partially brought about by current COPD treatments like steroid and antibiotic usage, and so future therapy may need to take the respiratory microbiome into further consideration for various approaches (Wang et al., 2016).

Cystic fibrosis (CF) is a genetic disease that causes normal cellular secretion of mucus, sweat, and digestive juices to become thicker and viscous. In the respiratory system, the buildup of sticky mucus can clog airways, impair lung function, and make breathing difficult. Bacterial pathogens, like *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Haemophilus parainfluenzae,* tend to grow in the sputum and can cause infections which worsening CF conditions (Keogh and Stanojevic, 2018). Their biofilm-forming capabilities also contribute to the excess mucus production, further causing complications as infectious agents can be resilient and persistent (Høiby et al, 2010, Orazi and O'Toole, 2017). While changes in the microbiome are not typically responsible for exacerbations of CF, antibiotic administration is the primary treatment option to eliminate these pathogens residing in the mucus, however, prolonged use can result in decreased microbiome diversity and dysbiosis in the respiratory system as well as other areas (Zhao et al., 2012, Carmody et al., 2013 Price et al., 2013, Dickson et al., 2014).

Pneumonia is a microbial infection of the lungs that can cause the alveoli to fill with pus or other liquids, and severe cases can be life-threatening, especially to children, the elderly, and those who are immunocompromised (Wardlaw et al., 2006, Chalmers et al., 2011, Valley et al., 2015). The intensity of the infection is directly correlated with the microbial load and diversity, so etiologic determination is important for proper treatment, as the onset of pneumonia can have bacterial, fungal, or viral origins (Dickson et al., 2014, Iwai et al., 2014). Viral pneumonia is commonly caused by influenza or rhinovirus, however, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has now also become a major cause post 2019 (Jain et al., 2015, Zhou et al., 2020, Pettigrew et al., 2021). Respiratory viral infections are the most common cause acute respiratory illnesses, and often times, these viral infections then lead to secondary bacterial infections, like pneumonia, due to host immune reactions and induced dysbiosis in the respiratory tract and gastrointestinal system (Hanada et al., 2018). *Streptococcus pneumoniae* is the most common culprit for bacterial pneumonia, and while it regularly resides in the upper respiratory tract, under dysbiotic conditions this organism can proliferate and spread to the lower respiratory tract and cause illness (File, 2003, de Steenhuijsen Piters et al., 2014). In patients with pneumonia, there is a decrease in many Gram-negative anaerobic bacteria that are apart of the resident microbiota, some of which are associated with a reduced risk of hospital-acquired pneumonia and clearance of S. *pneumoniae* (Bousbia et al., 2012, de Steenhuijsen Piters et al., 2014, Krone et al., 2014). Although, changes in the respiratory microbiome are more apparent in bacterial pneumonia rather than viral, it is not known whether this alteration in microbial consortia is a cause or effect of the disease, though it is likely conditional of both circumstances (Ramos-Sevillano et al., 2019, Pettigrew et al., 2021).

YouTube Video

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Conclusion

The respiratory microbiome is an up-and-coming avenue for research, diagnosis, and treatment of several pulmonary illnesses. While much of its characterization is still in it's infancy, proper identification of microorganisms is important for management of respiratory diseases (Nguyen et al., 2016). As antibiotic resistance continues to surge, novel approaches are necessary to mitigate not only respiratory illnesses, but to maintain general health. And similarly to other microbiome-related treatments, like fecal microbiota transplant for the gut, eventually oral or aerosol administered microbiota may be implemented to treat pulmonary conditions (Huang and Boushey, 2015). Continual research detailing both core and individual respiratory microbiomes will push the advancement of these 'futuristic' medical motions.

Drag and Drop Quiz

Drag each contributing factor of the respiratory microbiome composition into the appropriate category.

Query 16.1.3.5.1

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Check your Understanding

- How is the colonization of the respiratory microbiome influenced, and what factors affect its composition over time?
- What factors of the respiratory microbiome affect the development of asthma?
- Which microorganisms are implicated in COPD and periods of exacerbation? How does dysbiosis contribute to this chronic condition?
- Why do you think a greater change is observed in the respiratory microbiota in patients with bacterial pneumonia versus viral?

Media Attributions

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16.1.3.6: The Vaginal Microbiome

The Vaginal Microbiome

The vaginal microbiome is a reproductive organ-specific niche that harbors a unique collection of microorganisms that are important in a variety of aspects to human health. This microbial community has significance in maintaining vaginal homeostasis, protecting against urogenital infections, host immunity, and reproductive capacities. In recent years, next generation sequencing (NGS) techniques have been employed to classify the vaginal microbiome into community state types (CSTs), or vaginotypes, based upon composition, which can enhance epidemiological studies to make better associations between the microbiome and host-vaginal health (France et al., 2020, Mancabelli et al., 2021).

Composition and Role

The vaginal microbiome is composed of over 200 different bacterial species, though it is primarily dominated by members from *Lactobacillus* genus (Ma et al., 2012, Auriemma et al., 2021). The *Lactobacilli* protect the vagina from potential pathogen invasion through their fermentation of vaginal epithelial cell-produced glycogen into lactic acid, which lowers vaginal pH, as well as their production of various antimicrobial compounds, and resource/space competitive inhibition (Boskey et al., 2001, Amabebe and Anumba, 2018, Chee et al., 2020, Jang et al., 2019). Though, the bacteriome is usually the emphasized feature of the vaginal microbiome, it also harbors protists, fungi, archaea and viruses, with each occupying their own niche in the normal healthy network (Belay et al., 1990, Bradford and Ravel, 2017, Happel et al., 2020, Chacra and Fenollar, 2021). The composition isn't always fixed however, as factors like the menstrual cycle, hormone fluctuation, sexual partners, hygiene, genetics, age, the environment, drug use, and other aspects of lifestyle can affect the microbial makeup (Aagaard et al., 2012, Fettweis et al., 2014, Hyman et al., 2014, Zapata and Quagliarello, 2015, Martin and Marrazzo, 2016, Diop et al., 2019, Chacra and Fenollar, 2021).

As mentioned earlier, using 16S rRNA sequencing, the vaginal microbiome has been categorized into CSTs and allowed for deeper analysis, where comparisons of the consortia within these classifications can be used to make associations with host and vaginal health. There are 5 main CSTs each predominated by a particular species of *Lactobacilli,* except for group IV, which has been further dissected into additional subgroups: CST I—*L. crispatus* dominated, CST II—*L. gasseri* dominated, CST III—*L. iners* dominated, and CST V—*L. jensenii* dominated (Ravel et al., 2011, France et al., 2020, Chacra and Fenollar, 2021, Mancabelli et al., 2021). CST IV is not dominated by any particular species, and contains a mixture of both strict and facultative anaerobes including *Gardnerella, Atopobium*, *Lactobacillus*, *Bifidobacterium*, etc., where certain controversial subgroups (e.g. CST IV-A, CST IV-B, CST IV-C, CST IV-D, CST IV-G, etc.) have various combinations depending on the study (Gajer et al., 2012, Albert et al., 2015, France et al., 2020, Mancabelli et al., 2021). Each of the five groups has correlations with vaginal pH, microbial colonization and biodiversity, as well as host characteristics such as pregnancy, ethnicity, and age, though it is not always absolute (France et al., 2020, Mancabelli et al., 2021). With reproducible organization of the vaginal microbiome, connections can be made with medical conditions, which could benefit treatment and diagnosis of vaginal diseases and associated affairs.

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Dysbiosis and Disease

As with other microbiomes associated with the human body, disturbance of the resident vaginal microbiome can result in complications of health. Many diseases of the urogenital tract such as bacterial vaginosis (BV), urinary tract infections (UTIs), yeast infections, and several sexually transmitted infections (STIs) are caused by pathogenic microbes associated with dysbiosis (Taha et al., 1998, Donders et al., 2000, Wiesenfeld et al., 2003; Lai et al., 2009, De Seta et al., 2019, Mancabelli et al., 2021).

Normally, the local flora maintains homeostasis, however, changes in composition provide opportunistic pathogens a window to proliferate and invade.

Bacterial vaginosis, associated with CST IV, stems from a perturbance of the vaginal flora, specifically a decrease in *Lactobacilli* and an increase in other microbes like *Gardnerlla vaginalis, Atopboium vaginae, Ureaplasma urealyticum*, and others that are only usually found in low numbers (Gajer et al., 2012, Margolis and Fredricks, 2015, Onderdonk et al., 2016, Zozaya et al., 2016). This condition can be asymptomatic in up to half the women with BV, and in the others can be diagnosed by observed changes in vaginal discharge or by the Nugent scoring system which utilizes a Gram stain (Figure 1) (Nugent et al., 1991, Amsel et al., 1983, Schwebke, 2000). While not exactly considered a sexually transmitted disease, bacterial vaginosis is commonly associated with certain sexual practices, though other factors such as hygiene, nutrition, intrauterine devices, hormonal changes, and certain comorbidities can contribute to susceptibility (Avonts et al, 1990, Calzolari et al., 2000, Neggers et al., 2007, Verstraelen et al., 2010, Zabor et al, 2010, Margolis and Fredricks, 2015). Women with this disease also have a higher risk to contract sexually transmitted infections, and it can be linked to reproductive complications and poor infant health (Wiesenfeld et al., 2003, Prince et al., 2015, Chacra and Fenollar, 2021). Typically, antibiotics targeting anaerobic bacteria are administered to treat BV, however recurrence is common, likely due to the antimicrobial-resistant nature of biofilms formed by the pathogens and/or regular exposure to external reservoirs (Swidinski et al., 2008, Oduyebo et al., 2009, Marrazzo et al., 2012, Bradshaw and Sobel, 2016). Probiotics, specifically containing *L. crispatus*, may be the better option, and vaginal microbiota transplantation from a healthy donors is a promising treatment course of action (Hemmerling et al., 2010, Ma et al., 2019).

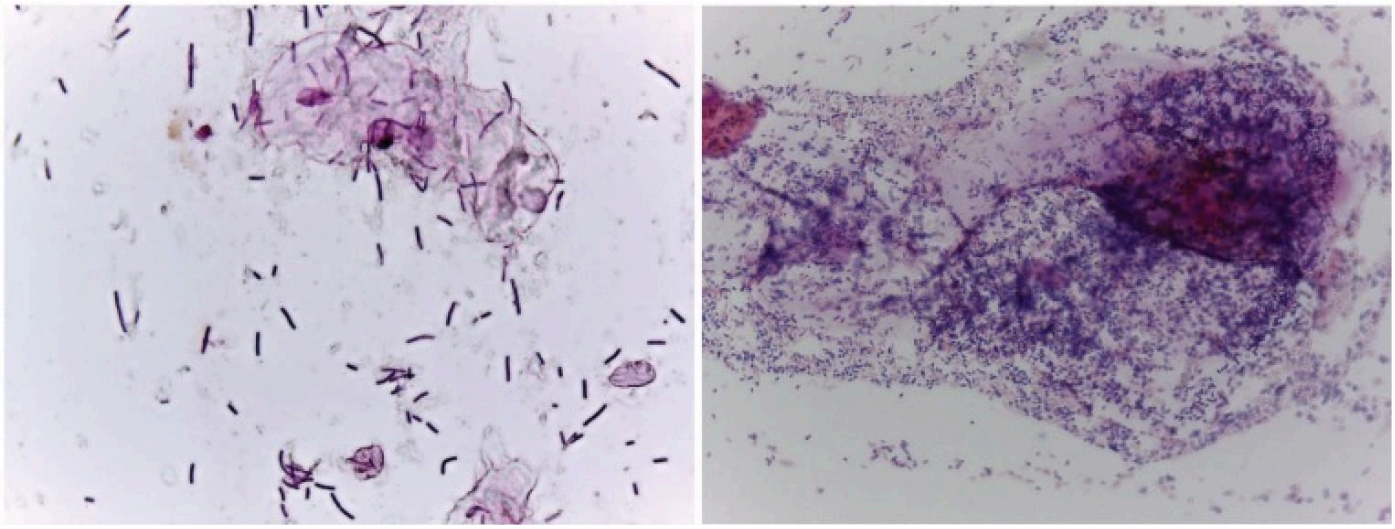


Figure 1. Examples of Gram-stained slides from women with (right, Nugent score = 9) and without (left, Nugent score = 1) BV. In women with a lactobacilli-dominated microbiome (left), long purple rods are the main morphotype. In contrast, women with BV tend to have a lot more bacteria overall, with a significant fraction that do not stain as Gram-positive (i.e. pink). Morphotypes in BV tend not to be long Gram-positive rods. Although not part of the Nugent scoring system, women with BV tend to have large conglomerations of bacteria associated with epithelial cells as seen in the upper right quadrant (Lewis and Gilbert, 2020).

Urinary tract infections are a common problem, especially for females, which are disproportionately affected. This infection is most likely to occur in the urethra or bladder (though in severe cases the kidneys can be affected), which causes pain in the pelvic area and during urination, the frequent urge to urinate, and the presence of blood in urine (Lee and Neild, 2007, Sheerin, 2011, Hooton, 2012). The vaginal microbiome, or more specifically some normal residents, like *Escherichia coli*, can move to the urogenital tract and cause issues resulting in a UTI, which often occurs via sexual activity (Nicolle et al., 1982, Foxman, 2014, Stapleton, 2016, Lewis and Gilbert, 2020). Other fastidious microorganisms, like those abundant in women experiencing BV, contribute to a higher risk of contracting an infection in the urinary tract as compared with those not suffering from dysbiosis in the vagina (Hillebrand et al., 2002, Sumati and Saritha, 2009). In these cases, the vaginal opening may harbor potential uropathogens (Figure 2) and transient exposure to the urinary tract could prompt colonization or other reactions (e.g. immunomodulation) that results in a UTI (Lewis and Gilbert, 2020). Antibiotics are traditionally used to treat UTIs, however probiotics and estrogen administration could help to restore the *Lactobacillus* colonization and protect against complicated and recurrent infections (Raz and Stamm, 1993, Eriksen, 1999, Prais et al., 2003, Stapleton et al., 2011, Tan and Chlebicki, 2016, Lewis and Gilbert, 2020).

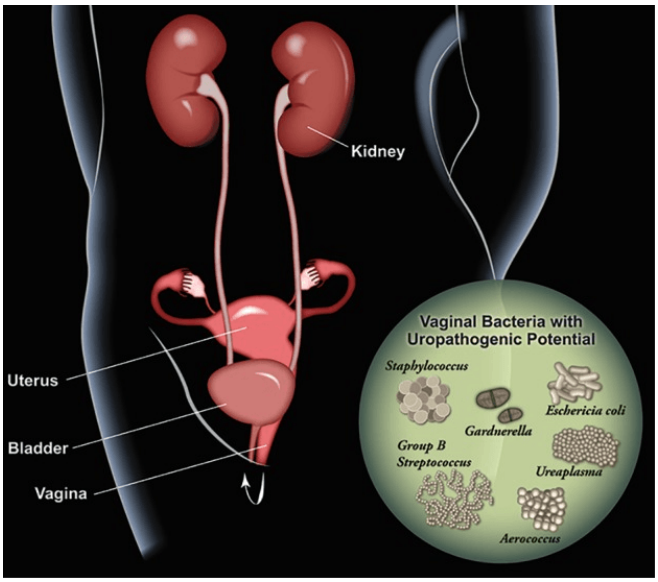


Figure 2. Schematic illustrating vaginal bacteria with potential to impact the urinary tract. The vagina can serve as a reservoir for several bacterial species known to be causes of UTI (E. coli, GBS, Staphylococcus) as well as underappreciated potential uropathogens (G. vaginalis, Aerococcs Ureaplasma) that can cause UTI and have been associated with urological conditions such as urgency incontinence and "sterile" pyuria (Lewis and Gilbert, 2020).

Yeast infection of the vaginal region caused by *Candida* species, also known as vulvovaginal candidiasis (VVC), is a common condition with severe symptoms and a high recurrence rate (Oerlemans et al., 2020). Those affected experience vaginal itchiness or soreness, dyspareunia (painful intercourse), abnormal vaginal discharge, redness, swelling, and thinning of the vaginal wall (Chew and Than, 2016, Oerlemans et al., 2020). While it is the second-most common infection of the vagina behind BV, this disease primarily affects premenopausal women with a low vaginal pH value under 4.5 (Kim and Park, 2017, Gupta et al., 2019). The exact cause of VVC isn't exactly clear, though it is thought it can come as a result of microbiome dysbiosis induced by prolonged antibiotic usage, which allows various *Candida* species to overgrow and establish an infection (Goldacre et al., 1979, Mitchell, 2004, Peters et al., 2014, van de Wijgert and Verwijs, 2020). Traditionally, antifungal medication has been used to treat VVC, however administration of probiotic vaginal microbes may be more prudent as their mechanisms of pathogen colonization and biofilm formation inhibition are more effective to prevent disease recurrence (Petrova et al., 2016, Tachedjian et al., 2017, Allonsius et al., 2019, Oerlemans et al., 2020, van de Wijgert and Verwijs, 2020).

Individuals with vaginal microbiome dysbiosis characterized by a decrease in abundance of *Lactobacilli* species (i.e. BV) are at a higher risk of contracting sexually transmitted infections, such as those caused by *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, *Chlamydia trachomatis*, and *Mycoplasma genitalium* (Martin et al., 1999, Cherpes et al., 2003, Peipert et al., 2008, Brotman et al., 2010, Molenaar et al., 2018, De Seta et al., 2022). Infections caused by these organisms usually result in symptoms similar to other genital infections such as vaginal itching, pain, unusual discharge, rash, etc. which like other conditions (e.g. vaginitis), result in decreased epithelial integrity and can exacerbate pathogen invasion (Miller and Shattock, 2003, Greenbaum et al., 2019). In those individuals with BV and non-inflamed tissue, the increased risk for STIs could be due to the negative effects dysbiosis-related bacteria have on the innate immune system (Murphy and Mitchell, 2016, Liebenberg et al., 2017). Similarly, contraction of sexually transmitted viral infections like human immunodeficiency virus (HIV), herpesviruses, and human papillomavirus (HPV) are frequently associated with vaginal dysbiosis, immunomodulation, and disruption of the epithelial barrier (Sewankambo et al., 1997, Borgdorff et al., 2016, Siqueira et al., 2019, Torcia, 2019, De Seta et al., 2022). While there is correlation between vaginal dysbiosis and STIs, the protective mechanisms of the resident vaginal microbiota are unknown and still need to be uncovered (De Seta et al., 2022).

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Reproduction, Pregnancy, and Infant health

The vaginal microbiome has further implications in host immunity, fertility, pregnancy, spontaneous preterm birth, and infant health (Anahtar et al., 2015, Fettweis et al., 2019, Gupta et al., 2020, Xu et al., 2020). Indeed, there are a multitude of factors that affect reproduction like age, genetics, hormone levels, fallopian tube blockage, menstrual cycle, and vaginal pH, however only recently has the vaginal microbiome been studied for its association with various fertility factors (Xu et al., 2020, Fan et al., 2022).

Changes in the resident vaginal flora and infections by certain pathogens can cause complications for reproductive health and pregnancy. For example, infection by Group B *Streptococcus* (GBS) has been associated with a decline in ovarian function, pregnancy loss, preterm delivery, and is the leading cause of bacteremia and meningitis in newborns (Zaleznik et al., 2000, Phares et al., 2008, Kolter and Henneke, 2017, Tazi et al., 2019, Xu et al., 2020). The vaginal microbiome of pregnant women is less rich and diverse than non-pregnant individuals, likely caused by changes in sex hormone levels (Farage et al., 2010, Aagaard et al., 2012). These alterations can cause shifts in the vaginal microbiome that could then result in infection and a risk of preterm or spontaneous labor (Wylie et al., 2018, Fettweis et al., 2019, Feehily et al., 2020, Gupta et al., 2020).

Infants become introduced to the microbial world via their mother, and predominately right after birth where vaginal versus cesarean delivery has a great impact on composition (Chu et al., 2017). However, exposure may happen earlier *in utero*, as this environment may not be as sterile as once thought as some studies have shown the presence of microbes in the placenta and amniotic fluid (Aagaard et al., 2014, Collado et al., 2016, Kolter and Henneke, 2017). The establishment of a newborn's microbiome has profound effects on the development of immunity and metabolism as well as the onset of diseases like atopic dermatitis and obesity in later life (Rautava et al., 2012, Collado et al., 2016, Ta et al., 2020).

Conclusion

The vaginal microbiome is a complex community which affects many facets of human health and disease including urogenital, reproductive, immune, and infant. Characterization of the vaginal flora has allowed categorization into community state types which can help to predict and diagnose disease states. Within so, these dynamic changes that occur under various conditions produce a unique fingerprint for the vaginal microbiome which can be analyzed and potentially treated in a specific manner (Ceccarani et al., 2019, Lagenaur et al., 2020, Abou Chacra and Fenollar, 2021). While antibiotic administration has its benefits, novel approaches using targeted application of probiotic microbiomes (e.g. a gel containing specific *Lactobacilli* species) could help in treating diseases associated with vaginal dysbiosis by restoring those disrupted communities, as well as alleviating certain negative consequences of chemotherapy (Pino et al., 2019, Lagenaur et al., 2020 Oerlemans et al., 2020). More in-depth and continued research of the vaginal microbiome is necessary to illuminate the interactions and connections of it members to human health.

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Drag and Drop Quiz

Drag the species of bacteria that dominates each vaginal community state type.

Query 16.1.3.6.1

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Check your Understanding

- Explain vaginal microbiome CSTs. Why are they important?
- Which CST is associated with BV, and which genus is typically absent?
- How does BV contribute to the development of other conditions like UTIs, VVC, and STIs?
- How does the vaginal microbiome influence reproduction?
- Where does a newborn acquire its microbiome, and what factors affect the composition?
- What alternatives to antimicrobials are promising for the treatment of vaginal microbiome associated diseases?

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16.1.3.7: Mental Health and Multi-Microbiome Interactions

Mental Health and Multi-Microbiome Interactions

It may seem obvious that localized microbiomes are responsible for diseases related to their respective areas (e.g., IBD and the gut microbiome or AD and the skin microbiome), however, it is a fascinating phenomenon that various microbiomes can affect each other and influence health in different parts of the body. Even more captivating is the link between certain microbiomes and mental health conditions presuming the brain is devoid of microbes.

These links between microbiomes are referred to as axes, and initial connections began with the most well-studied microbiome, the gut. Since many gut-derived microbial-produced molecules and compounds are spread through the bloodstream, associations with various organs are formed, such as the gut-brain axis, gut-skin axis, gut-lung axis, or a combination of multiple; gut-brain-skin axis. There are likely overlapping connections between all microbial components that form the human holobiome, thus teasing apart the exact members and their functions is a dutiful task.

Gut Interaction with Other Microbiomes

As mentioned earlier, the dissemination of molecules and compounds from the gut to the rest of the body creates an interconnected highway affecting most, if not all, parts of the body. Certainly, juxtaposed regions such as the oral cavity and the proximal portions of the GI tract have a relationship between their microbiomes, which it termed the gut-oral axis (GOA). These linked microbiomes have been shown to have immunomodulatory roles in the development of rheumatoid arthritis (RA) and osteoarthritis (OA) under dysbiosis, where the abundance of oral *Porphyromonas gingivalis* and intestinal *Prevotella copri* could be responsible (Drago et al., 2019, du Teil Espina et al., 2019). It has also been proposed that dysbiosis of the gut-oral microbiome axis is implicated in cirrhosis of the liver through pathogen invasion, resultant systemic inflammation, and impaired immunity and liver function (Acharya et al., 2017). Even gastrointestinal conditions like IBD and cancer of the colon, liver, and pancreas are linked with both the gut and oral microbiome dysbiosis, further demonstrating this strong interorgan connection to human health (Park et al., 2021).

The gut and the skin microbiomes are also linked via the gut-skin axis (GSA), and as the primary interface to the environment, they have major roles in physiological health (Figure 1). Dysbiosis of the gut-skin microbiome axis has influence on both GI and cutaneous disorders such as IBD, celiac disease, atopic dermatitis, psoriasis, acne, and other dermatologic issues, where each of these diseases can be associated with the 'partner disease' (i.e. a disease in one system linked to a disease in another system) (O'Neill et al., 2016, Salem et al., 2018, De Pessemier et al., 2021). Though crosstalk is bidirectional, more research seems to have focused on skin disorders and homeostasis as a result of gut microbiome health, where diet, immunomodulation, intestinal permeability, and metabolite secretion are major contributing factors (De Pessemier et al., 2021). However, there is evidence that *Mallassezia restricta,* a fungal member of the skin microbiota, is associated with Crohn's disease and can exacerbate colitis (Limon et al., 2019, Sinha et al., 2021).

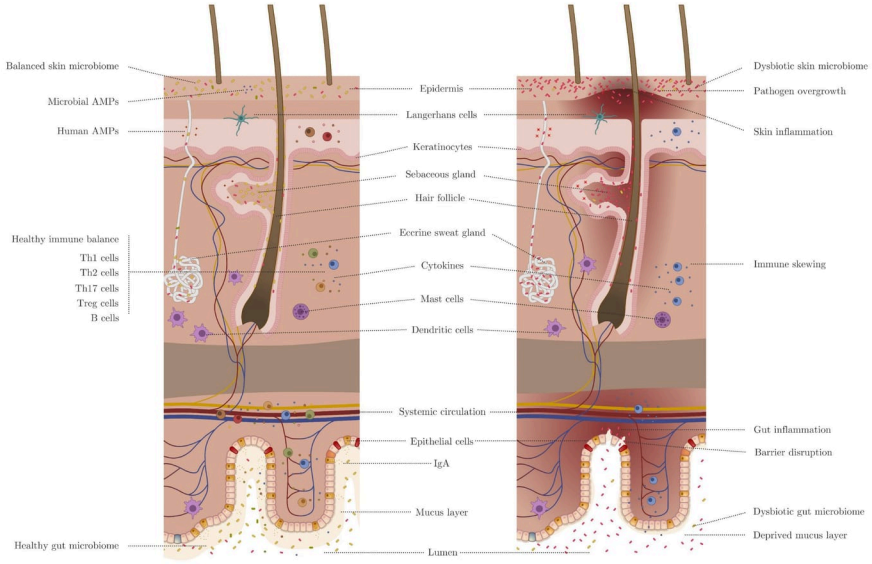


Figure 1. Inflammatory and microbial influences between the gut and skin for a healthy state (left) and a dysbiotic state (right): The intestinal and epidermal barriers are connected through the systemic circulation (blood and lymph) and are visualized here together in a simplistic manner. The dysbiotic state is characterized by an impaired gut barrier (imbalance in gut microbiome, reduced mucus layer, reduced IgA secretion, barrier disruption, intestinal permeation into the bloodstream, and gut inflammation) and an impaired skin barrier (imbalance in skin microbiome, reduced human and microbial antimicrobial peptides (AMP) production, skin rashes/thickening/lesions, and skin inflammation). Gut and skin dysbiosis are connected through an immune imbalance (Th2 skewing in this example), whereas crosstalk can be bidirectional (De Pessemier et al., 2021).

The gut-lung axis (GLA) has roles in the regulation of immunity and the development of various respiratory diseases. (Frati et al., 2019). The respiratory system and GI tract are connected by the mesenteric lymphatic system, where intact or fragmented microbes and their metabolites enter systemic circulation after passing through the intestinal barrier and can migrate to the pulmonary system to modulate immune responses (Enaud et al., 2020). The pathophysiology of diseases such as atopy and asthma are complicated and can be contributed to a variety of factors, however, there is evidence that dysbiosis of the gut microbiome contributes to the development of asthma, particularly in youths who exhibit a decrease in *Lachnospira* and increase in *Clostridium* spp. (Penders et al., 2007, Watson et al.,2019). Gut dysbiosis is also involved in chronic obstructive pulmonary disease (COPD) exacerbation, where fiber deficiency in an individual's diet can contribute to chronic inflammation. Metabolism of fiber by gut microbes produces anti-inflammatory short-chain fatty acids (SCFAs), which could reduce inflammation both systemically and in the lungs, and so targeted dietary intervention for these patients may be a viable treatment addition for COPD and other respiratory diseases associated with inflammation like COVID-19 (Li et al., 2018, Vaughan et al., 2019, Allali et al., 2021). Moreover, SCFAs also have an important role in the defense against secondary infections in those afflicted by viral respiratory infections, further demonstrating the importance of gut microbiome health in connection with the GLA (Sensio et al., 2020).

Like other axes, immunomodulation by the gut microbiome also has influence on the gut-vagina axis (GVA), though it is less extensively studied. One promising avenue of treating vaginal diseases, specifically cervical cancer associated with human papilloma virus (HPV), is the use of mucosal lactic-acid bacteria (LAB)-based vaccines to modulate the gut microbiome. The approach could work as a prophylactic or for direct therapy, and be more easily administered via an oral route instead of parenteral (Taghinezhad-S, et al., 2021). Endometriosis and infertility are also disorders associated with sex hormone levels and inflammation, which once again are influenced by the gut microbiome composition and state. Specifically, there are some members in the gut who can affect the levels of circulating estrogen through metabolic processes and an altered state could lead to increased risk or symptom severity of these disorders (Salliss et al., 2022). Other female reproductive-associated diseases such as polycystic ovarian syndrome (PCOS), also associated with gut dysbiosis, could be ameliorated by diet modification and restoration of gut homeostasis. Here, the use of flaxseed oil could increase diminished levels of SCFAs observed in those with PCOS and protect against inflammation characteristic of the disease (Wang et al., 2020).

The maternal microbiome, including gut, vagina, and breast milk, can greatly influence the colonization and health of the infant after birth, but also affect the fetus prior to delivery. Fetal immune development is most likely influenced in the womb from translocation of maternal gut microbes and/or their metabolites across the placental barrier or ingestion of amniotic fluids (Walker et al., 2017, Nyangahu and Jaspan, 2019). Post-reproduction, the infant gut microbiome is continually developed through initial diet, and more specifically vertical transmission of the contents in the mother's breast milk which includes its own unique microbiome (Ojo-Okunola et al., 2018, Ojo-Okunola et al., 2019, Quin et al., 2020). The human milk microbiome promotes infant

gut colonization of probiotic strains which have roles in programming the immune and metabolic systems, as well as anti-infective, anti-allergic, and anti-tumor properties (Heikkila and Saris, 2003, Olivares et al., 2006, Lara-Villoslada et al., 2007, Civardi et al., 2015, Hassan et al., 2015, Walker and Iyengar, 2015, Boix-Amoros et al., 2016, Ojo-Okunola et al., 2018).

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Mental Health Axes

The thought of microorganisms controlling aspects of cognitive function in their host, especially humans, is fascinating to say the least. While connections between other microbiomes, organ systems, and diseases may be less surprising, the microbial link to psychiatric, neurodevelopmental, age-related, and neurodegenerative disorders is very much intriguing. The human microbiome can communicate with the brain in a variety of ways; through the immune system, metabolism, endocrine system, circulatory system, and the nervous system, where microbes, their induced immune response, and their metabolites such as short-chain fatty acids, branched chain amino acids, and peptidoglycans are involved (Figure 2) (Liang et al., 2018, Cryan et al., 2019, Olsen and Hicks, 2019, Hadian et al., 2020, Bear et al., 2021). Several local microbiomes each contribute affects to the mental state, and whether it is gut-, skin-, oral-, lung-, etc. derived can dictate roles in various disorders. This is not just a one-way street though, as microbes around the body can alter mental states but also be affected by governance of the brain in a bi-directional manner (Ma et al., 2019).

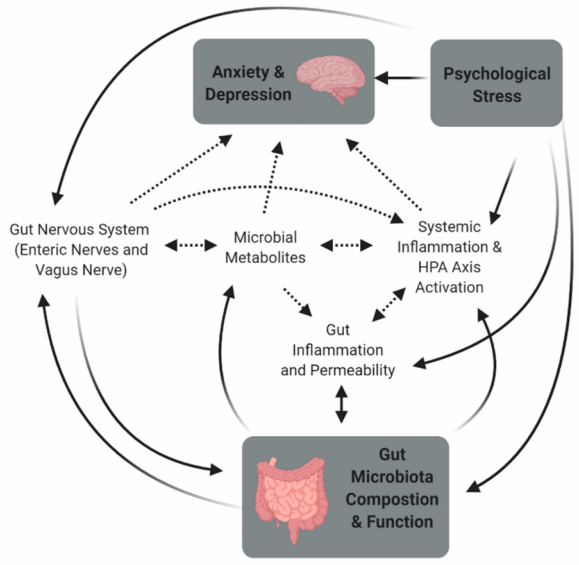


Figure 2. The proposed mechanisms of the microbiome-gut-brain axis (MGBA) are complex and intertwined. Emerging research shows that psychological stress interacts not only directly with the brain and mood, but also with many of the MGBA mechanisms thought to contribute to changes in mood with alteration of the gut microbiota. Solid lines indicate strong evidence of an effect, and dotted lines show proposed mechanisms with limited but emerging evidence. Abbreviations: HPA; Hypothalamic-Pituitary-Adrenal (Bear et al., 2021).

Gut-Brain

Similar to other types of microbiome and organ interactions, the gut's role in mental health is central and most well studied, which makes sense as it is the largest repository of microorganisms associated with the human body. The gut-brain axis (GBA; and gut plus essentially every other microbiome and brain axis, e.g., gut-skin-brain) is implicated in a number of cognitive functions and disorders including autism, anxiety, depression, stress, pain sensitivity, learning capacities, memory loss, moods and emotions,

behavior (dietary, social, and reproductive), schizophrenia, Parkinson's disease, and Alzheimer's disease (Desbonnet et al., 2013, Stumpf et al., 2013, Dash et al., 2015, Gareau, 2016, Luczynski et al., 2016, Hoban et al., 2017, Liang et al., 2018, Manderino et al., 2017, Nishida and Ochman, 2017, Vuong et al., 2017, Cowan et al., 2018, Cryan et al., 2019, Bear et al., 2021, Narengaowa et al., 2021). The gut microbiome actually develops in sync with the brain and psychology, and disturbances during different stages of growth can result in the onset of different diseases (Figure 3) (Borre et al., 2014, Gur et al., 2015, Sampson and Mazmanian, 2015, Dinan and Cryan, 2016, Luczynski et al., 2016, Sharon et al., 2016, Kundu et al., 2017, Vuong et al., 2017, Carlson et al., 2018, Liang et al., 2018).

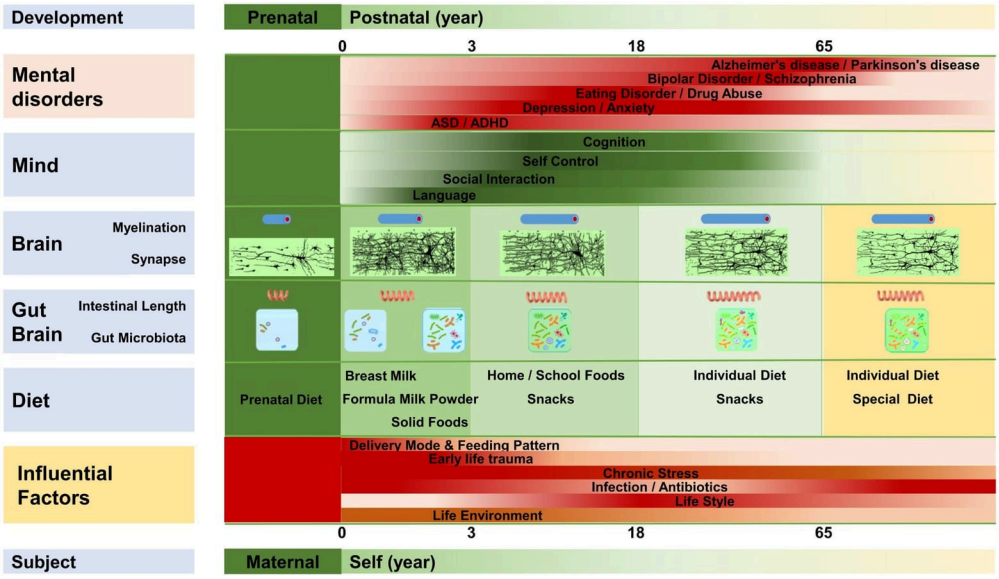


Figure 3. The gut-brain, brain, and mentality develop almost synchronously throughout the lifespan. The gut-brain, brain, and mentality undergo similar developmental patterns; all three are susceptible to several factors that influence the gut microbiota. Myelination, intestinal length, and the gut microbiota develop almost synchronously. Diet plays an important role in the maturation of the gut-brain and brain, and mentality is regulated by the development of the brain and gut-brain. Microbiota disruption at different stages is likely to increase the incidence of different mental disorders (Liang et al., 2018).

Early perturbation of the gut microbiome during the post-natal period, and even within the womb, can especially increase susceptibility to developing mental disorders since these are critical stages for development of the gut-brain axis and mind (Borre et al., 2014, Gur et al., 2015, Diaz Heijtz, 2016, Mika et al., 2016, Slykerman et al., 2016, O'Mahony et al., 2017, Liang et al., 2018). Even up through senescence, an abnormal gut microbiota is linked with several mental disorders, though the good news is that they can be remedied or improved by returning the gut to a homeostatic state. As the prevalence of mental disorders and neurological diseases have been steadily increasing, healing mental health by exploring and implementing options such as fecal microbiota transplant, diet intervention, probiotics, prebiotics, and psychobiotics are a must (Cryan and Dinan, 2012, Dinan et al., 2013, Liang et al., 2015, Pirbaglou et al., 2016, He et al., 2017, Kang et al., 2017, Mika et al., 2017, Bruce-Keller et al., 2018, Liang et al., 2018, Yang et al., 2018, Kesika et al., 2021, Margolis et al., 2021).

There are several ideas as to why there has been an increase in mental and neurological disorders in relation to the human microbiome. The "Gut Microbiota" hypothesis suggests this escalation is a direct result from gut microbiome dysbiosis due to factors of modern society such as diet, antibiotics, and stress (Liang et al., 2018b). The "Old Friends" hypothesis proposes that the co-evolution of early humanity with its microbiota in a less civilized and more natural ecosystem promoted the development of a stronger immune system, but now changes in lifestyle and environment leads to weaker immunity and subsequent disorders (Strachan, 1989, Rook and Lowry, 2008, Kramer et al., 2013, Rook, 2013). Lastly, the "Leaky Gut" theory implies that damage to the mucosal barrier of the gut increases intestinal permeability, which allows biomolecules and microorganisms to gain access various parts of the body that they normally couldn't, and thereafter cause disease (Leclercq et al., 2012, Smythies and Smythies, 2014, Kelly et al., 2015, Potgieter et al., 2015, Slyepchenko et al., 2017, Liang et al., 2018). All of theses propositions are clear in their indication that the gut microbiome and its part in immune development has a definite role in the functioning of the mind, though the exact extent and mechanisms remain to be discovered.

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Other Microbiomes and Mental Health

The majority of human microbiome interaction with regards to human health usually includes the gut to some degree, though there are some questions as to whether certain microbiomes create their own axes with the brain.

The oral microbiome can potentially get direct or indirect access to the brain through the olfactory tract, or via the circulatory system where blood can transport microbes to the blood-brain barrier (BBB), perivascular spaces, and circumventricular organs (Figure 4) (Olsen and Singhrao, 2015, Ranjan et al., 2018, Olsen and Hicks, 2019). Microbial access to the bloodstream can commonly occur during dental procedures, and pathogen invasion of the brain can impact neuro-immune activity and inflammation (Olsen, 2008). These oral-brain axis-derived infections could contribute to mental disorders such as Alzheimer's disease (AD), dementia, Down's syndrome, bipolar disorder, and autism spectrum disorder (ASD; which can lead to oral dysbiosis) (Ilievski et al., 2018, Olsen and Hicks, 2019, Maitre et al., 2020). Oral dysbiosis can also promote the development of ASD by affecting the metabolome and thus can create a troublesome positive feedback loop (Mussap et al., 2016, Wang et al., 2016).

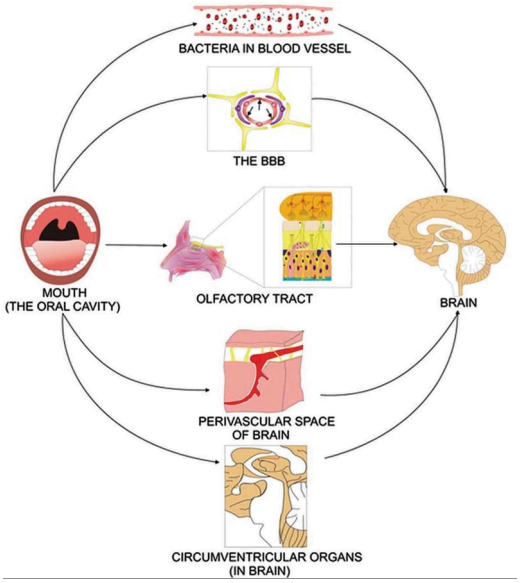


Figure 4. Direct and indirect mechanisms of infecting the brain. In the direct mechanism, the oral cavity infects the olfactory tract, and the olfactory nerve transfer the bacteria to the brain. In other mechanisms, bacteria inside the mouth infect the blood and find their way via blood, blood–brain barrier (BBB), perivascular spaces and circumventricular organs to the brain (Olsen and Hicks, 2019).

Concerning the skin-brain axis, dysbiosis of the skin microbiome and chronic wounds can elicit systemic effects and induce neural responses that eventually affect the central nervous system (Figure 5) (Hadian et al., 2020). Chronic wounds exhibit persistent inflammation and can have various etiologies including diabetic foot ulcers (DFU), venous ulcers, arterial ulcers, pressure ulcers, surgical wounds, and other traumatic wounds (Green et al., 2014, Renner and Erfurt-Berge, 2017, Bui et al., 2018, Pedras et al., 2018, Hadian et al., 2020). In these cases, a compromised skin barrier can allow pathogens and their derivatives to enter the bloodstream, and if the skin is in a dysbiotic state, then abundant pathogens such as *Staphylococcus aureus* and *Pseudomonas aeruginosa* can amplify this effect by inducing epithelial permeability (Roy et al., 2014, Basler et al., 2017). These microbes, metabolites, pro-inflammatory mediators, and other constituents circulate within the blood, potentially induce permeability in the blood-brain barrier (BBB), and eventually reach the brain to cause disorders such as wound-associated depression, anxiety, and other cognitive disorders (Wang et al., 2011, Zhang et al., 2015, Hadian et al., 2020). The skin-brain axis acts in a bi-direction

manner too, with studies showing connections between certain mental disorders like post-traumatic stress disorder, and skin diseases associated with dysbiosis like psoriasis, chronic urticaria (hives), and atopic dermatitis (Gupta et al., 2017, Beri, 2018).

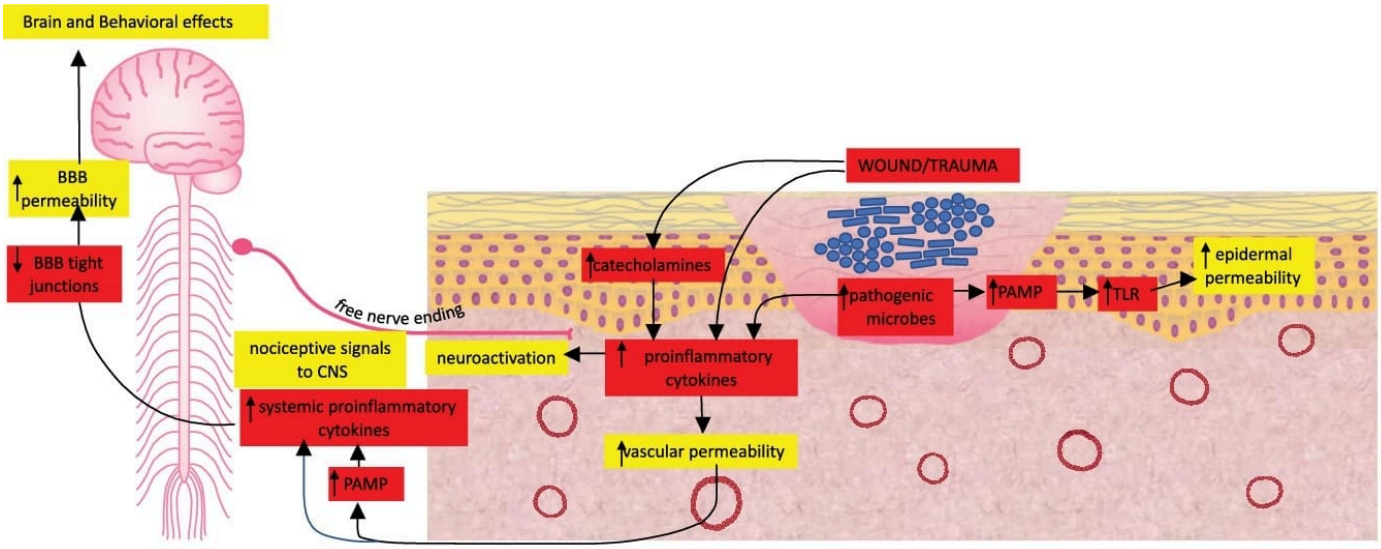


Figure 5. The chronic wound with its microbiota induces localized inflammatory alterations that can result in systemic effects by increasing both epidermal and vascular permeability and activating neurons to generate nocioceptive signals—all ultimately culminating in central nervous system effects. Red: Proposed mediators. Yellow: Proposed downstream events. BBB: blood brain barrier, CNS: central nervous system, PAMP: pathogen associated molecular pattern, TLR: toll like receptor (Hadian et al., 2020).

The lung-brain axis connects pulmonary microbes to neurodegenerative disorders and behavior characteristics, and though not much research has focused on this specific link, there are indications that air pollution can be a trigger. Pollutants in the air come from a variety of sources including engine emissions, coal combustion, biomass burning, and secondary photochemical products, such as ground level ozone (O_3) (Mumaw et al., 2016). These compounds can be a source of chronic neuroinflammation and persistently affect microglial cells in the central nervous system, which in turn can increase risk of diseases such as Alzheimer's disease, Parkinson's disease, and autism, as well as elicit a decline in cognitive function in the elderly (Power et al., 2011, Wellenius et al., 2012, Roberts et al., 2013, Volk et al., 2013, Heneka et al., 2014, Jung et al., 2015, Kirrane et al., 2015, Mumaw et al., 2016). It is likely that air pollution also negatively affects the lung microbiome, and dysbiosis could further aggravate immune responses and cognitive disruption (Mousavi et al., 2021, Whiteside et al., 2021).

Is there a brain microbiome?

That is, are there resident microbes residing with a living brain? With many neurodegenerative and neuropsychiatric diseases lacking a clear etiology, determining any and all potential associations could help in therapeutic efforts (Link, 2021). The healthy brain is an assumedly sterile environment, though the same was once thought about other organs like the lungs. Interestingly, one study found evidence for the existence of viable bacteria in the human brain. Here, researchers were interested to see whether microbial invasion accompanied damaged brains observed in HIV/AIDS. After sequencing total RNA from cerebral white matter, they found bacteria and phage sequences in both experimental and control brain samples, which was further validated by 16S rRNA gene target amplification and *in situ* staining (Branton et al., 2013, Link, 2021).

If there were resident microbes in the brain, they would certainly be at much lower abundances as compared with other regions such as the gut or the oral cavity. Though there has been much interest in characterizing the presence of pathogens in unhealthy brains for disorders like Alzheimer's disease, which is an arduous feat in itself, finding residents in a healthy state could prove even more difficult (Zhan et al., 2016, Alonzo et al., 2018, Dominy et al., 2019, Link, 2021). That is, identification approaches could easily miss novel or fastidious microorganisms, and contamination is hard to avoid. Furthermore, a wide-range of controlled and unbiased studies are necessary to catalogue a possible brain microbiome, however, completing this task in humans brings about ethical implications and sampling limitations (Link, 2021). It is fascinating to consider the prospect of symbiotic brain microorganisms, and how they could influence our health or who we are.

Conclusion

Mental faculties contribute greatly to human health, and therefore characterizing the involvement of the human microbiome is of substantial importance. Many of these select microbiomes overlap, and the disorders associated with each are likely entangled in a complex array. Brain functions are extremely complex as is, and piecing together the microbial puzzle within their reach further complicates matters. However, there is great optimism in considering the human microbiome as a source or target for advanced therapy to resolve mental disorders and other diseases, which could drastically change the way we think about medicine.

Discussion Concept Mapping

With a partner or as a class, connect two or more microbiomes using a concept map. Explain how and/or why the various microbiomes are linked (e.g., disease cause vs. effect, direct vs. indirect, pathways, consortia translocation, factors affecting composition, etc.).

Check your Understanding

- In what ways does the gut microbiome connect with other microbiomes and regions of the body? How does it influence the development of diseases in these areas?
- How could early use of antibiotics influence the development of asthma in children?
- How could gut microbiome metabolites (SCFAs) contribute to healthy human states?
- In what ways does the human microbiome communicate with the brain?
- What options are available to treat mental disorders through the gut microbiome?
- Why have mental illnesses been increasing in prevalence and how could the gut microbiome be involved?
- How are microbiomes, other than the gut, implicated in mental health?
- What role does skin microbiome dysbiosis and chronic wounds have in the development of cognitive disorders?

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16.1.4: PROTECTING AGAINST INFECTIOUS DISEASES, AND STD'S/STI'S

Learning Objectives

By the end of this chapter you will be able to:

- List the common types of pathogens (disease causing agents)
- Describe how the Immune system works to fight off infection
- Compare the role of the various types of immune cells
- Explain how vaccines work
- Explain the signs and symptoms of the most common STD's/STI's

How does the immune system fight off disease?

What are the different kinds of organisms that cause disease?

What can you do to try to stop the spread of diseases?

How do you know if you have an STD?

16.1.4.1: The Immune System

16.1.4.2: Sexually Transmitted Diseases (STD'S)

16.1.4.3: End-of-Chapter Material

16.1.4.4: Protecting Health- Optional Continued Learning

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16.1.4.1: The Immune System

Imagine a number that is ten billion times the number of stars in the universe, this is the estimated number of viruses on Earth[1]. Viruses are just one type of microorganism in our environment. Some microorganisms are detrimental to our health making us sick, others are important for our health (beneficial), and others are inconsequential. The microorganisms that cause diseases in humans are called **pathogens**. In total, there are about 1,400 known species of human pathogens that fall into five groups known as bacteria, virus, fungi, protozoa, and helminths (worms).

Pathogens are found in the air around us, the food we eat, what we drink, and the people and animals we are around, thus we are constantly exposed pathogens. Thankfully our immune system is in a constant battle working to identify the foreign invader (pathogen) and destroy them. This immune system battle is happening right now while you are reading this book!

The main purpose of the immune system is to protect your body from harmful substances, germs and cell changes that could make you ill. With this purpose, the immune system works to:

- fight disease-causing germs (pathogens) like bacteria, viruses, parasites or fungi, and to remove them from the body,
- recognize and neutralize harmful substances from the environment, and
- fight disease-causing changes in the body, such as cancer cells.

Your immune system is made up of two parts that work together to fight off disease. The innate immune system works to constantly find and destroy any foreign invaders, and the adaptive immune system works by remembering previous pathogens and infections to be able to launch a more efficient battle to destroy pathogens upon re-exposure.

The immune system includes white blood cells, organs, and tissues of the lymph system, such as the thymus, spleen, tonsils, lymph nodes, lymph vessels, and bone marrow. The white blood cells, or immune cells, that help the body fight infections and other diseases include neutrophils, eosinophils, basophils, mast cells, monocytes, macrophages, dendritic cells, natural killer cells, and lymphocytes (B cells and T cells).

The immune system is an amazing system of protection, however sometimes it cannot destroy the pathogen and this is when infection or disease occurs, like the Flu, Strep Throat, or a Sexually Transmitted Disease (STD).

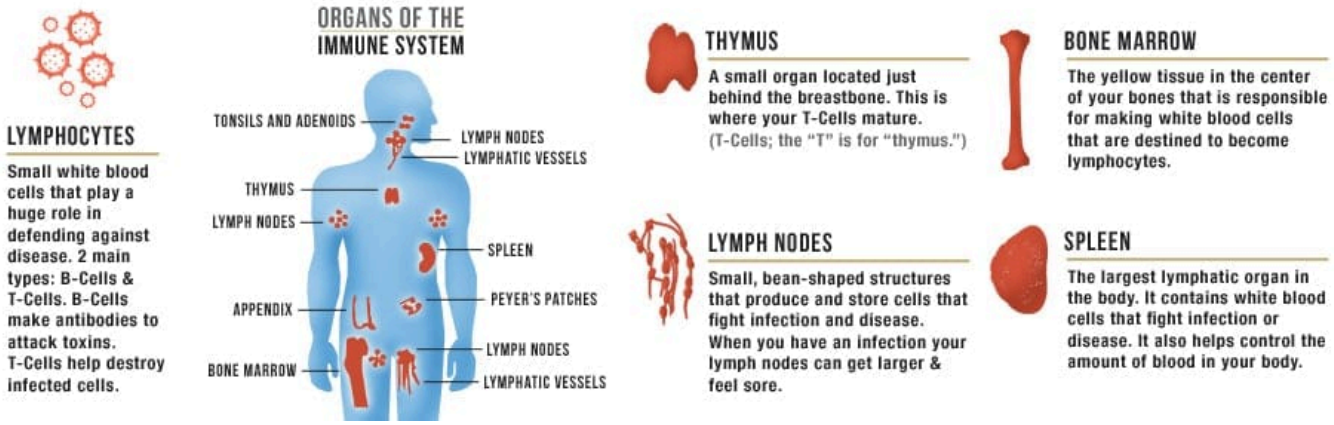


Figure 16.1.4.1.1*: Organs of the Immune System*

Pathogens and Infectious Diseases

The number of viruses and bacteria on earth is staggering[2] and they occupy essentially every environment. For example, a liter of surface seawater typically contains in excess of ten billion bacteria and 100 billion viruses. The vast majority of viruses and bacteria we are exposed to have no negative effect, some can even be beneficial, however a tiny fraction of these can severely affect our health. It is estimated that only about 1,400 of a trillion microbial species are human pathogens. Pathogens are too small to be seen by the naked eye and they live all around us in water, soil, and air.

The agents that cause disease, or pathogens, fall into five groups: viruses, bacteria, fungi, protozoa, and helminths (worms). Protozoa and worms are usually grouped together as parasites.

Table 16.1.4.1.1*: Type of Pathogen and Related Infectious Diseases*

Virus	Bacteria	Fungi	Parasites/Protozoa
• Common cold (Rhinoviruses) • The flu (influenza) • COVID-19 (SARS-CoV-2 virus) • Stomach flu (norovirus or rotovirus) • Hepatitis (Hepatitis, A, B, C, D, E virus) • Seasonal lung infection (Respiratory syncytial virus (RSV))	• Strep throat (Streptococcus bacterium) • salmonellosis (Salmonella bacteria) • Tuberculosis (Mycobacterium tuberculosis) • Whooping cough (Bordetella pertussis bacteria) • Chlamydia, gonorrhea and other sexually transmitted diseases (STDs).	• Ringworm (like athlete's foot). • Fungal nail infections. • Vaginal candidiasis (vaginal yeast infection). • Thrush.	• Giardiasis. • Toxoplasmosis. • Hookworms. • Pinworms.

Common Viruses and Mutations

Every year warnings are shared about the annual flu season. The flu is a contagious respiratory illness caused by the influenza viruses that infect the nose, throat, and lungs. It can cause mild to severe illness, and at times can lead to death. Although the flu can be caught year round, in the U.S. it is most common in the Fall and Winter seasons. The flu virus is not the same each year due to what is known as antigenic drift and antigenic shift which essentially indicates that the influenza virus has changed and thus the body will likely react differently to the variations.

Viruses can only replicate if they are absorbed by cells in the body, thus viruses survive based on the ability to continue to infect hosts. In order to continue to infect humans, the virus has to overcome the humans immune systems. Since the immune system can remember past viral infections, viruses mutate and change over time to be able to adapt to their surroundings and more effectively move from host to host. When viruses mutate they evolve into new variants. Virus variants are similar to a family tree with multiple lineages (or closely related groups of variants) and sublineages. Each variant starts with a parent lineage followed by descendant lineages. For example, with COVID-19, the BA.1.1.529 variant is from the Omicron variant.

Pandemics

There is a difference between an endemic, outbreak, epidemic, and pandemic[3]. An **endemic** condition occurs at a predictable rate among a population. An **outbreak** corresponds to an unpredicted increase in the number of people presenting a health condition or in the occurrence of cases in a new area. An **epidemic** is an outbreak that spreads to larger geographic areas. A **pandemic** is an epidemic that spreads globally.

Pandemics have occurred throughout history impacting the entire world, some of these include:

- Three plagues during the years: 541-543, 1347-1351, and 1885-ongoing.
- Six pandemics of cholera during the years: 1817-1824, 1827-1835, 1839-1856, 1863-1875, 1881-1886, and 1899-1893.
- And numerous flu pandemics: Russian flu from 1889-1893, Spanish flu from 1918-1919, Asian flu from 1957-1959, Hong Kong flu from 1968-1970, SARS from 2002-2003, Swine flu from 2009-2010, MERS from 2015-ongoing, and more recent COVID-19 from 2019-ongoing.

Table 16.1.4.1.2 List of some of the pandemics that occurred throughout history.

Pandemic	Timeline	Area of emergence	Pathogen	Vector	Death toll
Athenian Plague	430-26 B.C.	Ethiopia	Unknown	Unknown	Unknown

Pandemic	Timeline	Area of emergence	Pathogen	Vector	Death toll
Antonine Plague	165-180	Iraq	Variola virus	Humans	5 million
Justinian Plague	541-543	Egypt	Yersinia pestis	Rodents' associated fleas	30-50 million
Black Death	1347-1351	Central Asia	Yersinia pestis	Rodents' associated fleas	200 million
The Seven Cholera Pandemics	1817-present	India	Vibrio cholerae	Contaminated water	40 million
Spanish Flu	1918-1919	USA	Influenza A (H1N1)		50 million
Asian Flu	1957-1958	China	Influenza A (H2N2)		>1 million
Hong Kong Flu	1968	China	Influenza A (H3N2)		1-4 million
HIV/AIDS	1981-present	Central Africa	HIV		36 million
Severe acute respiratory syndrome coronavirus	2002-2003	China	Severe acute respiratory syndrome coronavirus	Bats	774
Swine Flu	2009-2010	Mexico	Influenza A (H1N1)		148000-249000
Ebola	2014-2016	Central Africa	Ebola virus	Unknown	11000
COVID-19	2019- July 2021 (ongoing)	China	SARS-Cov-2	Unknown	>4 million (ongoing)

The COVID-19 pandemic was caused by a virus called SARS-CoV-2. Viruses constantly change through mutation and sometimes these mutations result in a new variant of the virus. COVID variations include the Omicron variant and Delta variant, with new variants of the virus expected to occur. The COVOD-19 pandemic is the first global pandemic requiring large-scale responses since the 1918 Spanish flu. As of 2022, COVID-19 is still considered a pandemic and there is still concern of continued spread, sickness, and death.

Pandemics: The Chain of Infection

The way in which people become infected with a pathogen is referred to as the Chain of Infection.

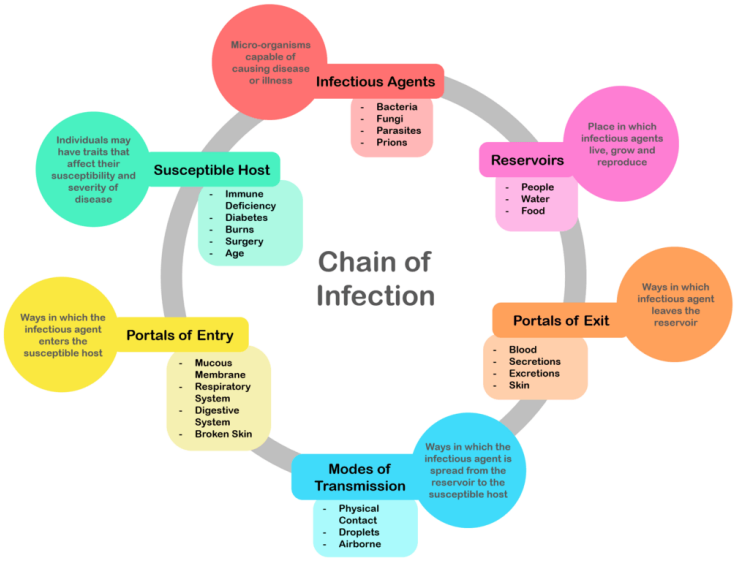


Figure 16.1.4.1.2 *: The Chain of Infection*

The chain of infection begins with the **"Infectious Agent."** The infectious agent is a pathogen, a microorganism that is capable of causing disease. There are about 1,400 different pathogens that fall within five main categories of bacteria, virus, fungi, protozoa, and worms.

The infectious agent begins in a "**Reservoir**." The reservoir could be another person, an animal, in water, or in food; it is the habitat in which the infectious agent normally lives, grows, and multiplies. The reservoir may or may not be the source from which an agent is transferred to a host. For example, the reservoir of Clostridium botulinum is soil, but the source of most botulism infections is improperly canned food containing C. botulinum spores. Human reservoirs may or may not show the effects of illness. A carrier is a person with inapparent infection who is capable of transmitting the pathogen to others. Asymptomatic or passive or healthy carriers are those who never experience symptoms despite being infected. Carriers commonly transmit disease because they do not realize they are infected, and consequently take no special precautions to prevent transmission.

The infectious agent needs a way to leave the reservoir through a **"Portal of Exit."** For a person, this could include breathing out air, or a cut through the skin, touching or rubbing your nose, coughing, sexual intercourse, feces, urine, mucus, or blood.

The infectious agent then needs a **"Mode of Transmission**" to the new host. The mode of transmission could be direct or indirect. Direct contact and direct spreading of droplets often occur when two people are close together or touching, this could be through hugging, sexual intercourse, or droplets spreading when talking or sneezing when someone is close by. Indirect transmission could occur through the air, on a vehicle such as food or drinks, or transmitted by an insect like a mosquito, flee, or tick.

The infectious agent then needs to a **"Portal of Entry**" into the new susceptible new host, these are ways the infectious agent could enter the body. The portal of entry must provide access to tissues in which the pathogen can multiply. This might include inhaling the infectious agent into the respiratory system, consuming it through food or drink therefore entering the digestive system, or entering directly into blood or tissues through breaks in the skin.

The final step in the Chain of Infection is when the infectious agent has successfully entered the **Susceptible Host**. If a pathogen gets past a host's defenses, it will attempt to infect the host and begin replicating itself; The pathogens must infect a host in order to grow or replicate. However, just because the pathogen has successfully entered the host does not mean they will get infected! This is where the power of the immune system steps in to fight off the infection destroying the infectious agent.

The survival of human pathogens, like viruses, bacteria, and parasites, is dependent upon quickly invading a human, replicating, and efficiently transmitting to others. Pathogens depend on the chain of infection for survival. You can take precautions to break the chain of infection at each step in the chain by doing the following:

- Recognize signs and symptoms of disease in order to get treatment and isolate when needed.
- Wash your hands and/or use hand sanitizer
- Cleaning and disinfect surfaces
- Get treatment from a doctor
    - If you have a bacterial infection you need antibiotics. *Antibiotics* are medicines that fight bacterial infections.

- Avoid touching your face
- Do not cough into your hand, cough into your arm or elbow.
- Use pest control
- Wear personal protective equipment to put a barrier between the portal of exit or entry.
- Use air purifiers to reduce airborne pathogens.
- Properly dispose of waste.
- Drink clean drinking water.
- Follow food safety guidelines.
- Immunizations/vaccines to reduce the susceptibility of the new host.

The Immune System Battle

When an infectious agent leaves a reservoir through a portal of exit and finds a mode of transmission, it is then up to the defenses of the new host to try to reduce the chances of infection. This is when the immune system battle commences which includes two main subsystems of the immune system, called the innate immune system and the adaptive immune system. The innate immune system is what you are born with and the adaptive immune system is developed overtime as your body is exposed to pathogens. The innate immune response is always present and attempts to defend against all pathogens rather than focusing on specific ones. Conversely, the adaptive immune response stores information about past infections and mounts pathogen-specific defenses.

The innate immune system includes the bodies physical and chemical barriers along with white blood cells that are always present in the blood and tissues ready to destroy any and all invading pathogens. The adaptive immune system also includes white blood cells, but they are more specialized and ready to destroy specific pathogens.

Immune System: Physical and Chemical Barriers

The first step in the battle against pathogens is to put up a physical barrier against the portal of entry. The largest physical barrier against pathogens is our skin. Skin provides provides both a barrier of entry and a means to destroy pathogens through skin acidity and dryness. The areas of the body that are not covered with skin have alternative methods of defenses using mucus and secretions, like tears in the eyes, wax in the ears, and cilia and mucus in the nose, mouth, and lungs. Despite these barriers, pathogens may enter the body through skin abrasions or punctures, or by collecting on mucosal surfaces in large numbers that overcome the mucus or cilia. Some pathogens have evolved specific mechanisms that allow them to overcome physical and chemical barriers. When pathogens do enter the body, the innate and adaptive immune systems responds.

The Innate and Adaptive Immune System

The main job of the innate immune system is to fight harmful substances and germs that enter the body, for instance through the skin or digestive system. The innate immune system is the rapid response to any invading pathogen, the response is non-specific meaning the same response for any and all pathogens. The adaptive immune system makes antibodies and uses them to specifically fight certain germs that the body has previously come into contact with. This is also known as an “acquired” (learned) or specific immune response. Because the adaptive immune system is constantly learning and adapting, the body can also fight bacteria or viruses that change over time.

Both the innate and the adaptive immune system rely on markers that are on body cells. These markers tell the immune system whether the cell is a human cell that belongs in the body, or whether the cell is foreign. Pathogens have two markers. One marker is non-specific called a Pathogen-Associated Molecular Patterns (PAMPs), the other markers is specific called an Antigen. Many pathogens share the same PAMPs, however have unique and distinctive antigens; Every invader’s antigenic pattern is unique. The innate immune cells have receptors called Pattern Recognizing Molecules (PRMs) that recognize the PAMP. When the innate cells recognize the PAMP they begin the battle to destroy the foreign invaders. Adaptive immune system cells recognize the specific antigens on the pathogen and launch a battle specifically to destroy that pathogen.

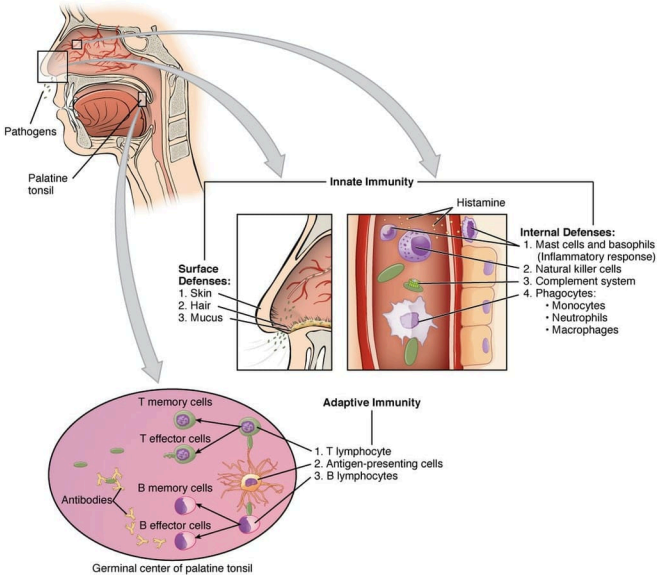


Figure 16.1.4.1.3 *: Diagram of the Innate and Adaptive Immune System*

The innate immune system cells are the first to respond, these include the following types of leukocytes: mast cells, macrophages, natural killer cells, dendritic cells, monocytes, neutrophils, basophils, and eosinophils (described in Figure 11.?). Cells of the adaptive immune system are classified as lymphocytes (a type of leukocyte) and include two main types: T-cells and B-cells (the letters denote 'thymus' and 'bone marrow', the tissues where each of these leukocytes mature).

Cell type	Characteristics	Location	Image
Mast cell	Dilates blood vessels and induces inflammation through release of histamines and heparin. Recruits macrophages and neutrophils. Involved in wound healing and defense against pathogens but can also be responsible for allergic reactions.	Connective tissues, mucous membranes	
Macrophage	Phagocytic cell that consumes foreign pathogens and cancer cells. Stimulates response of other immune cells.	Migrates from blood vessels into tissues.	
Natural killer cell	Kills tumor cells and virus-infected cells.	Circulates in blood and migrates into tissues.	
Dendritic cell	Presents antigens on its surface, thereby triggering adaptive immunity.	Present in epithelial tissue, including skin, lung and tissues of the digestive tract. Migrates to lymph nodes upon activation.	
Monocyte	Differentiates into macrophages and dendritic cells in response to inflammation.	Stored in spleen, moves through blood vessels to infected tissues.	
Neutrophil	First responders at the site of infection or trauma, this abundant phagocytic cell represents 50-60 percent of all leukocytes. Releases toxins that kill or inhibit bacteria and fungi and recruits other immune cells to the site of infection.	Migrates from blood vessels into tissues.	
Basophil	Responsible for defense against parasites. Releases histamines that cause inflammation and may be responsible for allergic reactions.	Circulates in blood and migrates to tissues.	
Eosinophil	Releases toxins that kill bacteria and parasites but also causes tissue damage.	Circulates in blood and migrates to tissues.	

Figure 16.1.4.1.4: The characteristics and location of cells involved in the innate immune system

Steps to the The Immune System Battle:

- The cellular immune response begins when a pathogen gets through the bodies physical and chemical barriers.
- If a pathogen gets past the hosts defenses it will attempt to infect the host and begin replicating itself. The subsequent battle between the germs and the body's immune system will cause the symptoms of illness.
- The first immune cells to respond to the invading pathogen are the innate immune cells: mast cells, macrophages, natural killer cells, dendritic cells, monocytes, neutrophils, basophils, and eosinophils. These cells are always ready to fight off pathogens and work hard to destroy the foreign invaders.
- Actions of the innate immune system cells
    - Dendritic Cells: Ingest pathogen and help activate the adaptive immune system by presenting their antigen to Helping T-Cells and killer T-Cells.

    - Neutrophils: Migrate from the bloodstream to ingest and kill bacteria and fungi and recruit more immune cells.
    - Macrophages: Known as the “big eaters”, they ingest pathogens and dead cells and help activate the adaptive immune system by presenting their antigen. They also recruit more immune cells.
    - Mast Cells: launch inflammatory response and recruit macrophages and neutrophils.
    - Natural Killer cells: Detect and kill tumor or virus infected cells.
    - Basophils: Defend against parasites and contribute to inflammatory response.
    - Eosinophils: Kill bacteria and parasites.
- The innate immune cells alert the whole body that there is a problem by activating the inflammatory response and initiating the adaptive immune system.
- The inflammatory response brings swelling, pain and higher temperature, which attracts more cells to the site of infection. This means more immune cells join the fight to destroy the pathogen.

- The innate immune cells provide important information to the adaptive immune cells to “train” the adaptive immune cells how to destroy the pathogen.
- Training the adaptive immune cells is done in two ways, by releasing cytokines and displaying the pathogens antigens.
    - Cytokines are signals that tell cells what to do and where to go. Your body responds to threats in different ways depending on the cytokine signal released by your immune cells.
    - The antigen is displayed when the innate immune cells capture and breakdown the invader.
    - Together, the cytokines and antigens train individual adaptive immune cells to recognize and destroy specific patterns of each foreign invader.
- The Adaptive Immune System Cells
    - Helper and killer T-Cells are activated after the Dendritic cells engulf the pathogen.
    - When the helper T-Cells create B-Cells they are initiating the adaptive immune system.
    - Antibodies, B Cells, are then produced that attach to the pathogen.
    - The B Cells divide to produce plasma and memory cells.
    - If the same pathogen invades again, the memory cells help the immune system activate much quicker.
- When the adaptive cells are “trained” how to fight a specific antigen, they remember how to fight it, thus the next time that this pathogen tries to infect you your adaptive immune cells will remember it and destroy it quickly.
- The ability of the immune system to remember previous pathogens is commonly called adaptive or acquired immunity and is the basis for vaccines.
- However, pathogens really want to live and they can be tricky. Some pathogens, including those that cause flu, strep throat, and malaria, can mutate and change the way they look to your immune system over time by changing their antigen markers thus disguising themselves marking it harder for your immune system to recognize the mutated germs even though you’ve been exposed to them before. This is why you can get sick from flu, strep throat, or COVID multiple times.

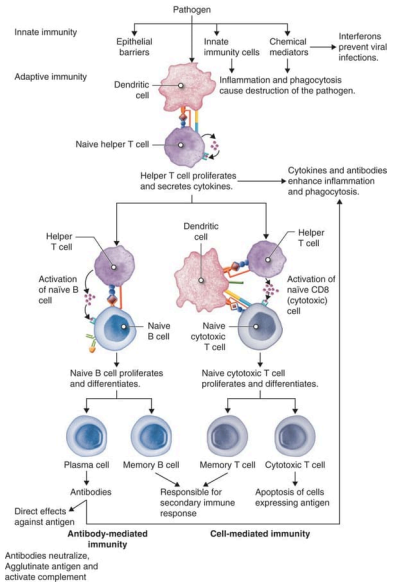


Figure 16.1.4.1.5 : Overview of Innate and Adaptive Immunity

Vaccines

It is possible to acquire adaptive immunity naturally or artificially. Natural immunity results from natural exposure to an antigen.

For example, someone sneezes the influenza virus into the air and then it is breathed into another person's nasal passageway. However, artificial immunity refers to deliberately introducing an antigen into an individual to stimulate an immune response, known as a vaccine. Whether you have been introduced to a pathogen naturally or artificially the end result is the same, to develop memory cells to acquire immunity against the pathogen.

If the immune system did not have the ability to remember pathogens then vaccines would not work; vaccines are effective because of memory cells. The mechanism underlying vaccination is that exposure of the adaptive immune system to a small dose of an antigen will produce an initial immune response. More importantly, this small dose of antigen establishes a population of memory T and B cells that will live long-term in the body. When that antigen is encountered again, the immune system is already primed. Upon a subsequent exposure, a more robust and faster response is established and the pathogen is destroyed faster. Vaccines can either prevent or decrease the severity of infections.

There are several different types of vaccines and even more types of vaccines in development. Each type is designed to teach your immune system how to fight off certain kinds of germs—and the serious diseases they cause. When scientists create vaccines, they consider how your immune system responds to the germ, who needs to be vaccinated against the germ, and the best technology or approach to create the vaccine.

Table 16.1.4.1.3 *: Vaccine Types, Characteristics, and Protections from Disease*

Vaccine Type	Characteristics	Vaccine Protects against
Inactivated vaccines	• Inactivated vaccines use the killed version of the germ that causes a disease. • Inactivated vaccines usually don't provide immunity (protection) that's as strong as live vaccines. So you may need several doses over time (booster shots) in order to get ongoing immunity against diseases.	• Hepatitis A • Flu (shot only) • Polio • (shot only)Rabies
Live-attenuated vaccines	• Live vaccines use a weakened (or attenuated) form of the germ that causes a disease. • Because these vaccines are so similar to the natural infection that they help prevent, they create a strong and long-lasting immune response. Just 1 or 2 doses of most live vaccines can give you a lifetime of protection against a germ and the disease it causes. • But live vaccines also have some limitations. For example: ◦ Because they contain a small amount of the weakened live virus, some people should talk to their health care provider before receiving them, such as people with weakened immune systems, long-term health problems, or people who've had an organ transplant. ◦ They need to be kept cool, so they don't travel well. That means they can't be used in countries with limited access to refrigerators.	• Measles, mumps, rubella (MMR combined vaccine) • Rotavirus • Smallpox • Chickenpox • Yellow fever
Messenger RNA (mRNA) vaccines	• Researchers have been studying and working with mRNA vaccines for decades and this technology was used to make some of the COVID-19 vaccines. • mRNA vaccines make proteins in order to trigger an immune response. • mRNA vaccines have several benefits compared to other types of vaccines, including shorter manufacturing times and, because they do not contain a live virus, no risk of causing disease in the person getting vaccinated.	• COVID-19

Vaccine Type	Characteristics	Vaccine Protects against
Subunit, recombinant, polysaccharide, and conjugate vaccines	• Subunit, recombinant, polysaccharide, and conjugate vaccines use specific pieces of the germ—like its protein, sugar, or capsid (a casing around the germ). • Because these vaccines use only specific pieces of the germ, they give a very strong immune response that's targeted to key parts of the germ. They can also be used on almost everyone who needs them, including people with weakened immune systems and long-term health problems. • One limitation of these vaccines is that you may need booster shots to get ongoing protection against diseases.	• Hib (Haemophilus influenzae type b) disease • Hepatitis BHPV (Human papillomavirus) • Whooping cough (part of the DTaP combined vaccine) • Pneumococcal disease • Meningococcal disease • Shingles
Toxoid vaccines	• Toxoid vaccines use a toxin (harmful product) made by the germ that causes a disease. They create immunity to the parts of the germ that cause a disease instead of the germ itself. That means the immune response is targeted to the toxin instead of the whole germ.Like some other types of vaccines, you may need booster shots to get ongoing	• Diphtheria • Tetanus
Viral vector vaccines	• For decades, scientists studied viral vector vaccines. Some vaccines recently used for Ebola outbreaks have used viral vector technology, and a number of studies have focused on viral vector vaccines against other infectious diseases such as Zika, flu, and HIV. Scientists used this technology to make COVID-19 vaccines as well. • Viral vector vaccines use a modified version of a different virus as a vector to deliver protection. Several different viruses have been used as vectors, including influenza, vesicular stomatitis virus (VSV), measles virus, and adenovirus, which causes the common cold. Adenovirus is one of the viral vectors used in some COVID-19 vaccines being studied in clinical trials.	• Ebola • COVID-19
DNA vaccines	• In development. • Easy and inexpensive to make—and they produce strong, long-term immunity.	In development. No vaccines available yet.
Recombinant vector vaccines (platform-based vaccines)	• In development • Act like a natural infection, so they're especially good at teaching the immune system how to fight germs.	In development. No vaccines available yet.

There is another way to get temporary immunity and that is called passive immunity, which is when antibodies are provided to the person from a donor recipient, for example from a mother to child as antibodies move across the placenta before birth. Passive immunity is not long-lasting because the individual does not produce memory cells.

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16.1.4.2: Sexually Transmitted Diseases (STD'S)

There are approximately 20 different infections that are known to be transmitted through sexual contact. One in five people in the U.S. has an STD. While sexually transmitted diseases (STDs) affect individuals of all ages, STDs take a particularly heavy toll on young people. CDC estimates that youth ages 15-24 account for almost half of the 26 million new sexually transmitted infections that occurred in the United States in 2018.

Many cases of chlamydia, gonorrhea, and syphilis continue to go undiagnosed and unreported, and data on several additional STDs — such as human papillomavirus, herpes simplex virus, and trichomoniasis — are not routinely reported to CDC. Many STD's are asymptomatic, meaning they do not show any symptoms, yet can still be spread to sexual partners. As a result, the CDC data on rates of STD's only captures a fraction of the true burden of STDs in America. However, it provides important insights into the scope, distribution, and trends in STD diagnoses in the country.

Table

Year			
Rate of Syphilis	**Rate of Chlamydia**	**Rater of Gonorrhea**	
1985	28.4	17.4	383
1990	54.3	160.2	276.4
1995	26	187.8	147.5
2000	11.2	251.4	128.7
2005	11.2	329.4	114.6
2010	14.8	423.6	100.2
2015	23.2	475	123
2020	40.8	481.3	206.5

It is important to understand the risk factors and symptoms of STD's in order to protect yourself and your partners. It is also important to understand the impacts to your health if you do not get treatment.

Women who do not get treatment for STD's can get Pelvic Inflammatory Disease (PID). PID is a serious condition which left untreated can cause scar tissue and abscesses to develop in the reproductive tract which can lead to permanent damage to the reproductive organs. PID can cause ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

For more detailed information, review the CDC fact sheet for Pelvic Inflammatory Disease (PID

Partners who do not get treated for an STD can be at an increased risk of contracting or spreading HIV/AIDS. If you get an STD and you have a sore or break in the skin from the STD, this may allow HIV to more easily enter your body and people who have HIV are more likely to spread HIV if they have an STD. The same behaviors and circumstances that may put you at risk for getting an STD also can put you at greater risk for getting HIV. In addition, having a sore or break in the skin from an STD may allow HIV to more easily enter your body. If you are sexually active, get tested for STDs and HIV regularly, even if you don't have symptoms.

For more detailed information, review the CDC fact sheet for HIV/AIDS & STDs

Bacterial Vaginosis

Bacterial vaginosis (BV) is a condition that happens when there is too much of certain bacteria in the vagina. This changes the normal balance of bacteria in the vagina. BV is the most common vaginal condition in women ages 15-44.

Researchers do not know the cause of BV. However, we do know the condition most often occurs in those who are sexually active. BV is a result of an imbalance of "good" and "harmful" bacteria in a vagina. Douching, not using condoms, and having new or

multiple sex partners can upset the normal balance of vaginal bacteria, increasing your risk for getting BV.

We also do not know how sex causes BV. There also is no research to show that treating a sex partner affects whether someone gets BV. Having BV can increase your chances of getting other STDs.

BV rarely affects those who have never had sex.

You cannot get BV from toilet seats, bedding, or swimming pools.

Many people with BV do not have symptoms. If you do have symptoms, you may notice:

- A thin white or gray vaginal discharge;
- Pain, itching, or burning in the vagina;
- A strong fish-like odor, especially after sex;
- Burning when peeing; and
- Itching around the outside of the vagina.

For more detailed information, review the CDC fact sheet for Bacterial Vaginosis (BV)

Chlamydia

Chlamydia is a common bacterial STD that can cause infection among both men and women. It can cause permanent damage to a woman's reproductive system. This can make it difficult or impossible to get pregnant later. Chlamydia can also cause a potentially fatal ectopic pregnancy (pregnancy that occurs outside the womb).

You can get chlamydia by having vaginal, anal, or oral sex with someone who has chlamydia. Also, you can still get chlamydia even if your sex partner does not ejaculate (cum). A pregnant person with chlamydia can give the infection to their baby during childbirth.

Chlamydia often has no symptoms, but it can cause serious health problems, even without symptoms. If symptoms occur, they may not appear until several weeks after having sex with a partner who has chlamydia.

Even when chlamydia has no symptoms, it can damage a woman's reproductive system.

Women with symptoms may notice:

- An abnormal vaginal discharge; and
- A burning sensation when peeing.

Symptoms in men can include:

- A discharge from their penis;
- A burning sensation when peeing; and
- Pain and swelling in one or both testicles (although this is less common).

Men and women can also get chlamydia in their rectum. This happens either by having receptive anal sex, or by spread from another infected site (such as the vagina). While these infections often cause no symptoms, they can cause

- Rectal pain;
- Discharge; and
- Bleeding.

See a healthcare provider if you notice any of these symptoms. You should also see a provider if your partner has an STD or symptoms of one. Symptoms can include

- An unusual sore;
- A smelly discharge;
- Burning when peeing; or
- Bleeding between periods.

For more detailed information, review the CDC fact sheet for Chlamydia

Gonorrhea

Gonorrhea is is a common bacterial STD that can cause infection in the genitals, rectum, and throat. It is very common, especially among young people ages 15-24 years.

You can get gonorrhea by having vaginal, anal, or oral sex with someone who has gonorrhea. A pregnant person with gonorrhea can give the infection to their baby during childbirth.

Gonorrhea often has no symptoms, but it can cause serious health problems, even without symptoms.

Most women with gonorrhea do not have any symptoms. Even when a woman has symptoms, they are often mild and can be mistaken for a bladder or vaginal infection.

Symptoms in women can include:

- Painful or burning sensation when peeing;
- Increased vaginal discharge; and
- Vaginal bleeding between periods.

Men who do have symptoms may have:

- A burning sensation when peeing;
- A white, yellow, or green discharge from the penis; and
- Painful or swollen testicles (although this is less common).

Rectal infections may either cause no symptoms or cause symptoms in both men and women that may include:

- Discharge;
- Anal itching;
- Soreness;
- Bleeding; and
- Painful bowel movements.

See your healthcare provider if you notice any of these symptoms. You should also see a provider if your partner has an STD or symptoms of one. Symptoms can include an unusual sore, a smelly discharge, burning when peeing, or bleeding between periods.

For more detailed information, review the CDC fact sheet for Gonorrhea

Genital Herpes

Genital herpes is common viral STD in the United States. In 2018, CDC estimates show there were 572,000 new genital herpes infections in the United States among people aged 14 to 49.

HSV-1 often causes oral herpes, which can result in cold sores or fever blisters on or around the mouth. HSV-1 is typically acquired during childhood, is very common, and often has no symptoms. HSV-2 is a sexually transmitted disease that causes genital herpes. Oral herpes caused by HSV-1 can spread from the mouth to the genitals through oral sex, thus Genital herpes is an STD that can be caused by two types of viruses – herpes simplex virus type 1 (HSV-1) and herpes simplex virus type 2 (HSV-2).

You can get genital herpes by having vaginal, anal, or oral sex with someone who has the infection. You can get herpes if you have contact with:

- A herpes sore;
- Saliva from a partner with an oral herpes infection;
- Genital fluids from a partner with a genital herpes infection;
- Skin in the oral area of a partner with oral herpes; or
- Skin in the genital area of a partner with genital herpes.

You also can get genital herpes from a sex partner who does not have a visible sore or is unaware of their infection. It is also possible to get genital herpes if you receive oral sex from a partner with oral herpes.

You will not get herpes from toilet seats, bedding, or swimming pools. You also will not get it from touching objects, such as silverware, soap, or towels.

Most people with genital herpes have no symptoms or have very mild symptoms. Mild symptoms may go unnoticed or be mistaken for other skin conditions like a pimple or ingrown hair. Because of this, most people do not know they have a herpes infection.

Herpes sores usually appear as one or more blisters on or around the genitals, rectum or mouth. This is known as having an "outbreak". The blisters break and leave painful sores that may take a week or more to heal. Flu-like symptoms (e.g., fever, body aches, or swollen glands) also may occur during the first outbreak.

For more detailed information, review the CDC fact sheet for Genital Herpes

Hepatitis

Hepatitis means inflammation of the liver. The liver is a vital organ that processes nutrients, filters the blood, and fights infections. When the liver is inflamed or damaged, its function can be affected. Heavy alcohol use, toxins, some medications, and certain medical conditions can cause hepatitis. However, hepatitis is often caused by a virus. In the United States, the most common types of viral hepatitis are hepatitis A, hepatitis B, and hepatitis C (there is also Hepatitis D and E).

Hepatitis A and B can be transmitted through sexual activity, it is less common to be infected with Hepatitis C through sexual intercourse.

For more detailed information, review the CDC fact sheet for Hepatitis

Human Papillomavirus Virus (HPV)- Genital Warts

HPV is a viral STD and the most common STD/STI. There were about 43 million HPV infections in 2018, many among people in their late teens and early 20s. There are many different types of HPV. Some types can cause health problems, including genital warts and cancers. But there are vaccines that can stop these health problems from happening. HPV is a different virus than HIV and HSV (herpes).

You can get HPV by having vaginal, anal, or oral sex with someone who has the virus. It is most commonly spread during vaginal or anal sex. It also spreads through close skin-to-skin touching during sex. A person with HPV can pass the infection to someone even when they have no signs or symptoms. If you are sexually active, you can get HPV, even if you have had sex with only one person. You also can develop symptoms years after having sex with someone who has the infection. This makes it hard to know when you first got it.

HPV can cause cervical and other cancers, including cancer of the vulva, vagina, penis, or anus. It can also cause cancer in the back of the throat (called oropharyngeal cancer). This can include the base of the tongue and tonsils. Cancer often takes years, even decades, to develop after a person gets HPV. Genital warts and cancers result from different types of HPV.

There is no test to find out a person's "HPV status." Also, there is no approved HPV test to find HPV in the mouth or throat. However, there are HPV tests that can screen for cervical cancer. Most people with HPV do not know they have the infection. They never develop symptoms or health problems from it. Some people find out they have HPV when they get genital warts. Women may find out they have HPV when they get an abnormal Pap test result (during cervical cancer screening). Others may only find out once they've developed more serious problems from HPV, such as cancers.

There is a vaccine available to prevent new HPV infections. The HPV vaccine is recommended for routine vaccination starting at age 11 or 12 years (can be started at age 9). Vaccination is not recommended for everyone older than age 26 years, however adults ages 27 through 45 years might decide to get the HPV vaccine based on discussion with their clinician, if they did not get adequately vaccinated when they were younger.

For more detailed information, review the CDC fact sheet for Human Papillomavirus (HPV

Syphilis

Syphilis is a bacterial sexually transmitted infection (STI) that can cause serious health problems without treatment. Infection develops in stages (primary, secondary, latent, and tertiary). Each stage can have different signs and symptoms.

You can get syphilis by direct contact with a syphilis sore during vaginal, anal, or oral sex. You cannot get syphilis through casual contact with objects, such as toilet seats or doorknobs.

Syphilis can spread from a mother with syphilis to her unborn baby.

There are four stages of syphilis (primary, secondary, latent, and tertiary). Each stage has different signs and symptoms. Without treatment, syphilis can spread to the brain and nervous system (neurosyphilis), the eye (ocular syphilis), or the ear (otosyphilis) during any of the four stages.

- Primary Stage
  - During the first (primary) stage of syphilis, you may notice a single sore or multiple sores. The sore is the location where syphilis entered your body. These sores usually occur in, on, or around the penis, vagina, anus, rectum, or mouth.
  - Sores are usually (but not always) firm, round, and painless. Because the sore is painless, you may not notice it. The sore usually lasts 3 to 6 weeks and heals regardless of whether you receive treatment.
  - Even after the sore goes away, you must still receive treatment. This will stop your infection from moving to the secondary stage.
- Secondary Stage
  - During the secondary stage, you may have skin rashes and/or sores in your mouth, vagina, or anus.
  - This stage usually starts with a rash on one or more areas of your body. The rash can show up when your primary sore is healing or several weeks after the sore has healed. The rash usually won't itch and can be on the palms of your hands and/or the bottoms of your feet and look rough, red, or reddish-brown.
  - Other symptoms may include fever, swollen lymph nodes, sore throat, patchy hair loss, headaches, weight loss, muscle aches, and fatigue.
  - The symptoms from this stage will go not away unless you receive treatment. Without the right treatment, your infection will move to the latent and possibly tertiary stages of syphilis.
- Latent Stage
  - The latent stage of syphilis is a period when there are no visible signs or symptoms. Without treatment, you can continue to have syphilis in your body for years.
- Tertiary Stage
  - Most people with untreated syphilis do not develop tertiary syphilis. However, when it does happen, it can affect many different organ systems. These include the heart and blood vessels, and the brain and nervous system. Tertiary syphilis is very serious and would occur 10–30 years after your infection began. In tertiary syphilis, the disease damages your internal organs and can result in death. A healthcare provider can usually diagnose tertiary syphilis with the help of multiple tests.

For more detailed information, review the CDC fact sheet for Syphilis

Trichomoniasis

Trichomoniasis (or "trich") is a very common STD caused by infection with Trichomonas vaginalis (a protozoan parasite). Although symptoms vary, most people who have trich cannot tell they have it.

Sexually active people can get trich by having sex without a condom with a partner who has trich.

In women, the infection is most commonly found in the lower genital tract (vulva, vagina, cervix, or urethra). In men, the infection is most commonly found inside the penis (urethra). During sex, the parasite usually spreads from a penis to a vagina, or from a vagina to a penis. It can also spread from a vagina to another vagina.

It is not common for the parasite to infect other body parts, like the hands, mouth, or anus. It is unclear why some people with the infection get symptoms while others do not. It probably depends on factors like a person's age and overall health. People with trich can pass the infection to others, even if they do not have symptoms.

About 70% of people with the infection do not have any signs or symptoms. When trich does cause symptoms, they can range

from mild irritation to severe inflammation. Some people get symptoms within 5 to 28 days after getting the infection. Others do not develop symptoms until much later. Symptoms can come and go.

Men with trich may notice:

- Itching or irritation inside the penis;
- Burning after peeing or ejaculating; and
- Discharge from the penis.

Women with trich may notice:

- Itching, burning, redness or soreness of the genitals;
- Discomfort when peeing; and
- A clear, white, yellowish, or greenish vaginal discharge (i.e., thin discharge or increased volume) with a fishy smell.

Having trich can make sex feel unpleasant. Without treatment, the infection can last for months or even years.

For more detailed information, review the CDC fact sheet for Trichomoniasis

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16.1.4.3: End-of-Chapter Material

Key takeaways for this Chapter

- The immune system is constantly working to keep you healthy.
- There are about 1,400 known pathogens that cause disease in humans.
- There are steps you can take to break the chain of infection and stop disease transmission.
- The bodies first barrier to disease are the physical and chemical barriers.
- The innate and adaptive immune system work in tandem to protect you.
- The immune system has an incredible ability to remember past infections.
- The ability to remember pathogens is the foundation for Vaccines
- There are several different types of vaccines.
- STD's are very common
- Most STDs are asymptomatic.

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16.1.4.4: Protecting Health- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

Can you actually boost your immune system? Here's the truth

How mRNA medicine will change the world

How we study the microbes living in your gut

Insights on HIV, in stunning data visuals

Sex, drugs and HIV — let's get rational

The Immune System

Ugly History: The US syphilis experiment

We're covered in germs. Let's design for that.

What is HPV and how can you protect yourself from it?

Which is better: Soap or hand sanitizer?

Why it's so hard to cure HIV/AIDS

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- 4: Cell Structure has no license indicated.

16.1.5: ENVIRONMENTAL MICROBIOMES

16.1.5.1: Environmental Nutrient Cycling and Human Health
16.1.5.2: The Ocean Microbiome and Marine Life
16.1.5.3: Soil Microbiomes
16.1.5.4: Plant Microbiomes
16.1.5.5: Pollution and Bioremediation

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16.1.5.1: Environmental Nutrient Cycling and Human Health

Environmental Nutrient Cycling and Human Health

The importance of microorganisms is unquestionable in regard to how nutrients circulate throughout each ecosystem. There are direct and indirect links between Earth's ecosystems and human health, though like other microbial networks, they are sometimes unfathomably complex.

Climate change may be the most obvious association between environmental and human health, however, the solution to balance is not one likely easily achieved. Each type of ecosystem is unique, and reflects different changes to anthropogenic activity. Global soil microbiomes and organic foliar litter have great impact on worldwide biogeochemical cycling, plant health, and bioremediation, where environmental changes can disrupt microbial taxonomic distribution and functional profiles (Albright et al., 2020, Naylor et al., 2020). The ocean microbiome is vast considering it is the largest ecosystem on the planet, and plays a tremendous part in biogeochemical cycling, ecosystem dynamics, and response to climate change(Moran, 2015, Acinas et al., 2019, Marz et al., 2021). Also, since much of the ocean microbiome is uncharted, it could also serve as a major untapped reservoir for novel and progressive biosynthetic products (Paoli et al., 2021). Other aquatic environments such rivers, lakes, wetlands, and freshwater systems and their interaction with sediments and plants greatly influence carbon and other nutrient cycles in their respective ecosystems (Amado and Roland, 2017, Avila et al., 2019, Trevathan-Tackett et al., 2021).

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

In a cyclic manner, climate change can also greatly affect microbiome dynamics of large ecosystems like glaciers, tundra, permafrost, and even dry deserts, which can further exacerbate disturbances in that region and beyond. (Hamilton et al., 2013, Tripathi et al., 2019, Vigneron et al., 2019, Hough et al., 2020, Ray et al., 2020). These environments harbor several dormant microorganisms that can produce greenhouse gases like carbon dioxide and methane, and if they become metabolically active en masse, this could drastically increase contribution to climate change (Feng et al., 2020). Not only can ecosystem biodiversity be affected, but these changes can impact human society and health. Thus, it is important to consider analytical strategies to better understand global change so future actions can be coordinated to mitigate any negative consequences, and evaluating microbiomes may be part of the solution.

Global Change and the Soil Microbiome: A Human-Health Perspective

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The importance of the gut and the soil microbiomes as determinants of human and ecosystem health, respectively, is gaining rapid acceptation in the medical and ecological literatures. This suggests that there is a wealth of highly transferable knowledge about the microbial ecology of human and non-human ecosystems that is currently being generated in parallel, but mostly in isolation from one another. I suggest that effectively sharing this knowledge could greatly help at more efficiently understanding and restoring human health and the functioning of ecosystems, which are currently under wide-spread pressure. I illustrate this by comparing the effects of nitrogen deposition on ecosystem carbon sequestration with unhealthy dietary habits and human disease. The deposition of N, a key nutrient for plant growth, may increase carbon sequestration (equivalent to obesity) through several mechanisms, including a reduction in the ability of soil microbes to process organic matter, which some argue could help mitigate climate change. However, this usually results in a degradation of ecosystem health and, thus, cannot represent a real solution. Similarly, human obesity is linked to an alteration of the composition and functioning of microbial communities

inhabiting the gut, which is often attributed to unhealthy dietary habits, including ingesting high amounts of simple sugars and processed foods. Finally, I advocate for the explicit recognition of the many commonalities between the functioning of the gut and ecosystems and a broader multidisciplinary collaboration among experts in ecology and human health, including the engineering of soil microbial communities designed *ad-hoc* to restore ecosystem health.

Nitrogen Deposition and Carbon Sequestration in a Changing Climate

It has been widely proposed that atmospheric nitrogen (N) deposition could help mitigate climate change by increasing the rates of carbon (C) sequestration in terrestrial ecosystems (Knorr et al., 2005; Reich et al., 2006; Yue et al., 2016). Two commonly observed responses are typically proposed as mechanisms: first, a greater amount of N usually implies a higher capacity for plant growth, which would result in a greater amount of C retained within the system (Magnani et al., 2007; de Vries et al., 2009; Laubhann et al., 2009). Of course, for this to be true, it is necessary that the increase in the rates of C uptake and accumulation exceed the C emission rates, whatever the main route by which the latter happens, including plant and/or microbial respiration and changes in fire dynamics due to an excess of biomass accumulation (Dezi et al., 2010; Fenn et al., 2010). The second main mechanism is linked to a reduction in decomposition rates, particularly of recalcitrant organic matter, which would, therefore, accumulate within the system (Knorr et al., 2005; Waldrop and Zak, 2006). Otherwise, this accumulated C may be lost to the atmosphere in the form of CO_2 after being respired by soil microorganisms (Janssens et al., 2010). Of course, the relative importance of these mechanisms depend on how plant communities and soil microorganisms respond, directly and indirectly, to the additional inputs of N which, in any case, usually ends up resulting in a disruption of the interaction between these two key components of the ecosystem (Liu et al., 2014).

The Need for a New Perspective

In this article, I will adopt a human health perspective, hardly used in the discipline of global change ecology, to substantiate why atmospheric N deposition cannot represent a positive (i.e., healthy) alternative to mitigate climate change. In the medical literature, it is now widely recognized that human beings are like ecosystems (in fact, some consider us as living ecosystems) in which the eukaryotic cells that form part of our bodies and the prokaryotic cells that live in and on us are deeply interconnected, whereas the enormous importance of our microbiome to human health is also increasingly gaining acceptation (Bengmark, 1998; Berendsen et al., 2012; Ha et al., 2014; Alivisatos et al., 2015; Tilg and Adolph, 2015; Blaser, 2016; Blaser et al., 2016). The fact that many modern diseases, including conditions of the nervous and circulatory systems, skin and heart and allergies (including atopic dermatitis and food allergies), are directly caused by alterations in the microbial communities that live in our interior and exterior is also gaining rapid acceptation (Ha et al., 2014; Tilg and Adolph, 2015; Chang et al., 2016; Tang and Lodge, 2016). In this sense, the word ecosystem is widely used in the current literature of integrative medicine and gastroenterology. However, the opposite does not frequently happen in ecology [i.e., (cautiously) comparing ecosystems with the human body], despite the wealth of knowledge in the medical and human health literature that we, as ecologists, could apply in, for example, issues related to understanding the functioning (i.e., metabolism) of ecosystems and plant-soil-microbe interactions subjected to human pressure (Berendsen et al., 2012; Blaser et al., 2016; Table 1; Figure 1). Therefore, I will finally defend the need to approach problems in ecology from a more multidisciplinary, fresher perspective.

Characteristics associated with a healthy gut	Impacts associated with an unhealthy diet	References	Characteristics of healthy soils and ecosystems	Impacts associated with nitrogen deposition	References
Higher bacterial diversity and abundance that are able to metabolize more food sources and provide essential molecules such as vitamins, hormones, etc.	Functionally and compositionally impoverished gut communities	Thomas et al., 2014	Higher microbial diversity and abundance	Functionally and compositionally impoverished soil communities	Leff et al., 2015; Berg et al., 2017
Protection against disease through the stimulation of the immune system. More longevous individuals	Disease (obesity, diabetes, depression, inflammation etc.). People die younger	Berendsen et al., 2012; Ha et al., 2014; Thomas et al., 2014; Alivisatos et al., 2015; Tilg and Adolph, 2015; Xu et al., 2015; Blaser, 2016	Higher stability and resistance to disturbance	Die-back due to long-term N toxicity, altered fire regimes, pest outbreaks, less tolerance to frost, heat waves, etc.	Bobbink et al., 2010
Lean phenotype	Obese phenotype	Joyce and Gahan, 2014	Rapid processing, transformation and stabilization of litter inputs in the long-term soil pool	Accumulation of intact and partially decomposed leaf litter (i.e., carbon accumulation)	Knorr et al., 2005
High-energy feeling	Low-energy feeling	Umu et al., 2013	Higher ecosystem functionality and supply of key services such as air and water purification, food resources for pollinators, protections against extreme events such as floods, heat waves, etc.	Lower functionality and reduced supply of key services	Costanza et al., 1997; Jones et al., 2014
Well-trained immune system. No medication required. This is also associated with a smaller social cost	Weak immune system. Medication is very often required to treat diverse conditions. Development of drug-resistant strains. Higher social cost	Round and Mazmanian, 2009; Blaser, 2016	High ability to self-regenerate. No or very little management required. No extra cost involved	Management required, including applying herbicides, weeding, etc. High monetary cost	Costanza et al., 1997; Chiquoine et al., 2016
Higher Bacteroidetes to Firmicutes ratio	Lower Bacteroidetes to Firmicutes ratio	Mathur and Barlow, 2015	Higher fungal to bacterial biomass and activity ratio. Higher abundance and diversity of mutualistic mycorrhizal strains	Lower fungal to bacterial ratio. Less mutualistic mycorrhizal strains	Frey et al., 2004; Treseder, 2004; Waldrop et al., 2004; de Vries et al., 2006; Wallenstein et al., 2006

Table 1. The importance of the gut and the soil microbiomes as determinants of human and ecosystem health, respectively, is gaining rapid acceptation in the medical and ecological literatures.

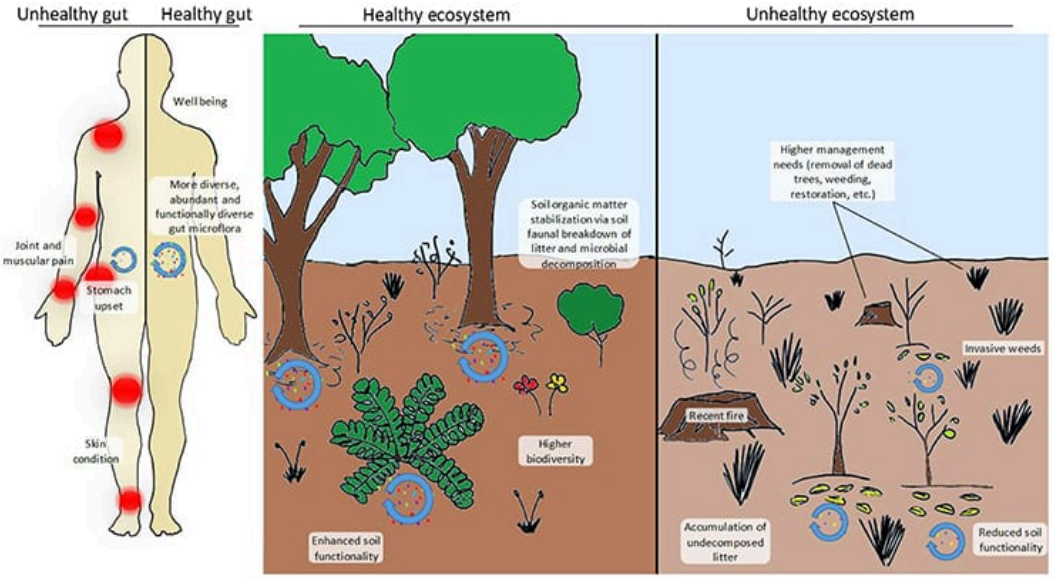


Figure 1. Comparison between a healthy and an unhealthy gut (left-hand side panel) and a healthy and an unhealthy ecosystem (right-hand side panel). In the case of the human individual, his/her gut microbiota is less diverse ("red" microbes are completely absent), less abundant and contains more pathogenic taxa ("yellow" microbes). The individual with the healthy gut has a more functional and more abundant microbiota that provides him/her with essential nutrients, hormones, amino acids, etc. and stimulates his/her immune system. A healthy gut is also less prone to become infected by pathogens and can process toxic compounds (i.e., detoxify) more easily. The disturbed (i.e., unhealthy) ecosystem shown here has recently been affected by a devastating fire fuelled by the accumulation of N-loving exotic grasses that have altered the natural fire dynamics of the system. Facilitated by the altered fire dynamics, the system has also become chronically dominated by weedy grasses, therefore requiring intensive (and costly) management practices (dead tree removal, weeding and restoration), also posing a threat to nearby human populations and their properties. Biodiversity (in terms of microbial, faunal and plant communities) is remarkably higher in the healthy ecosystem, which also has a higher potential to process organic matter inputs and stabilize them in the long-term soil pool. In contrast, undecomposed or partially decomposed litter accumulates on the functionally impoverished soil of the unhealthy ecosystem. This pattern is in agreement with reported observations of higher soil carbon sequestration under increased nitrogen deposition scenarios due to the inhibition of soil enzymes and the reduction of microbial biomass but poses relevant questions such as: Is this type of N deposition-induced carbon sequestration desirable? And, does it really represent a long-term (or even short-term) solution?

Why Nitrogen Deposition Cannot be the Solution to Climate Change

The reason why I think that a temporary, N deposition-induced increase in the rate of C sequestration will not contribute to mitigating climate change in the long term is equivalent to the reason of those that argue that an increase in obesity rates

in human populations derived from a diet rich in simple sugars and processed food and the consequent alteration of their microbiome will not successfully and permanently solve any public health problem of today's societies. Ingesting large amounts of simple sugars, processed foods, sugary drinks and saturated fats is definitely better than starving, but that does not mean that it is a healthy practice. And the same happens with N deposition and C sequestration. In ecosystems where N is still a limiting nutrient, which is quite common worldwide (LeBauer and Treseder, 2008), an increase in the availability of N can increase ecosystem productivity to levels comparable to human obesity (Tian et al., 2016), but that does not mean that the ecosystem is healthier and, therefore, that this will result in a long-term benefit (Bobbink et al., 2010; Jones et al., 2014). In this sense, a healthy ecosystem may be defined here as a highly multifunctional ecosystem that can maintain an adequate supply of services, at least as compared to a previously defined reference state.

In medicine, the term dysbiosis refers to changes in the composition of the microbiome that are not beneficial to the individuals, including a loss of abundance and diversity of beneficial microorganisms and increased number of pathogens, and that result in the development of a condition (Ha et al., 2014; Tilg and Adolph, 2015). This term could also be used to describe ecosystems that are dysfunctional due to alterations of their microbial communities. In this sense, it has been repeatedly shown through experimental studies and meta-analyses that increased N deposition is typically associated with changes in soil microbial communities (usually related to a decrease in abundance and biodiversity; Treseder, 2004, 2008; Ramirez et al., 2010; Zeng et al., 2015), reduced ecosystem functionality (alterations of energy metabolism; Waldrop and Zak, 2006; Treseder, 2008; Liu et al., 2014) and short- to mid-term increases in C sequestration, especially in aboveground biomass, but also in the soil and roots (comparable to obesity, as previously mentioned; Xia and Wan, 2008; Yue et al., 2016). Given that metabolic disorders and obesity in humans are clearly associated with a deterioration in the health status of individuals that may even result in cases of fatality due to chronic diseases, sudden death or, quite commonly in the natural world, to increased sensitivity to other environmental stresses (Mathur and Barlow, 2015; Monteiro et al., 2015), I think that we would do well to be cautious when we consider, perhaps naively, the potential benefits of a N that, after all, is the result of the atmospheric pollution derived from our activities (Gruber and Galloway, 2008).

The "Deceptively Simple" Solution

The connections between human health, disease, and the microbiome, especially in the case of the gut, are becoming increasingly apparent and are attracting the public attention, especially because of the high social cost of unhealthy dietary habits and lifestyles and the "deceptively simple" solution of the problem (Mathur and Barlow, 2015; Tilg and Adolph, 2015; Blaser, 2016). In the case of both people and ecosystems, (i) ensuring a healthy supply of nutrients derived from the breakdown and cycling of unprocessed food/organic matter, (ii) minimizing the use of antibiotics (particularly those associated with the livestock industry in the case of ecosystems; Park and Choi, 2008) and chemicals (including herbicides and pesticides in the case of ecosystems) that destroy the microbiome, unless this is strictly necessary, and (iii) promoting practices that favor the system's ability to self-regenerate, something that living systems do wonderfully well, and that increase its resilience against pathogens and extreme events could be part of the solution, if not all, of the problem.

Of course, there are opportunities to aid in the recovery of our damaged and degraded ecosystems as well as there are possibilities to recover the lost or damaged intestinal flora (Brudnak, 2002; Sheth et al., 2016). This can be achieved by the use of properly designed probiotics or fecal transplants or, in the case of ecosystems, inocula assembled in the lab from pure cultures or soil samples obtained in the field from healthy ecosystems (Bowker, 2007; Chiquoine et al., 2016; Wubs et al., 2016) in conjunction with a balanced nutrient supply (i.e., organic matter inputs, the equivalent to prebiotics; Mathur and Barlow, 2015; Sheth et al., 2016). In this sense, the concept of synbiotics (i.e., synchronous administration of probiotics and prebiotics) could represent a particularly promising benchmark borrowed from the human health literature to successfully restore degraded ecosystems (Tang and Lodge, 2016) and, thus, the human probiotics industry has an opportunity to play a key role in this development.

Concluding Remarks

Recognizing and understanding the similarities and deep connections between the gut and the belowground world, where roots are the equivalent to our gut and the rhizosphere is the gut microflora (Berendsen et al., 2012) can help us advance the understanding of ecosystems by leaps and bounds through the search of similar microbial indicators of disease (e.g., Bacteroidetes to Firmicutes ratio in humans; Mathur and Barlow, 2015) and, therefore, to implement quick and successful measures in ecosystem management rather than relying, perhaps naively, on that the very same thing that caused climate change (i.e., pollutant emissions to the atmosphere) will also be part of the solution. From here, I advocate for the development of a new field of research that specifically aims at recognizing and make practical use of the profound links between the functioning of the gut and the ecosystems that extend beyond our bodies and that benefits from a truly multidisciplinary collaboration among experts in the areas of global change ecology and human health.

Author Contributions

The author confirms being the sole contributor of this work and approved it for publication.

Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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- What are some suggested solutions to improve environmental and human health concerning microbiomes?

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16.1.5.2: The Ocean Microbiome and Marine Life

The Ocean Microbiome and Marine Life

The ocean is teeming with life, both macro and micro, where their adaptation and success are dependent on both a local and global scale. Oceanic microorganisms have major roles in nutrient cycling, ecological interactions, and influence and respond to environmental changes (Doney et al., 2012). Temperature is the strongest factor that determines microbial community composition, which parallels depth stratification, and these communities can serve as indicators for anthropogenically-induced climate changes (Sunagawa et al., 2015). It is predicted that carbon fixation by microbial primary producers will decrease which will have downstream effects on ocean microbiome structure and overall trophic level interactions (Moran, 2015).

While free-living marine microorganisms can provide relevant information and predictive models about the ocean, those host-associated microbes can also give environmental insight into the largest ecosystem on the planet.

Marine Animal Microbiomes: Toward Understanding Host–Microbiome Interactions in a Changing Ocean

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All animals on Earth form associations with microorganisms, including protists, bacteria, archaea, fungi, and viruses. In the ocean, animal–microbial relationships were historically explored in single host–symbiont systems. However, new explorations into the diversity of microorganisms associating with diverse marine animal hosts is moving the field into studies that address interactions between the animal host and a more multi-member microbiome. The potential for microbiomes to influence the health, physiology, behavior, and ecology of marine animals could alter current understandings of how marine animals adapt to change, and especially the growing climate-related and anthropogenic-induced changes already impacting the ocean environment. This review explores the nature of marine animal–microbiome relationships and interactions, and possible factors that may shift associations from symbiotic to dissociated states. I present a brief review of current microbiome research and opportunities, using examples of select marine animals that span diverse phyla within the Animalia, including systems that are more and less developed for symbiosis research, including two represented in my own research program. Lastly, I consider challenges and emerging solutions for moving these and other study systems into a more detailed understanding of host–microbiome interactions within a changing ocean.

Introduction

Marine animals are the icons of life in the oceans. They represent about two million species (Mora et al., 2011) and include a wide range of body designs, from the highly simplistic sponges lacking true tissues and organs to the complex vertebrates containing specialized tissues and organs, such as fish and marine mammals, with some iconic representatives presented in Figure 1. The bodies of marine animals span several orders of magnitude in size, from the abundant planktonic copepod (1–2 mm) to the highly mobile blue whale (30 m), the largest animal on Earth. Marine animals are key members of ocean ecosystems and serve as both prey of and predators for other animals within the complex ocean food web. In contrast to terrestrial animals, marine animals have developed strategies for osmoregulation as well as highly specialized approaches for maintaining homeostasis within diverse temperature, oxygen and pressure gradients of the ocean (Graham, 1990; Knoll and Carroll, 1999). Marine animals also possess sophisticated specializations and functions that promote their success on or within their benthic or pelagic habitats, including specializations for living or enduring depths (outlined in Figure 1) that vary widely in factors such as light availability, access to food and predator exposure.

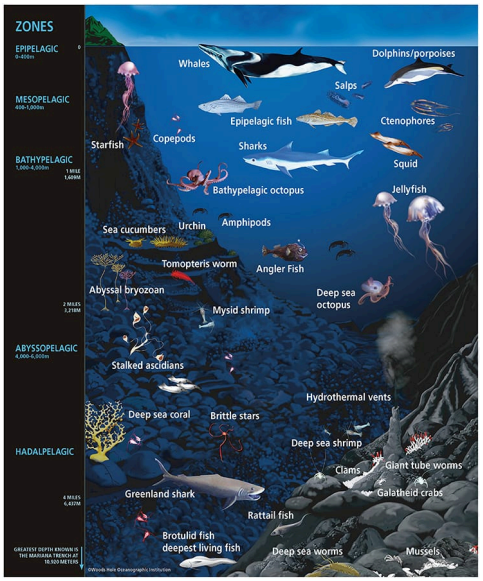


Figure 1. Illustration and common names of representative ocean animal life within their approximate depth-defined ecological habitats. Microorganisms exist on the surfaces and within the tissues and organs of the diverse life inhabiting the ocean, across all ocean habitats. Animals are not drawn to scale.

Marine animals share the sea with a vast diversity of microorganisms, including protists, bacteria, archaea, fungi, and viruses which comprise millions of cells in each milliliter of the 1.3 billion km^3 of water comprising the oceans (Eakins and Sharman, 2010). These microorganisms are several micrometers or smaller in size, but collectively their roles in oxygen production, nutrient cycling, and organic matter degradation provide critical functions to the oceans and Earth (Arrigo, 2005; Falkowski et al., 2008). Microorganisms that associate with marine animals are part of the animal's microbiome, or collection of microorganisms that reside on or within the animal. Some of the microorganisms comprising the microbiomes of marine animals are thought to originate from this surrounding supply of seawater-associated cells (e.g., Nussbaumer et al., 2006), while other cells appear to have strict inheritance patterns, passed on through generations from the host (Sharp et al., 2007).

Over the past two decades, the widespread application of genomic and more integrative microbiological approaches have advanced our understanding of animal microbiomes (reviewed within McFall-Ngai et al., 2013). Symbiotic relationships between microorganisms and marine animals have been studied for decades, but technological advancements are providing new insights into the sheer diversity of microbial life in association with animals in the sea (Smith, 2001; Douglas, 2010). For example, reef-building corals are acknowledged as the icons of animal–microbial symbiosis in the sea, with corals hosting photosynthetic symbionts that make critical contributions to host nutrition (Muscatine et al., 1981). New reports of diverse protists, bacteria, archaea, and viruses in association with corals provide insights into the role of these cells for fulfilling diverse functional processes within the different niches of the coral host (reviewed within Thompson et al., 2015; Bourne et al., 2016). In fact, for many terrestrial animals, new reports of microbial symbioses provide insights into the variety of genetic and biochemical interactions and the ways that microorganisms contribute to animal health, behavior, and ecology (e.g., Ley, 2010; Cho and Blaser, 2012).

Understanding the microbiomes of marine animals is a growing research area within the field of marine science. Currently, the science is heavily focused on identifying consistent or "core" microbial members of the microbiome (Shade and Handelsman, 2012). After first gaining an understanding of "who's there" generally using diversity-based surveys targeting the small subunit (SSU) ribosomal RNA (rRNA) gene, these microbiomes are then often examined as a whole or in smaller units to understand the function of the cells, the nature of the associations and ultimately gain insight into the role of the microbiome in animal health, physiology, ecology, and behavior (Ezenwa et al., 2012; McFall-Ngai et al., 2013). Additionally, the ocean environment is changing at unprecedented rates due to climate-related and anthropogenic-induced impacts (Halpern et al., 2008; Doney et al., 2012), and the microbiome is also being investigated for its possible role as a sentinel of a changing host (Ainsworth and Gates, 2016).

How environmental changes and animal life history events affect the microbiomes of marine animals is growing area of research, and there is an emerging focus on better understanding interactions between the animal, microbiome, and ocean environment, including the elements that may define their exchanges (e.g., Meron et al., 2011; Lesser et al., 2016; Webster et al., 2016). Therefore, this review considers the symbiosis and dissociated stages of animal–microbiome associations, and discusses factors and causes that may alter interactions between animals and their microbiome. Next, this review discusses current research examining animal–microbiome relationships and interactions, by focusing on select systems that represent

diverse marine animal phyla and which span the range of being more to less developed for microbiome research. Two of these systems, corals and marine mammals, are represented in my own research program. Lastly, this review concludes with a discussion of challenges in marine animal–microbiome research and opportunities available to further advance knowledge of animal–microbiome interactions in the ocean.

Conceptual Model of Factors Contributing to Host-Microbiome Interactions

Host–microbiome dynamics are generally described as falling into two main categories: symbiosis, in which the organisms are involved in a normal metabolic and immune signaling interactions, and secondly dysbiosis, in which the relationship or interactions are heavily altered, possibly related to a major stress or infection event. While host–microbiome symbiosis and dysbiosis has been mostly considered in humans and humanized models (Hamdi et al., 2011; Nicholson et al., 2012; Scharschmidt and Fischbach, 2013), many of the same concepts are applicable to organisms in the sea (Egan and Gardiner, 2016), and are being explored in various systems (discussed below). The exact factors and mechanisms tipping the scale between symbiosis and dysbiosis will probably vary with complexity of the host anatomy and immune functioning (e.g., simplistic sponges and corals compared to more complex fish and sharks) as well as with the complexity of interactions that may occur between the members of the microbiome.

A normal animal–microbiome relationship in the ocean could be referred to as a “symbiotic” state, although the exact nature of the relationship may vary for each cell in the association. For example, cells residing on the surface or within the gut cavity of an animal are physically associated, yet do not share as intimate of an association as those microbes residing intracellularly with the host’s cells. This normal symbiotic state is subject to a variety of environmental fluctuations, which are generally defined by the characteristics of the habitat (Figure 1). For example, in the ocean’s upper photic zone, animals are exposed to variations in temperature and light, and host–symbiont interactions, especially in ectothermal animals, could alter on cycles such as seasons that generally control the temperature and light environment. Normal fluctuations in animal-specific patterns could also alter host–microbiome relationships. For example, changes in diet, possibly due to short-term prey availability, can alter gut microbiota and host–microbiome metabolic exchanges in other systems (e.g., David et al., 2014), and similar diet trends may also affect marine animals. Stress is another factor more complex animals encounter on a daily basis (e.g., squid, crabs, fish), which could be related to social/territorial encounters or chasing or fleeing from prey, and the short-term production of stress hormones such as cortisol can influence host–microbiome relationships (e.g., Moloney et al., 2014).

There are also normal animal life events that occur on longer time frames or that are more drastic in scope, such as animal development, aging, and reproduction. In non-marine animals, these factors have been shown to cause alterations in animal-microbial relationships (e.g., Heintz and Mair, 2014). These changes can be drastic enough to cause a state of “altered symbiosis” that could extend for short or longer term. For example, the gut microbiome of women generally becomes altered during pregnancy (Koren et al., 2012). Events resulting in normal animal stress may also lead to a more altered symbiotic state, for example if social conflict was more chronic, perhaps due to the pressures of a particular habitat. Data from humans and humanized models suggests that the microbial community and associated genes do fluctuate with the normal variations and animal life events, and both may be considered “healthy” fluctuations (Nicholson et al., 2012). However, how these fluctuations affect exchanges between the host and microbiome is much less understood.

If symbiosis and altered symbiosis are considered as normal host–microbiome variations throughout an organism’s life, dysbiosis is the breakdown in the relationship, generally related to one or more major stressors, and can greatly alter host health and lead to a disease state (Holmes et al., 2011). The stressor may come from an external source, such as a pollutant, infective agent, or a longer-term natural environmental change—and there are probably countless other factors that could fit this category (Figure 2). For example, one of the most visible signs of host–microbiome dysbiosis is with scleractinian corals, whose relationship with unicellular algae breaks down after long-term yet small increases in seawater temperature, causing the coral to become “bleached” (Brown, 1997). In humanized models, major stressors such as malnutrition are related to less physically visible changes in innate immunity, which are linked to microbial ecology (Hashimoto et al., 2012). Understanding the relationship between symbiosis, dysbiosis and host health and functioning are general topics of research in most host–microbiome studies, but the environmental changes occurring in the ocean environment have made this area of research more pressing for marine animals. Overall, the concepts behind the model presented in Figure 2, as well as variations of this model, are generally driving much of the current research examining animal-microbial relationships in the ocean.

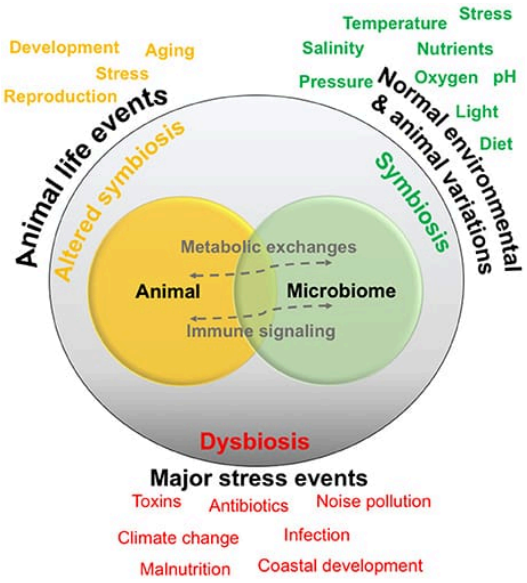


Figure 2. Conceptual diagram of a host-microbiome relationship. Relationships are generally thought to exist in a symbiotic state, and are normally exposed to environmental and animal-specific factors that may cause natural variations. Some events may change the relationship into a functioning but altered symbiotic state, whereas extreme stress events may cause dysbiosis or a breakdown of the relationship and interactions.

Overview of Diverse and Emerging Animal-Microbiome Study Systems

The microbiomes of diverse marine animals are currently under study, from simplistic organisms including sponges (e.g., Webster et al., 2010) and ctenophores (Daniels and Breitbart, 2012) to more complex organisms such as sea squirts (Blasiak et al., 2014) and sharks (Givens et al., 2015). Below I present some of the current study systems that represent a diverse cross-section of marine animal phyla, and trends of research in these systems including focus on symbiosis and dysbiosis. The organisms are generally presented in order from increasing to decreasing knowledge about the host-microbiome relationship.

The relationship between the Hawaiian bobtail squid *Euprymna scolopes* (phylum Mollusca) and the bioluminescent bacterium *Vibrio fisheri* (also recognized as *Aliivibrio fisheri*) is one of the best studied symbiotic relationships in the sea and is a choice system for general symbiosis research (Figures 3A,B). The *E. scolopes*-*V. fisheri* relationship has provided insight into fundamental processes in animal-microbial symbioses, and especially biochemical interactions and signaling between the host and bacterium (McFall-Ngai, 2000, 2014). Much of this research focuses on establishment of the symbiosis, with less focus on dysbiosis. Additionally, because *V. fisheri* exists in the light organ, these studies have been primarily limited to this one isolated relationship, with the remainder of the squid's microbiome virtually unstudied (but see Barbieri et al., 2001; Collins et al., 2012). The *E. scolopes*–*V. fisheri* system offers simplicity for the study of host–microbial interactions and numerous helpful developments in animal husbandry, genomic tools, and experimental design that could be applied to ask more comprehensive questions about squid–microbiome interactions, including the conditions leading to dysbiosis of relationships.

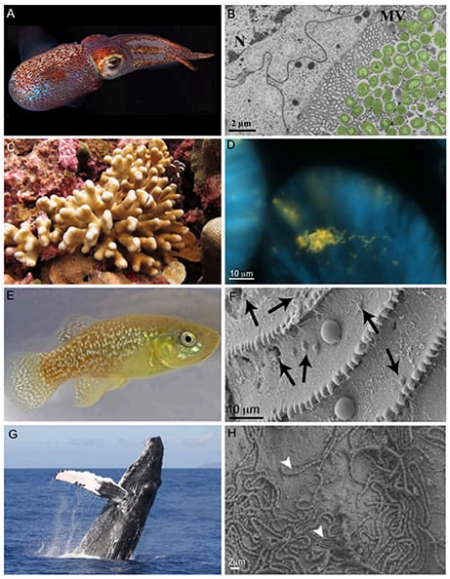


Figure 3. Photographs of marine animals and their associated microbiomes from select study systems. Photographs include: the Hawaiian bobtail squid Euprymna scolopes (A) and a transmission electron micrograph of Vibrio fisheri cells associating with dense microvilli (MV) and in proximity to the epithelial nucleus (N) within the light organ (B); the reef-building coral Stylophora pistillata (C) and a microscopy image of Endozoicomonas cells (probed yellow using in situ hybridization) within the tentacles of a S. pistillata host (D); the Atlantic killifish (Fundulus heteroclitus) (E) and a scanning electron microscopy (SEM) image of the surface and scales of the fish, with arrows pointing to bacterial-sized cells and larger cells (which are not noted) are presumably phytoplankton (F); a humpback whale (Megaptera novaeangliae) breaching (G) and a scanning electron microscopy image of a humpback's skin surface associated bacteria, with arrows indicating two different cell morphologies (H). Photographs (A,B) were produced by M. McFall-Ngai and were previously published photographs (McFall-Ngai, 2014), (C,H) were previously published by the author Neave et al. (2016) and Apprill et al. (2014), photograph (D) was taken by Liping Xun and photograph (E) by Evan D'Alessandro.

Similar to *E. scolope*, the gutless marine oligochaete worm *Olavius algarvensis* (phylum Annelida) is another relatively well-studied marine host to microbes. One major difference is that it has been studied within the context of a larger consortium of microorganisms compared to *E. scolope*. These 3 cm long worms reside within shallow marine sediments of the Mediterranean Sea. The worms do not contain a mouth or a digestive or excretory system, but are instead nourished with the help of a suite of extracellular bacterial endosymbionts that reside upon coordinated use of sulfur present in the environment (Dubilier et al., 2001). This system has benefited from some of the most sophisticated 'omics and visualization tools (Woyke et al., 2006). For example, multi-labeled probing has improved visualization of the microbiome (Schimak et al., 2016) and transcriptomics and proteomics have been applied to examine host–microbiome interactions, including energy transfer between the host and microbes (Kleiner et al., 2012) and recognition of the consortia by the worm's innate immune system (Wippler et al., 2016). The major strength of this system is that it does offer the ability to study host–microbiome interactions with a low diversity microbial consortium, and it also offers a number of host and microbial genomic resources (e.g., Woyke et al., 2006; Ruehland et al., 2008). Dysbiosis has not been heavily investigated in this system, and given the growing knowledge of host–microbial interactions, *O. algarvensis* could be an imperative animal for dysbiosis research.

As mentioned above, corals (phylum Cnidaria) (Figure 3C) are one of the most common examples of an animal host whose symbiosis with microalgae can turn to dysbiosis, and is visibly detected as bleaching. Coral microbiomes have been examined in a variety of studies, which demonstrate how variations in the ocean environment, most notably temperature, light, and inorganic nutrients, affect the abundance and performance of the microalgal symbionts, as well as calcification and physiology of the host (Dubinsky and Jokiel, 1994; Anthony et al., 2008). Studies have also suggested that resident bacteria, archaea, and fungi additionally contribute to nutrient and organic matter cycling within the coral, with viruses also possibly playing a role in structuring the composition of these members, thus providing one of the first glimpses at a multi-domain marine animal symbiosis (reviewed in Bourne et al., 2016). The gammaproteobacterium *Endozoicomonas* is emerging as a central member of the coral's microbiome, with flexibility in its lifestyle (Figure 3D) (Neave et al., 2016, 2017). Ocean disturbances including elevated temperature and ocean acidification have been shown to disrupt the coral's associated bacteria (Thurber et al., 2009; Meron et al., 2011), including relationships with *Endozoicomonas* (Morrow et al., 2015). However, some members of this microbiome appear to be stable across large environmental gradients (Hernandez-Agreda et al., 2016). In addition to nutrition, the microbiome plays a role in coral health and stress. Temperature and light stress to corals can result in overproduction of reactive oxygen species (ROS), which can be detrimental to *Symbiodinium* and result in bleaching, but the associated bacteria have also recently been shown to contribute extracellular ROS (Diaz et al., 2016; Zhang et al., 2016), which could play a signaling role with the host or

within the microbiome. Given the recent mass bleaching occurring on reefs (Hughes et al., 2017), corals will likely continue to be a useful and popular system for symbiosis and dysbiosis research. There are number of resources available to further promote study of the coral microbiome, including integrated databases (Franklin et al., 2012; Madin et al., 2016), a growing number of host and microbial genomes (Shinzato et al., 2011; Bayer et al., 2012; Neave et al., 2017), and laboratory amendable "model" systems (Weis et al., 2008; Baumgarten et al., 2015).

Sponges (phylum Porifera) are common members of the ocean's diverse benthic habitats and their abundance and ability to filter large volumes of seawater have led to the awareness that these organisms play critical roles in influencing benthic and pelagic processes in the ocean (Bell, 2008). They are one of the oldest lineages of animals, and have a relatively simple body plan that commonly associates with bacteria, archaea, algal protists, fungi, and viruses (reviewed within Webster and Thomas, 2016). Sponge microbiomes are composed of specialists and generalists, and complexity of their microbiome appears to be shaped by host phylogeny (Thomas et al., 2016). Studies have shown that the sponge microbiome contributes to nitrogen cycling in the oceans, especially through the oxidation of ammonia by archaea and bacteria (Bayer et al., 2008; Radax et al., 2012). Most recently, microbial symbionts of tropical sponges were shown to produce and store polyphosphate granules (Zhang et al., 2015), perhaps enabling the host to survive periods of phosphate depletion in oligotrophic marine environments (Colman, 2015). The microbiomes of some sponge species do appear to change in community structure in response to changing environmental conditions, including temperature (Simister et al., 2012a) and ocean acidification (Morrow et al., 2015; Ribes et al., 2016), as well as synergistic impacts (Lesser et al., 2016). Understanding the effect of these altered host–microbiome interactions on sponge growth and ecology are topics for further research. As such, there are a number of resources to support research on sponges including a curated database of sponge–microbial sequences (Simister et al., 2012b), cultivated microbial isolates and sponge cell cultures from some species (Taylor et al., 2007) to facilitate investigations.

Atlantic killifish, (*Fundulus* spp., Phylum Chordata) (Figure 3E) are one of the most abundant estuarine fishes in North America, and are related to other families with more global distributions in coastal areas (Fritz et al., 1975; Lotrich, 1975). The killifish have a broad North American geographic distribution yet limited subpopulation movement, and thus the Atlantic killifish have become a useful field-residing model species for examining biological and ecological responses to natural environment conditions (salinity, oxygen, pH, and temperature) as well as chemical pollutants (Burnett et al., 2007). While the killifish microbiome (Figure 3F) has not been extensively studied, there is work examining the influence of pollutants on the skin and mucus of the fish, which suggests that this skin microbial community is relatively resistant to change (Larsen et al., 2015). Populations of the fish offer a unique host genetic resistance to toxicity (Hahn et al., 2004), and it is possible that this resistance is also facilitated by features of the microbiome. The Atlantic killifish appear to be an ideal study species for microbiome investigations and especially the response of the host–microbiome symbiosis to changing ocean conditions. Specifically, the killifish can be maintained in laboratory aquaria, they are hardy and amendable to experimental manipulation, and spawning material can be acquired for developmental (Burnett et al., 2007).

The microbiomes of marine mammals (phylum Chordata) (Figure 3G) have recently been investigated and offer a comparative study system to terrestrial mammals (reviewed within Nelson et al., 2015). Marine mammals are often viewed as sentinel species of the ocean, because they appear to rapidly respond to ocean conditions, disturbances, and pathogens similarly to humans (Bossart, 2011). Several studies have examined the skin (Figure 3H), gut and respiratory microbiomes of diverse marine mammal species, and describe species-specific relationships (Johnson et al., 2009; Apprill et al., 2014; Bik et al., 2016). Connections between the community composition of the microbiome and animal health (Apprill et al., 2014) and diet (Nelson et al., 2013; Sanders et al., 2015) have been made, and more detailed studies are needed to understand these specific connections. While there are very limited resources available for studying host–microbiome interactions in marine mammals, there are some animals in captivity as well as well-studied populations that will heighten investigations of host–microbiome symbiosis and dysbiosis in these sentinel species.

Challenges and Emerging Solutions to Studying Animal–Microbiome Interactions

A number of the systems highlighted above are currently examining animal–microbiome interactions, but these are generally most developed in systems such as *O. algarvensis* that offer lower complexity microbiomes, or within the single host–symbiont relationship between *E. scolopes* and *V. fisheri*. As such, a major challenge to the field is exploring host–microbiome interactions within the context of a diverse microbiome, and especially if the microbiome includes members such a uncharacterized protists, fungi, and viruses, which have generally not been described in most marine animal systems. Therefore, a through description of the microbiome is a first necessity, but this still presents many challenges on a variety of levels. For example, amplifying or shotgun sequencing microbial DNA with the presence of abundant host cells often requires optimization or high sequencing output (e.g., Rocha et al., 2014; Weber et al., 2017). Taxonomic databases generally contain few microbial sequences from many of these animals, and therefore simple tasks such as assigning taxonomy can be challenging. Developing animal-specific databases (Simister et al., 2012b), which include the next-generation supplied sequences generally not available in curated taxonomic

databases, could help alleviate this problem. There are also a number of new tools for metagenomics-based analysis, including advancements in binning genomes from complex samples (Kang et al., 2015; Graham et al., 2017) as well as new visualization methods for comparing genomes (Eren et al., 2015; Wagner et al., 2017). A challenging issue that has received less attention is how to gain information from unknown genes and gene families, which can make up over half of the environmental microbial genomes. Algorithms utilizing gene function predictions do provide some assistance with this problem (Mi et al., 2015), and these tools may improve as more environmental microbial genomes are available. Lastly, computational tools are emerging to facilitate identifying associations between host genetic variation and microbiome composition (Lynch et al., 2016).

Once some of these hurdles are overcome and a comprehensive view of the microbiome is available, researchers can then explore the nature of the host–microbiome relationship. Visualization using a variety of different microscopy-based techniques is a powerful tool to recognize the physical relationship between a host and the microbiome, as well as the organization of cells within the microbiome. Electron microscopy provides the most detailed information about this organization, but this is less useful for complex microbiomes because taxonomically distinct microbial cells with similar appearances cannot be distinguished. Fluorescent *in situ* hybridization (FISH), and especially using a multi-taxonomic, simultaneous probing technique such as Combinatorial Labeling and Spectral Imaging FISH (CLASI-FISH) (Valm et al., 2011) can provide significant insight into host–microbe and microbe–microbe interactions. FISH techniques do require optimization for some animal systems, such as corals that possess autofluorescent host tissues (Wada et al., 2016). Visualization techniques can also be paired with isotope probing, to provide opportunities to trace the transfer of specific molecules between the host and microbiome, as well as within the microbiome using Nano-SIMS and Nano-SIP approaches (Musat et al., 2016). There have also been many recent instrumental and database advances in the field of metabolomics (Beisken et al., 2015), and this approach is beginning to be applied to examine host–microbiome interactions (Gomez et al., 2015; Sogin et al., 2016). An understanding of specific microbial metabolites will help facilitate targeted investigations of how these products affect the host nutritional and immune systems.

Lastly, experimental manipulation is a challenge to the study of host–microbial interactions in the ocean. Studying the animals in their natural environment is the most ideal approach because it ensures that the surrounding seawater microbial community is maintained. However, natural experiments are only as helpful as the natural variability in the host-microbe system, and generally only afford the opportunity to study events such as seasonality, animal growth or other life history events. Artificial systems such as aquaria or mesocosms offer opportunities to manipulate environmental conditions or expose the animal to antibiotics or other molecules that are difficult to dose in the wild. However, not all animals are ideal for these systems (e.g., large whales, hydrothermal vent worms), and it can be challenging to reproduce some environmental conditions. Advances in aquaria design that offer consistency in environmental conditions and the ability to manipulate complex environmental interactions, such as the Australian Institute of Marine Science's National Sea Simulator, provide opportunities to conduct more realistic experiments. As the need to understand how host–microbiome interactions will alter with the forecasted changes in ocean temperature and pH, facilities such as this will become critical to animal–microbiome research in the ocean.

While studies of marine animal–microbiome interactions are certainly plagued by a number of challenges, the future is also very bright for this emerging field. Many of the new bioinformatics and methodological advancements now available to marine biologists stem from the biomedical field, and thus marine animal microbiome research, as well as other environmental-based fields, are profiting from the elevation in microbiome research funding and attention. There could also be growing interest in using marine animals as models for examining resilience, promoted by the fact that alterations in the ocean conditions are often outpacing those in terrestrial environments. Given the phylogenetic breath of animals in the ocean, coupled with the many diverse ocean environments, there is certainly a wealth of research opportunities available to study host–microbiome interactions in the ocean.

Author Contributions

The author confirms being the sole contributor of this work and approved it for publication.

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Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Studying Ocean Microbiomes Data

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Prevalence of certain marine topics appearing in combination with the term holobiont in the title, abstract, and/or keywords of scientific publications from 1990 to February 2021 (N = 1269). Bars indicate the percentage of publications that contain terms related to a certain marine topic (cnidarians, corals, sponges, etc.). It is important to note that the different topics may overlap in several publications. For example, many publications treat of the topics of coral and sponge holobionts together. Data retrieved from the curated citation and abstract database Scopus on the date 10/03/2021. (Stevenne et al., 2021)

Check your Understanding

- Which environmental factor is the biggest driver of change for the community composition of free-living oceanic microbes?
- What factors affect the normal symbiotic state between marine host and their microbiome?
- Describe one well-studied marine animal-microbial symbiosis and its importance.
- What are some challenges to studying marine host-associated microbiomes?

Media Attributions

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16.1.5.3: Soil Microbiomes

Soil Microbiomes

The terrestrial landscape on Earth harbors countless microbes that have major responsibilities in shaping their surrounding environment. One gram of soil can contain up to 10 billion microorganisms and consist of thousands of different species. Each ecosystem has unique soil properties that cultivate a diverse array of microbial communities, which are primarily composed of bacteria, however archaea, protists, fungi, viruses, and other microscopic organisms can be found in varying abundances too. The composition and health of the surrounding environment and its macro inhabitants are dependent on their soil borne microbial partners, and a disturbance in the balance of the soil microbiome can have far-reaching effects (Omotayo and Babalola, 2021).

Environmental and agricultural sustainability is important in a number of regards, especially maintaining biodiversity, plant and animal health, ecosystem homeostasis, and even human health. Anthropogenic effects on the climate and environment have become abundantly apparent, and it is imperative to adjust mindsets to become more environmentally conscious, not only to preserve aspects of nature, but to accommodate an increasing human population. The soil is foundational to agricultural practices, and therefore food production, and so a better understanding of various soil microbiomes could serve to benefit future applications and practices (Tosi et al., 2020). One possibility, is to become less reliant on synthetic nitrogen fertilizers for soil, and utilize symbiotic nitrogen-fixing bacteria as sources for plant nitrogen.

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Microbe to Microbiome: A Paradigm Shift in the Application of Microorganisms for Sustainable Agriculture

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Light, water and healthy soil are three essential natural resources required for agricultural productivity. Industrialization of agriculture has resulted in intensification of cropping practices using enormous amounts of chemical pesticides and fertilizers that damage these natural resources. Therefore, there is a need to embrace agriculture practices that do not depend on greater use of fertilizers and water to meet the growing demand of global food requirements. Plants and soil harbor millions of microorganisms, which collectively form a microbial community known as the microbiome. An effective microbiome can offer benefits to its host, including plant growth promotion, nutrient use efficiency, and control of pests and phytopathogens. Therefore, there is an immediate need to bring functional potential of plant-associated microbiome and its innovation into crop production. In addition to that, new scientific methodologies that can track the nutrient flux through the plant, its resident microbiome and surrounding soil, will offer new opportunities for the design of more efficient microbial consortia design. It is now increasingly acknowledged that the diversity of a microbial inoculum is as important as its plant growth promoting ability. Not surprisingly, outcomes from such plant and soil microbiome studies have resulted in a paradigm shift away from single, specific soil microbes to a more holistic microbiome approach for enhancing crop productivity and the restoration of soil health. Herein, we have reviewed this paradigm shift and discussed various aspects of benign microbiome-based approaches for sustainable agriculture.

Introduction

The health of soil plays an essential role in the ability of plants to produce food, fuel, and fiber for a growing world population. To

keep pace, the total area of cultivated land worldwide has increased over 500% in the last five decades with a 700% increase in fertilizer use and a several-fold increase in pesticide use (Banerjee et al., 2019). In addition to being the world's largest agricultural producers and exporters, the EU, Brazil, United States, and China also are some of the world's largest pesticide users – each using 827 million, 831 million, 1.2 billion, and 3.9 billion pounds of pesticides, respectively, in 2016 (Donley, 2019). However, these numbers are not sustainable from either a supply-chain or environmental perspective. Thus, because natural resources are limited and their overuse pollutes the environment, the continued use of fertilizers and water to meet the demand of future global food requirements is not sustainable. Of relevance here is that agricultural intensification with high resource use and low crop diversity can negatively affect soil- and plant-associated microbiota (the so-called "phytobiome") with subsequent impacts on critical ecosystem services (Matson et al., 1997).

There is growing evidence that aboveground plant diversity supports belowground microbial biodiversity, primarily through root exudation and rhizo-deposition (Bais et al., 2006; Eisenhauer et al., 2017; Morella et al., 2020). These more simple carbohydrates released into the soil primarily feed bacteria (Gunina and Kuzyakov, 2015) and are the most abundant near the root surface and diffuse along a gradient as distance from the root increases (Gao et al., 2011). The microbial composition is more abundant and complex in the rhizosphere, the narrow zone surrounding plant roots, with up to 10^9 cells per gram in typical rhizospheric soil, comprising up to 10^6 taxa (Lakshmanan et al., 2017). The more complex carbohydrates (e.g., lignin, cellulose) are largely degraded by decomposer fungi that break down these recalcitrant compounds into forms that can be used by other microbes. This conversion is largely decoupled from conventional agricultural practices, wherein the organic matter content is often lost to the system (Craven and Ray, 2019), and the carbon flux is at least partially unregulated in this regard. Again, defining nutrient fluxes with techniques like Stable Isotope Labeling (SIP) holds great potential to define and construct resilient, functioning and beneficial microbiomes that can contribute to future holistic agriculture. Thus, applying an efficient and diverse soil microbiome backed by these new technologies can facilitate and promote sustainable agriculture and can effectively contribute to meet the triple requirements of economic, social and environmental sustainability (Ray and Craven, 2016).

Historically, microorganisms that promote plant growth and nutrient acquisition have been used largely as single strains in agriculture to offset such fertilizer inputs as nitrogen and phosphorous. However, studies of natural populations suggest that groups of microbes with distinct function niches play pivotal roles in adhering and desorbing inorganic nutrients to physical surfaces, as well as breaking down organic residues and incorporating them into the soil (Lakshmanan et al., 2014; Finkel et al., 2017; Kumar and Dubey, 2020). Conceptually, such observations support the idea of the microbiome as a second genome or an extended genome of the plant (Vandenkoornhuyse et al., 2015). It is now evident that improving plant performance in a sustainable manner is beyond the binary interaction between a specific microbe or a consortium of beneficial microbes and a targeted host plant. This is a much more complex set of interactions than previously thought that requires modeling for improving predictable outcomes. In this review, we will highlight the current state of the art for the incorporation of specific plant growth-promoting microorganisms and discuss the principles and management practices for next-generation, microbiome-based approaches for sustainable agriculture.

Application of Beneficial Microbes in Sustainable Agriculture: Past, Present and Future

Since the early 1800s, the United States Department of Agriculture has recommended the use of certain rhizobacteria to improve nitrogen fertility in leguminous crops (Schneider, 1892). Since that time, a great deal of research has been conducted on this relationship between legumes and these bacteria, now termed rhizobia, that inhabit unique structures, the nodules, that form on the roots. Rhizobia infecting these nodules are now capable of "biological nitrogen fixation," whereby di-nitrogen is fixed into forms that can be used by the plant. Symbiotically, the bacteria trade these nitrogenous compounds to the host plant in exchange for photosynthetically derived carbon. Despite these limited applications, much remains to be learned regarding both the functional and taxonomic diversity of these symbiotic bacteria and their host plants, the role they play in the global nitrogen cycle, and ultimately, how they can best be harnessed for improving plant productivity. This is particularly true for marginal lands that are not suited for row crop production but will need to be incorporated into global food and forage production approaches moving forward. Further, such degraded lands must but regenerated with the goal of restoring soil health and productivity. Any successful endeavor in this regard must include a characterization of the soil microbiome, both taxonomically and functionally. Attempts currently are underway to fix nitrogen in such non-legumes as wheat, corn and other staple crops that produce the bulk of human food by engineering symbiotic relationships using synthetic biology approaches (Rogers and Oldroyd, 2014; Ryu et al., 2020). Such approaches would significantly impact global food supplies, and may function adequately to reduce the arable land required to meet productivity goals.

Plant growth-promoting microbes not only play critical and diverse roles in growth promotion *per se*, but also in improving various aspects of plant resilience against a wide array of biotic and abiotic stresses (Arnold et al., 2003; Sun et al., 2010; Agler et

al., 2016; Azad and Kaminskyj, 2016; Singh, 2016; Oleńska et al., 2020; Rai et al., 2020). In this context, researchers globally have worked over the last several decades on plant growth-promoting microorganisms, such as root-associated mycorrhizal fungi, across a broad range of crops and encompassing a wide range of agro-climatic conditions. For perspective, Brundrett and Tedersoo (2018) recently reviewed 135 years of mycorrhizal research and reported that merely 8% of the vascular plants are non-mycorrhizal, suggesting that plant families associating with mycorrhizae have been very successful over the evolution of the plant kingdom.

Traditionally, agricultural application of beneficial microorganisms involves a few types of well-characterized microbes, such as mycorrhizal fungi or rhizobia bacteria, for which the mechanisms underlying the plant growth promotion effects are well understood. Further, most of these studies focused solely on the ability of the applied microorganisms to facilitate such specific plant growth-promoting traits as phosphate solubilization, nitrogen fixation, ACC deaminase production (Sarkar et al., 2018), siderophore production, biofilm formation, plant hormone production, biotic, and abiotic stress tolerance or resistance, among others (Weyens et al., 2009; Bhattacharyya and Jha, 2012; Singh et al., 2019). While these beneficial microorganisms can impart considerable benefits to plant growth and fitness, they are typically documented in simple, one-on-one studies, often conducted in sterile soils in greenhouse conditions. As a consequence, the effects found in such simplified conditions often fail to translate to more complex field situations (Chutia et al., 2007; Nicot et al., 2011; Parnell et al., 2016). Soil in field plots have more complex microbial environments that are presumably adapted to the local eco-environment.

In recent years, next-generation sequencing has revolutionized our understanding of microbial community composition and function, and together with improved culturing methodologies has greatly facilitated the use of biologicals in the field (Schweitzer et al., 2008; Panke-Buisse et al., 2014; Mueller and Sachs, 2015). Specifically, metagenomics-based approaches have uncovered vast, previously unrecognized populations of microbes that may have new or enhanced properties that could be used for agriculture, bioremediation, and human health. For example, comparative analyses of rhizosphere metagenomes from resistant and susceptible tomato plants enabled the identification and assembly of a flavobacterial genome that was far more abundant in the resistant plant rhizosphere microbiome than in that of the susceptible plants. Such findings certainly reveal a role for native microbiota in protecting plants from phytopathogens, and pave a way forward for the development of probiotics to ameliorate plant diseases akin to human health (Kwak et al., 2018). In another study, a 16S rRNA gene amplicon sequencing analysis of maize root microbiome led to the identification of bacteria that promote growth under low temperature conditions (Beirinckx et al., 2020). Additionally, principles of consortium design that rely on cross-talk, cross-feeding and/or substrate channeling between different microorganisms offer new opportunities for “intelligent” consortia design (Calvo et al., 2014; Vorholt et al., 2017; Paredes et al., 2018). We propose that the manipulation of the plant microbiome holds tremendous potential for agricultural improvement (Table 1). Through recent years of research, it is elucidated how microbes worked in nature before, and how decades of chemical fertilizer use have silenced their ability to improve plant fitness and soil health. Therefore, designing a microbial consortium that carefully weighs and evaluates the relationship between inoculants and the resident microbiome would substantially improve the plant growth-promoting potential and resilience of agricultural biologicals to boost plant growth. In this review, we will discuss the key considerations that would improve the likelihood of microbial products to improve crop yield, decrease disease severity and/or ameliorate abiotic stress response. Further, it is likely that such considerations would reduce the inconsistency between the performances of beneficial microbes from controlled greenhouse conditions and more natural environments.

Category	Salient findings	Reference
Plant growth promotion	Chilling temperatures critically affects growth of Maize in N. hemisphere. This study reported enrichment of *Comamonadaceae* and the *Pseudomonadaceae* in the root endosphere of maize grown under chilling conditions. Additionally two bacterial strains were identified from the root endosphere that could boost maize growth under chilling conditions.	Beirinckx et al., 2020
	A root endophytic bacteria Sphingomonas sp. Cra20 improved growth of *Arabidopsis thaliana* under drought stress by stimulating the growth of lateral roots and root hairs. Additionally, the relative abundance of Sphingomonas increased in the rhizosphere bacterial community in the water-deficit treatment, suggesting the role of Sphingomonas sp. Cra20 in alleviating drought induced stress.	Luo et al., 2019
	A community-based culture collection (CBC) approach was undertaken to isolate bacteria from the stalks and rhizosphere of Sugarcane. Subsequently, a synthetic community was designed by cross-referencing the CBC with the sugarcane microbiome profile that comprised of highly abundant bacterial groups from roots and stalks. The synthetic community could successfully improve the biomass of sugarcane, and was found to displace the native rhizosphere bacteria community.	Armanhi et al., 2018
	Willows (Salix spp.) were grown in gamma-irradiated petroleum-contaminated soils. Plants were inoculated with contaminated rhizosphere soil from a willow that grew well, or with contaminated bulk soil in which the plants had died. Willows inoculated with bulk soil performed better than those inoculated with rhizosphere soil. Microbiomes of different treatments were divergent at the beginning, but had converged at the end of the study, suggesting lasting effect of inoculated microbiome on plant growth, but not on the rhizosphere microbiome.	Yergeau et al., 2015
Plant defense response	Microbiome structure of Banana endosphere in the roots and shoot tips were investigated during plant growth and wilting processes. The keystone bacterial species belonging to the family *Enterobacteriaceae* family were isolated and further engineered to express ACC deaminase. Plants inoculated with engineered *Enterobacteriaceae* strains increased resistance to the Fusarium wilt disease. The findings illustrate that the keystone species in the banana microbiome plays functional role in the wilt resistance.	Liu et al., 2019
	Composts represent a sustainable way to suppress diseases and improve plant growth. Compost derived microbial communities enriched in the rhizosphere of Tomato were analyzed for antifungal activity against soil-borne fungal pathogens. Subsequently, microbial synthetic communities (SynComs) were designed with an overarching aim to improve plant fitness. SynComs were found to promote tomato growth as well as suppressed Fusarium wilt symptoms in controlled conditions.	Tsolakidou et al., 2019
	Tomato variety Hawaii 7996 is resistant to the soil-borne pathogen *Ralstonia solanacearum*, whereas the Moneymaker variety is susceptible to the pathogen. Rhizosphere microbiome analysis revealed clear differences in community profile of these two varieties. Transplantation of rhizosphere microbiota from resistant plants suppressed disease symptoms in susceptible plants. Additionally, a flavobacterium strain isolated from resistant plant rhizosphere microbiome was found to suppress R. solanacearum in susceptible plants.	Kwak et al., 2018
	A simplified synthetic bacterial community based on maize rhizosphere microbiome was designed representing most dominant phyla to study their functional attributes in maize seedlings. This synthetic community inhibited the phytopathogenic fungus *Fusarium verticillioides*, both *in planta* and *in vitro*. This study indicates how community profile information can be utilized to design beneficial microbial consortia for improving plant fitness and productivity	Niu et al., 2017
Abiotic stress response and nutrient use efficiency	Recognition of microbes by plant immune system mediated by phosphate stress was investigated. A representative synthetic bacterial community (SynCom) was designed that comprised of 35 bacteria isolated from the roots of Brassicaceae. SynCom enhanced the activity of PHR1, the master transcriptional regulator of the PSR, in Arabidopsis thaliana grown under limited phosphate. Additionally PHR1, repressed plant's immune system in phosphorous starved regime, validating plant's prioritization of nutritional stress over defense.	Castrillo et al., 2017
	Nitrogen-use efficiency of indica varieties of rice is superior to that of japonica varieties. Root microbiome analysis of these two varieties revealed that microbiota of indica and japonica highly distinct. Further, it was found that this distinctness was associated with a rice nitrate transporter and sensor NRT1.1B. Based on microbiome analysis, microbial synthetic communities (SynComs) were designed. It was found that indica-enriched SynCom improved rice growth in organic nitrogen conditions compared with a japonica-enriched SynCom.	Zhang et al., 2019
	Root associated microbiome of drought-sensitive pepper plant (*Capsicum annuum* L.) were analyzed focusing on role of microbes conferring plant growth under water limitation. Subsequently pepper root associated culturable bacteria were isolated and evaluated for plant growth promotion and drought tolerance abilities. The composition of the cultivable community associated to rhizosphere and root surrounding soil fractions shared a high similarity. Most of these isolates were able to promote plant growth and alleviate drought-induced stress with enhanced abilities observed in *Bacillus* and the *Rhizobacteria* strains.	Marasco et al., 2012
	Community profiling microbiome associated with superior halo-tolerant seepweed Suaeda salsa revealed that rhizospheric and endophytic bacterial community were enriched in genes responsible for salt stress acclimatization. This suggest that S. salsa preferentially recruit halotolerant taxa to confront soil salinity. Based on root endosphere core microbiota, halotolerant bacterial and fungal strains belonging to Pseudomonadales and Montagnulaceae were isolated. It was demonstrated that these core microbiome members were successfully able to improve growth and salt tolerance in the non-host rice plant.	Yuan et al., 2016

Table 1. List of recent publications in plant and soil microbiome focusing on plant fitness and productivity.

Microbes for Plant Growth Promotion: A Reductionist Approach

Sustainable agriculture primarily focuses on reducing the dependency of plants on chemical fertilizers and improving their ability to grow on marginal soil types. For such purposes, individual microorganisms for plant growth-promotion have largely focused on those that facilitate growth and development by enhancing acquisition of nutrient resources from the environment, including fixed nitrogen, iron and phosphate, or modulating growth by altering plant hormone levels (Figure 1) (Hayat et al., 2010). Another approach aimed at reducing yield losses to disease relies on microbes that decrease or prevent the deleterious effects of plant pathogens by several different mechanisms (Glick, 2012), i.e., by acting as a biocontrol agent. Microbe-based plant growth-promoting products, more popularly marketed as biofertilizer, has been commercially available in many countries since the 1950s (Timmusk et al., 2017). Application of such plant growth-promoting microbes in agricultural context and more specifically as inoculants has been nicely reviewed by Souza et al. (2015). However, under certain cases, the results obtained in the laboratory could not be reproduced in the field primarily due to the presence of many crop species and crop varieties, variable environmental conditions between fields, (Timmusk et al., 2017; Saad et al., 2020), occasionally due to the low quality of the inocula, and their inability to compete with the indigenous population. In that context, it is important to consider the fact that there is always greater likelihood of success by introducing mixed cultures of compatible microorganisms, rather than single, pure cultures. This is simply because each strain in the multi-strain consortium can compete effectively with the indigenous rhizosphere population and enhance plant growth with its partners. For example, sequential inoculation of nitrogen fixing bacterium *Azotobacter vinelandii*, followed by plant growth-promoting root-endophytic fungus *Serendipita indica* demonstrated better growth in rice (Dabral et al., 2020). Dual inoculation of *S. indica* and *Mycolicibacterium* strains boosted the beneficial effects in tomato (del Barrio-Duque et al., 2019) and that of arbuscular mycorrhizal fungus with plant growth-promoting bacteria *Bacillus subtilis* demonstrated better growth in wheat (Yadav et al., 2020) as compared to the singly inoculated plants. There also are numerous other reports that showed two strains used in a consortium promoted plant growth in a more effective manner (Nadeem et al., 2013; Fatnassi et al., 2015; Priyadharsini and Muthukumar, 2016). Nevertheless, to unlock the full potential of soil microbes for such nutrient cycling as nitrogen or phosphorus and providing plant protection against biotic and abiotic stress microbiomes, it is necessary to develop strategies to comprehend the functional capabilities of soil microbial communities. Irrespective of the approach, persistence is the first and foremost principle underlying the design of a successful microbial consortium for conferring plant growth promotion. This is not surprising, as the survival and activity of microbes in any soil system face a monumental task of competing with the myriad of microbes naturally adapted to that same soil. Thus, in addition to establishment of a compatible interaction with the host, a successful microbial inoculant has to subsequently compete and persist in the context of indigenous microbes as well as local abiotic conditions (Finkel et al., 2017). It has been reported that bacterial inoculations can persist in soil up to 7 weeks, but whether this inoculum also can provide plant growth benefits is not clear (Schreiter et al., 2014). While persistence or resilience of any microbial inoculum is more dependent on biotic components of a specific soil type, their persistence can be improved by inoculating crops with consortia rather than single strains (Verbruggen et al., 2012; Nemergut et al., 2013). Thus, it can arguably be stated that the diversity of a microbial inoculum, in addition to its plant growth-promoting traits, is critical for enhancing productivity and longevity (Cordero and Polz, 2014).

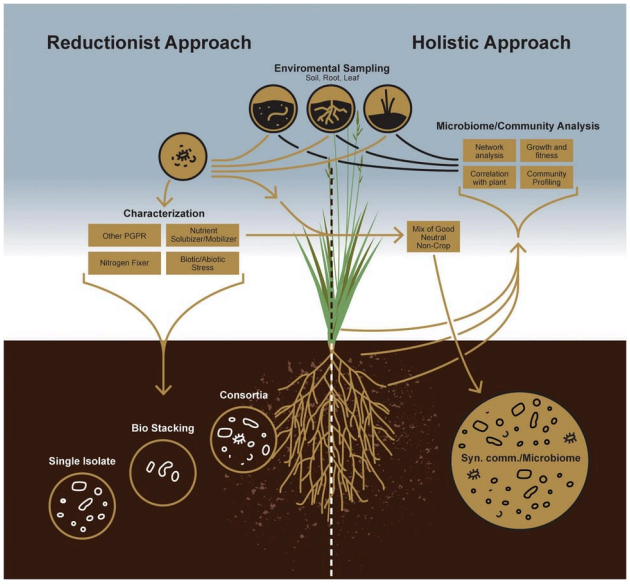


Figure 1. A schematic comparison between individual microorganism-based reductionist approach and microbial community-based holistic approach.

To improve the likelihood of success for such a management strategy, *a priori* knowledge of indigenous microbial populations competing with the introduced plant growth-promoting agent(s) is critical. While a reductionist approach can define the currency of individual plant-microbe interactions, the concepts of microbial community survival and functioning require, a more holistic, microbiome-based approach empowered by next-generation sequencing technology to study plant-microbe interactions at the community level (Figure 2). Indeed, this will enable researchers to design more robust, synthetic microbial consortia capable of reliably enhancing agricultural productivity.

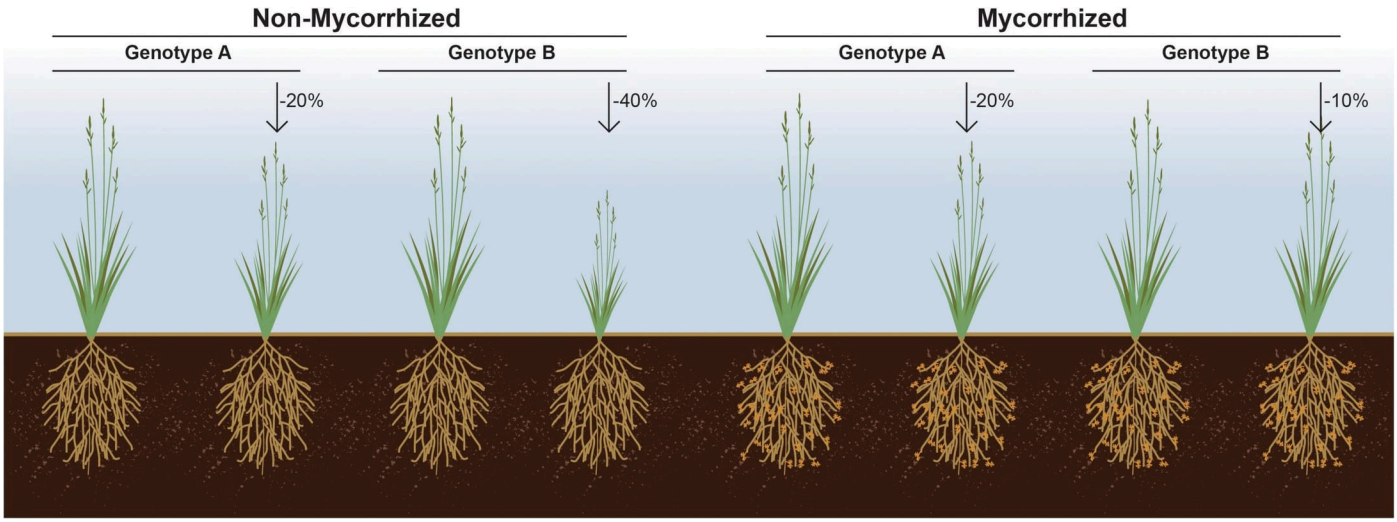


Figure 2. Responsiveness as the% gain in plant fitness attribute in response to symbiosis over un-colonized cohorts. This figure illustrates a hypothetical situation wherein genotype A loses less biomass (–20%) in response to soil nutrient limitation than does genotype B (–40%). However, if genotype B for its inherently associated rhizosphere microbiome responds optimally to a mycorrhizal symbiont, then it may be that it loses the least biomass (–10%) due to soil nutrient limitation, if the symbiont is present.% denotes loss in biomass due to soil nutrient limitation.

Microbiomes for Plant Growth Promotion: The Holistic Approach

Soil is a vastly heterogeneous growth medium, providing a wide spectrum of ecological niches for microorganisms that enable diverse strains to coexist and form complex microbial communities. When the earliest plants extended their roots into primordial soils, they encountered a habitat already teeming with bacterial and fungal life (Bulgarelli et al., 2013; Kemen, 2014). Since that early time, plants have interacted with rhizosphere microbes, evolving strategies to forge beneficial alliances with some while keeping others at bay. Such early associations certainly had consequences on plant growth and development. Therefore, a more holistic approach is needed to understand better these microbes and the roles they play in the overall health of plant and soil (Figure 1). Again, recent advances in next-generation sequencing technology and the decreasing costs associated with that technology now allow us to evaluate how microbial populations fluctuate in both space and time or to identify core microbiomes that appear conserved among host genotypes or species (Sergaki et al., 2018). Thus, although culture-independent methods have contributed tremendously to our understanding of plant-associated fungal and bacterial community structures, the study of microbiome functions remains challenging because of the inherent noise of plant-associated microbial communities. It is now well known that there are core sets of microbes that, depending on the host, are recognized as keystone taxa that consistently associate with healthy plants (Banerjee et al., 2018). Consequently, researchers working with specific plant-microbe interactions have increasingly acknowledged the mitigating impact these larger microbial communities have on individual plant-microbe outcomes for plant growth promotion or fitness. Now, plant-associated fungal and bacterial stains from various plant species are being isolated, which will provide in the near future an inestimable resource for assembling taxonomically defined microbial communities with increasing complexity. Therefore, it is now imperative to take advantage of this knowledge to design consortia of microbes to maintain a sustainable rhizosphere community, with key functional properties that include plant protection, nutrient acquisition, and alleviating biotic and abiotic stress responses. From that perspective, synthetic community (SynCom) approaches can provide functional and mechanistic insights into how plants regulate their microbiomes (Figure 1). Not surprisingly, recent culture-independent analyses thus have paved the way for developing SynComs more often (Bodenhausen et al., 2014; Armanhi et al., 2018; Carlström et al., 2019).

Mycorrhizal fungi, at least the arbuscular type, were early symbiotic partners of most land plant species, improving nutritional conditions through soil exploration and pathogen resistance of host plants (Klironomos et al., 2000). In reward for the essential physiological services, they receive ca. 20% of net photosynthetic products from plants (HoÈgberg et al., 2001). Other mycorrhizal

systems may have different nutritional benefits and costs, as has been proposed for the serendipitous system (Craven and Ray, 2019). Additionally, third-party partners can modulate the outcome of the tripartite interaction, such as the case of mycorrhizal helper bacteria (Frey-Klett et al., 2007), fungal endobacteria (Bonfante and Desirò, 2017; Bonfante et al., 2019) like *Candidatus Moeniiplasma glomeromycotorum* within the spores and hyphae of Glomeromycotina (Naito et al., 2017), *Rhizobium radiobacter* within *Serendipita indica* (Guo et al., 2017), and N_2-fixing endobacteria *Pseudomonas stutzeri* inside basidiomycetes yeast endophyte *Rhodotorula mucilaginosa* (Paul et al., 2020). Hence, it is imperative to consider the composition and functioning of these microbe–microbe interactions to understand plant–microbiome associations in a holistic manner.

Principles and Management of Rhizosphere Microbiomes for Sustainable Agriculture

Competence and Resilience of the Rhizosphere Microbiome: Impact of Introduced Microbes on Native Microbiomes

In 1904, the German agronomist and plant physiologist Lorenz Hiltner coined the term *rhizosphere* (Hartmann et al., 2008) to describe the area around a plant root inhabited by a unique population of microorganisms. Since then, numerous studies have been undertaken to decipher the interplay between plants and rhizosphere microorganisms, encompassing a wide variety of plant growth-promoting bacteria, fungi, insects, protozoans, viruses, etc. (Marschner, 2012; McNear, 2013). The majority of these studies have traditionally followed a simple principle for maximizing successful host infection by pre-inoculation onto the targeted crop of choice to provide a competitive advantage for a desired microbe. Conceptually, this increases the relative abundance of a given beneficial microbe in the rhizosphere, at least temporarily, to achieve the desired benefit. Such studies typically take place in a controlled, artificial condition, such as a defined growth medium in a greenhouse, where competition from a native rhizosphere community is relatively low or non-existent. As mentioned above, this approach occasionally has failed once field application is attempted or the benefits are dramatically reduced in amplitude and/or endurance.

As an example, Lekberg and Helgason (2018) conducted a literature survey of research papers published on mycorrhizal functioning spanning a 30-year period (1987–2017). The most striking finding of this survey was that less than 5% of the work scientifically manipulated mycorrhizal abundance in the field. While we are not arguing the merit of greenhouse-based studies where the number of variables can be controlled and accounted for, yield gains in field conditions will continue to be modest with such an approach. Rhizosphere competence must be evaluated in a field situation if the true power of this approach is to be realized.

Over the last few decades, mycorrhiza-based bio-fertilizers containing one or several species of fungi were developed in forestry and agriculture (Jeffries and Rhodes, 1987; Baraza et al., 2016; Igiehon and Babalola, 2017). These inoculants are generally effective in plant growth promotion under controlled lab and greenhouse conditions. However, few targeted efforts have been made to measure interactions between the introduced microbe(s) and the native mycorrhizal community, let alone the more complex rhizosphere microbiome (Svenningsen et al., 2018; Turrini et al., 2018). To optimize outcomes from these interactions, targeted research must be undertaken to understand how such mycorrhiza-based biofertilizer integrate themselves within the context of the native microbiome.

Integration of Rhizosphere Microbiomes in Plant-Microbe-Nutrient Relationships

The soil microbial community often assists plants by weathering minerals from rock surfaces and degrading recalcitrant soil organic matter whereby soil microbes break down soluble and insoluble organic matter and convert it into inorganic, plant-available forms. Soil organic matter turnover is thus considered a net positive, as it liberates the nutrients locked up in organic matter. For this reason, conventional farming has always relied heavily on soil tillage, along with such other intensive agricultural practices as usage of inorganic fertilizers, herbicides and pesticides. However, it is already clear that such practices have negative consequences on the functional diversity of soil microbiomes. Long-term chemical fertilization has been shown to dramatically decrease the soil pH, which leads to a decrease in bacterial diversity and other changes in microbial community structure (Sun et al., 2015). This was well documented in the work of Kumar et al. (2017), who showed that long-term application of high doses of inorganic nitrogenous fertilizers severely reduces relative abundance, diversity and structure of diazotrophs, which play a key role in converting atmospheric N_2 to plant-available ammonium.

As mentioned above, soil bacterial communities play a pivotal role in soil organic matter decomposition. In particular, soil carbon and nitrogen are critical factors for bacteria that rely on soil organic C and N decomposition to obtain energy (Chen et al., 2014; Wild et al., 2014; Tian et al., 2018). Further, different types of soil C selectively manipulate soil microbial community

composition, resulting in changes in such belowground ecosystem functions as decomposition and nutrient transfer and creating feedbacks that may affect overall plant growth and productivity (Orwin et al., 2006). For example, bacteria belonging to the genera *Chloroflexi*, *Nitrospirae*, and *Planctomycetes* preferentially feed on recalcitrant organic C, whereas *Proteobacteria* and *Bacteroidetes* prefer labile organic C present in the soil (Nie et al., 2018). For this reason, amending the soil with such organic fertilizers as compost or manure contributes to higher microbial diversity and biomass compared to mineral-fertilized soils, which in turn positively impacts soil health (Schmid et al., 2018; Banerjee et al., 2019). Unfortunately, only a few agroecosystem experiments exist that compare organic and conventional management strategies over an extended period for evaluation of impact on soil health and restoration (Raupp et al., 2006; Khatoon et al., 2020). Hartmann et al. (2015) took a metagenomics approach to assess microbial diversity of soil in response to more than 20 years of continuous organic and conventional farming. Not surprisingly, they found that organic farming increased richness, decreased evenness, and shifted the structure of the soil microbiota when compared with conventionally managed soils under mineral fertilization (Hartman et al., 2018; Li et al., 2020b). There also are reports of significant alterations in the microbial community composition of both summer maize and winter wheat in response to increased nitrogen fertilization dose (Wang et al., 2018; Li et al., 2020a). Clearly, a better understanding of the interactions between the soil microbiome and conventional agricultural practices is crucial for the development of sustainable management of soil fertility and crop production.

Managing the Rhizosphere Microbiome to Induce Disease Suppression in Soil

Disease suppressive soils were originally defined by Baker and Cook (1974) as “soils in which the pathogen does not establish or persist, establishes but causes little or no damage, or establishes and causes disease for a while but thereafter the disease is less important, although the pathogen may persist in the soil.” Disease suppressive soils are the best examples of microbiome-mediated protection of plants against root infections by soil-borne pathogens. Such disease-suppressive soils have been described for various soil-borne pathogens, including fungi, bacteria, oomycetes, and nematodes (Mazzola, 2007; Kwak et al., 2018). To date, several microbial genera have been proposed as key players in disease suppressiveness of soils, but the complexity of the microbiome, as well as the underlying mechanisms and microbial traits, remain elusive for most disease suppressive soils (Toyota and Shirai, 2018).

Recently, Carrión et al. (2019) showed that upon pathogen invasion, members of the *Chitinophagaceae* and *Flavobacteriaceae* became enriched within the plant endosphere. They proposed that this bacterial population shift led to the induction of enzymatic activities associated with fungal cell-wall degradation, as well as secondary metabolite biosynthesis, all aimed at accelerating and augmenting the plant defense response(s). Although the disease suppressive abilities of certain soils can be at least partially attributed to their physico-chemical properties, the capacity of a soil to suppress disease progression is more often attributed to agri-management practices and crop rotation (Weller et al., 2002). In classic studies by Gerlagh (1968) and Shipton et al. (1973), the authors have shown soil to become disease suppressive after mono-culturing wheat over time. More recently, a comparative metatranscriptome analysis of wheat rhizosphere microbiome grown in fields suppressive and non-suppressive to the plant pathogen *R. solani* AG8 clearly revealed distinct dominant taxa in these two soil types. Additionally, suppressive samples showed greater expression of polyketide cyclase, terpenoid biosynthesis, and cold shock proteins (Hayden et al., 2018). While development of probiotics for the human gut microbiome has already been an established field of research, the use of probiotics that comprises naturally occurring bacterial antagonists and competitors that suppress pathogens has recently emerged as a promising strategy for disease suppression in soil. A study on application of probiotic consortia that comprised predefined *Pseudomonas* species reported suppression of the bacterial plant pathogen *Ralstonia solanacearum* in the tomato rhizosphere microbiome (Hu et al., 2016). In another study, amendment of *Metarhizium*, an insect-pathogenic fungus that is commonly employed as biological control agents against crop pests, in the rhizosphere of common bean (*Phaseolus vulgaris*) significantly increased the relative abundance of plant growth promoting such taxa as *Bradyrhizobium*, *Flavobacterium*, *Chaetomium*, and *Trichoderma* while suppressing the root rot disease symptoms *Fusarium solani* (Barelli et al., 2020). Soil suppressive properties are mostly derived from the biological functions of soils. Therefore, elucidation of microbial functions in suppressive soils by a next-generation sequencing approach will facilitate the development of effective, consistent and durable disease management tools.

Impact of Agriculture Management Practices on the Soil Microbiome

One important context for plant-microbe interactions is soil structure, as it can vary greatly depending on land-use history, plant species composition and successional stage (Erktan et al., 2016). Besides playing pivotal roles in soil organic matter decomposition, carbon cycling, nutrient mobilization, etc., saprotrophic fungi also are involved in creating soil structure through the secretion of extracellular compounds and physical binding of soil via hyphal networks (Bergmann et al., 2016). Interestingly, studies on the impact of tillage on the soil fungal communities have shown mixed results. Reports in no-till systems have varied from increased ratios of fungal to bacterial biomass (Acosta-Martínez et al., 2010) to decreased ratios (Mbuthia et al., 2015),

as well as no change at all (Mathew et al., 2012). More recent studies have shown that soil fungal communities are negatively impacted by tillage, as they typically would be responsible for degrading crop residue left on the surface with no-till (Yin et al., 2017). More specifically, soil bacterial communities were primarily found to be structured by tillage, whereas soil fungal communities responded mainly to management type with additional effects by tillage (Hartman et al., 2018). Additionally, it is acknowledged that organically managed systems increased taxonomic and phylogenetic richness, diversity and heterogeneity of the soil microbiota when compared with conventional farming systems (Lupatini et al., 2017). In a simple definition, organic farming system consists of low-input agro-ecosystem farms in which plant productivity and ecosystem functionality are based on the natural availability of plant nutrients (Lammerts van Bueren et al., 2002). A study aimed at comparing the soil microbiome in conventional and organic farming systems in central Europe revealed no major differences among the main phyla of bacteria between the two farming styles (Armalytë et al., 2019), whereas another study that investigated the effects of 12 years of organic farming on soil microbiomes in northern China reported shifting of the community composition of dominant phyla and significant alterations of functional groups associated with ammonia oxidation, denitrification and phosphorus recycling when compared to conventional farming systems (Ding et al., 2019).

In addition to tillage, crop rotation also plays a pivotal role in increasing belowground microbial diversity compared to intensive mono-cropping practices. Although the United States Department of Agriculture has advocated [via the Conservation Reserve Program (CRP)] crop rotation to improve eroded land as early as 1985 (Allen and Vandever, 2005), its benefit on soil health has only been recognized recently. Several studies reported increases in such soil quality parameters as organic matter content, microbial biomass and respiration under crop rotation management when compared with a mono-cropping system (Campbell et al., 1991; Luce et al., 2013). A meta-analysis of 122 studies that examined crop rotation revealed similar findings, namely that adding one or more crops in rotation to a monoculture substantially increased the soil microbial biomass along with increases in total soil C and N, respectively (McDaniel et al., 2014). In another study, soil microbial communities of corn and switchgrass in mono-cropping systems when compared with mixed prairie grasses demonstrated that bacterial and fungal biomass, especially arbuscular mycorrhizal fungi, were higher in plots with mixed prairie grasses (Jesus et al., 2016). A 16S amplicon-based metagenomic analysis of an almost 20-year-old field trial in Bernburg, Germany revealed a significant effect of tillage practice and the preceding crop on prokaryotic community structures (Babin et al., 2019)

Cover crops are typically unharvested crops planted between cash crops that augment C provisioning to the soil system not only via unharvested residues, but also as root exudates that can support many rhizosphere microbes during the active growing season of the cover crop. Other benefits attributed to cover cropping include improved N fertility by incorporating legumes as a cover crop, reduced soil compaction via deep-rooted plants, and reduced erosion by keeping a plant and its root system in the field year round (Fernandez et al., 2016). Of various crop rotation management practices, those that include cover crops sustain soil quality and productivity by enhancing soil C, N and microbial biomass (Kim et al., 2020), making them a cornerstone for sustainable agroecosystems. Nonetheless, very few studies have assessed the relationship between cover crop stands and their associated belowground microbial communities. Early research in unfertilized grasslands demonstrated that fungal communities respond positively to plant-derived C inputs, suggesting that inclusion of cover crops in a rotation may promote fungal community development (Denef et al., 2009). More recently, a field study tested this hypothesis by specifically examining the impact on soil microbial communities of eight fall-sown cover crop species grown singly and in multispecies mixtures following a spring oats (*Avena sativa* L.) cropping season and found that certain cover crops selectively favored particular microbial functional groups. Arbuscular mycorrhizal fungi were more abundant beneath oat and cereal rye (*Secale cereale* L.) cover crops, while non-AM fungi were positively associated with hairy vetch (*Vicia villosa* L.) (Finney et al., 2017). Beyond positively affecting soil C and increasing the diversity of such beneficial fungi as arbuscular mycorrhiza, clover as a cover crop is often reported to suppress the relative abundance of pathogenic fungi (Benitez et al., 2016). Contrarily, in a 2-year field study, cover crops reportedly increased overall phylogenetic diversity of fungi but did not change the relative abundance of saprophytes, symbionts or pathogens, implying that cover cropping does not always appear to contribute to functional changes in the fungal community (Schmidt et al., 2019).

Reassessment of Plant Responsiveness to Symbiosis

It is now increasingly evident that plants employ fine-tuned mechanisms to shape the structure and function of their microbiome, with different genotypes of the same plant species growing in the same soil yet associating with distinct microbial communities (Berendsen et al., 2012). This is demonstrated in the findings of Bazghaleh et al. (2015), who clearly demonstrated the importance of intraspecific host variation in the association of chickpea cultivars with AM and non-AM fungi. Therefore, specific traits of a plant that modulate its microbiome should be considered as a trait for plant breeding (Wallenstein, 2017).

Despite the obvious importance of beneficial microorganisms for plant growth and fitness, and the impact of plant genotype on shaping their microbiome composition, plant germplasm is typically screened in the absence of microbes, and the selection of best breeding lines made solely based on the interaction between plant genotype and performance under various abiotic factors. We propose that an *a priori* examination of the interaction between a plant genotype(s) and the symbiotic microbes

upon which it likely depends is an important factor in the selection of plant breeding lines. It seems very likely that a subset of rejected germplasm could outperform others, but only when coupled with a beneficial microbe or microbiome (Figure 2). Arguably, current breeding and selection efforts most likely result in decoupling of the soil microbiome from plant fitness. As a result, modern varieties may have lost their ability to support diverse microbiomes and thus, fail to gain the most from these interactions (Wallenstein, 2017).

It is now acknowledged that transitioning from a highly intensive mono-cropping system to a more diversified cropping system consisting of multiple host genotypes leads to increased bacterial and fungal diversity (Calderon et al., 2016). Hence, future plant breeding efforts should incorporate plant characteristics that are related to microbiome diversity. For example, efforts focusing on manipulating plant root exudates likely play a critical role in selective recruitment of the rhizosphere microbiome (Bakker et al., 2012). In support of this notion, it has been shown that plants can select which microbial populations receive the lion's share of root exudates, demonstrating a capacity by the host to refine its microbial composition. Hence, an unbiased screening of plant genotypes for responsiveness in the presence of a beneficial microbe or microbiome can set forth a new and potentially transformative paradigm in selecting microbes for plant growth promotion (Figure 2).

Significance of Mycorrhizas: A Critical Component of Healthy Soil Rhizospheres

Mycorrhizae are mutualistic associations between soil fungi and plant roots that gradually evolved to be reciprocally beneficial to both partners (Brundrett, 2002). The benefits are generally assumed to involve an exchange of photosynthetically derived carbon from the host plant in exchange for soil nutrients provided by the foraging mycorrhiza. While likely true of arum-type arbuscular types of mycorrhizae, there are other types that can derive carbon from organic matter in the soil, or even "steal" it from one host plant to supply to another (Allen and Allen, 1991). A recent study has reported that in contrast to *Arum maculatum*, in which carbon is entirely derived from photo-assimilation, the green leaves of *Paris quadrifolia* contain a striking 50% carbon of fungal origin. Such partial mycoheterotrophy could thus potentially be widespread among the roughly 100,000 plant species that are known to develop a Paris-type AM, with far-reaching implications for our understanding of C trading in plant-microbe communities (Giesemann et al., 2019). Exactly what the mycorrhiza gains from this interaction is still under debate, but benefits may involve a safe haven from the open, more competitive soil space and a second, more reliable carbon source (Sapp, 2004).

Mycorrhizae not only shape plant communities, but they also affect the functional diversity of their cohabitants in the rhizospheric microbiome. The mycelium of mycorrhizal fungi transports plant-derived carbon into the soil in the form of sugars, amino acids and polyols to help sustain the microbiome (Tarkka et al., 2018). More recent studies focusing on soil microbial ecology revealed that mycorrhizal fungi mediate many diverse interactions within the soil "mycorrhizosphere," including pathogens and mutualists that fix atmospheric nitrogen, take up phosphorus, produce vitamins, and/or protect against antagonists (Buée et al., 2009; Tedersoo et al., 2020). The "ectomycorrhizosphere," which forms a very specific interface between soil and many trees, hosts a large and diverse community of microorganisms that likely play roles in mineral weathering and solubilization processes (Uroz et al., 2007). This carbon-rich mycorrhizosphere also supports large communities of root-associated microorganisms that further accelerate weathering of minerals by excreting organic acids, phenolic compounds, protons, and siderophores (Drever and Vance, 1994; Illmer et al., 1995).

Similarly, the extraradical hyphae of arbuscular mycorrhiza provide a direct pathway for the translocation of photosynthetically derived carbon to the soil, leading to the development of nutrient-rich niches for other soil microorganisms, particularly bacteria. A quantitative real-time PCR method detected significantly higher 16S rDNA abundance in both the bulk and the rhizosphere soils of zucchini (*Cucurbita pepo* L.) inoculated with *Acaulospora laevis* and *Glomus mosseae* (Qin et al., 2014). Additionally, arbuscular mycorrhizae have been reported to increase the relative abundance of *Firmicutes*, *Streptomycetes*, *Comamonadaceae*, and *Oxalobacteraceae* inhabiting the mycorrhizosphere (Offre et al., 2007; Nuccio et al., 2013). While there is clear evidence that microbial communities in the rhizosphere function cohesively with their mycorrhizal partner in nutrient mobilization from soil minerals, nitrogen cycling and protection of plants against root pathogens, such bidirectional synergy is not always universal. There are reports that indicate suppressive effects of bacterial communities on mycorrhizal functioning and vice versa. While one study reported (Svenningsen et al., 2018) that soil with a higher abundance of *Acidobacteria* suppresses the normal functioning of extra-radical mycelium in arbuscular mycorrhizae, another study found that *Glomus intraradices* and *Glomus mosseae* suppressed most of the associated soil microbial community (Welc et al., 2010).

A Novel Type of Endophytic Symbiont: The *Serendipitaceae*

A diverse group of fungi in the Basidiomycota, the *Serendipitaceae* (formerly Sebacinales Group B) (Oberwinkler et al., 2014) encompasses endophytes and lineages that repeatedly evolved ericoid, orchid and ectomycorrhizal types. Accordingly, in many natural ecosystems these fungi form mycorrhizal symbioses with an astounding variety of host plants – every mycorrhizal type, in

fact, except for arbuscular. Previous research performed in our lab with a strain of this group, *Serendipita vermifera*, demonstrated plant growth-promoting properties in a variety of plants (Ghimire and Craven, 2011; Ray et al., 2015; Ray and Craven, 2016; Ray et al., 2020). Unfortunately, the agronomic utility of these fungi is hampered by the paucity of strains available, the large majority isolated from Australian orchids. We have begun to address this constraint by isolating the first North American strain of *Serendipita*, named *Serendipita vermifera* subsp. *bescii* NFPB0129, from the roots of a switchgrass plant in Ardmore, Oklahoma (Craven and Ray, 2017; Ray et al., 2018).

As mentioned above, soil organic matter has a tremendous influence on the biological, chemical, and physical properties of soils, making it a vital component of healthy agricultural systems. Whether a natural soil or an agricultural one, the release of the nutrients locked within SOM requires decomposers, primarily insects, fungi, and bacteria, to secrete organic acids and enzymes that can loosen and break down the cellulose and the recalcitrant lignin into nutritive forms that can be used by other microbes and plants. Unlike arbuscular mycorrhizae, which exchange inorganic, mineralized nutrients mined from the soil for carbon derived from host photosynthesis, members of the *Serendipitaceae* studied thus far have a complete arsenal of carbohydrate-active enzymes (CAZymes), representing approximately 4% of the entire gene set and rivaling the more well-studied saprophytic white and brown wood rotters, and much more than other symbiotic fungi. Additionally, genome analysis of *S. bescii* and *S. vermifera* suggests that *Serendipitaceae* fungi have the metabolic capacity to assimilate N from organic forms of N-containing compounds (Ray et al., 2019). We hypothesize that this carbohydrate-degrading enzyme complement endows these *Serendipitaceae* fungi with saprotrophic abilities (Craven and Ray, 2019). Unlike free-living decomposers that maintain a solitary lifestyle, seeking only dead or dying plant tissues as their source of subsistence, *Serendipitaceae* fungi seem to maintain a largely symbiotic lifestyle with the roots of living host plants. It currently is unclear whether there is expression of CAZymes while strains of *Serendipita* are in symbiosis with host plants, and if so, whether there is spatial or temporal separation from more mutualistic traits. Still, the capacity of some strains to form mycorrhizal relationships with orchids, where the seeds require carbon from the fungus for germination and often well into the plant's lifespan, suggests that these *Serendipitaceae* symbionts may be less of a carbon cost to their host plant. Presumably, this saved carbon could potentially be used for other symbiotic relationships or developmental processes. In any case, these intriguing fungi and their seemingly unlimited host range provide a novel symbiosis that could be used in a broad variety of cropping systems.

Conclusion

Soil-dwelling microorganisms are critical components of soil health, itself a determinant of plant productivity and stress tolerance. Deploying microbes to improve agriculture productivity is an extremely attractive approach that is non-transgenic and can be viewed collectively as the extended plant genome. Because these same microbes can contribute to restoring soil health and productivity, they have a bright future in low-input, sustainable agriculture that extends beyond more classically defined plant-microbe symbioses.

Author Contributions

PR and KC conceived and planned the overall idea of the review manuscript. PR, VL, JL, and KC wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Hotspot Quiz

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Check your Understanding

- What roles does the soil microbiome have in the movement towards sustainable agriculture?
- What is a rhizosphere?
- What type of soil fungi are associated with promoting plant health as well as the soil microbiome? How do they do so?
- What are the challenges with studying plant growth promoting microorganisms?
- Explain the difference between a reductionist vs. holistic approach for improving plant growth with microorganisms.
- What types of agricultural practices can alter the soil microbiome?
- How could the use of 'probiotics' suppress disease-causing soil microorganisms?

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16.1.5.4: Plant Microbiomes

Plant Microbiomes

Plant health is influenced by a variety of environmental factors, and though the soil content (including the microbial community present) is a major element, the distinct plant microbiome serves an important role. Similar to organ systems in the human body (e.g. skin, gut, etc.), the components of various plants (e.g. internal tissues, leaves, roots, etc.) can have unique microbial communities that contribute to its respective and overall vitality. A better understanding of the corresponding roles of plant microbiomes can be combined in a synergistic effort with other environmental microbiomes to maintain and promote sustainable agricultural practices, ecosystem biodiversity, and research model studies.

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Plant microbiome–an account of the factors that shape community composition and diversity

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Abstract

Plants live in association with diverse microorganisms, collectively called the microbiome. These microbes live either inside (endosphere) or outside (episphere) of plant tissues. Microbes play important roles in the ecology and physiology of plants. Significant progress has been made in revealing structure and dynamics of plant microbiome in the last few years. Various factors related to host, microbes as well as environment influence the community composition and diversity of plant microbiome. This review aimed to provide a general account of the factors (host, microbe and environment) that drive the microbial community composition in plant. First, we gave an overview of the aboveground and belowground plant microbiomes. Next, we discussed which host factors are involved in variation in plants followed by importance of microbe-microbe interactions and the elements of environment that influence composition and community structuring of plant microbiomes.

Introduction

A diverse kind of microorganisms associated with a higher organism (human, animal, plants etc.) is together defined as its microbiome. All higher organisms examined to date, including plants, insects, fish, rats, apes, and humans, harbor microbiomes [1,2]. Research on the human microbiome has progressed very quickly. Recently, researchers have also paid much attention to elucidating the composition and functions of plant and soil microbiomes. It is now believed that plants are not separate entities, but rather they live in association with a large variety of microbes. These microbes live either inside (endosphere) or outside (episphere) of plant tissues. Among these microorganisms, bacteria and fungi are predominant. About a few thousand bacterial and fungal taxa have been reported from plant tissues [3,4]. They play important roles such as increased nutrient availability, uptake by plants and increased plant stress tolerance. Thus, plant fitness (growth and survival) is the result of physical and physiological functions of the plant *per se* as well as the associated microbiome, which together are known as a plant holobiont [5].

The study of the association of plants with microorganisms precedes that of the animal and human microbiomes, notably the

roles of microbes in nitrogen and phosphorus uptake. The most notable examples are plant root-arbuscular mycorrhizal (AM) and legume-rhizobial symbioses, both of which greatly influence the ability of roots to uptake various nutrients from the soil. Some of these microbes cannot survive in the absence of the plant host (the 'obligate symbionts' including viruses, some bacteria and fungi), which provides space, oxygen, proteins, and carbohydrates to the microorganisms. The association of AM fungi with plants has been known since 1842, and over 80 % of land plants are found associated with them [6]. It is thought that AM fungi helped in the domestication of plants [7]. Traditionally, culturable microbes have been used for plant-microbe interaction studies with the enormous unculturable microbes remain uninvestigated and consequently, our knowledge of the roles of these unculturable microbes remains largely unknown.

Unraveling the types and outcomes of plant-microbe interactions has received considerable interest among ecologists, evolutionary biologists, plant biologists, and agronomists [4,8,9]. Recent developments in meta-omics and the establishment of large collections of microorganisms have dramatically increased our knowledge of the plant microbiome composition and diversity. The sequencing of marker genes of entire microbial communities, referred to as metagenomics, sheds light on the phylogenetic diversity of the microbiomes of plants. It also adds to the knowledge of the major biotic and abiotic factors responsible for shaping plant microbiome community assemblages [8].

However, our understanding on the roles of microbiomes, with respect to their impact on plant ecology and physiology, is still far from complete, and we are at the beginning of knowing their functions [10]. The outcome of this improved knowledge will have significant bearings on a variety of experiments and applications, such as development of biofertilizer and biopesticides for sustainable agricultural production with less reliance on agrochemicals, while augmenting yield and nutritional value [11].

In this review, we will present an account of recent studies and prospects of studying the plant microbiome. Firstly, we will present an overview of aboveground and belowground plant microbiomes. Next, we will discuss the factors driving the composition and community structuring of plant microbiomes. We will not address plant pathogenic microbes, although inclusion of this fraction of microbiome would make sense from a broader and more holistic viewpoint.

Rhizosphere microbiome

The rhizosphere comprises the 1–10 mm zone of soil immediately surrounding the roots that is under the influence of the plant through its deposition of root exudates, mucilage and dead plant cells [12]. A diverse array of organisms specialize in living in the rhizosphere, including bacteria, fungi, oomycetes, nematodes, algae, protozoa, viruses, and archaea [13]. The most frequently studied beneficial rhizosphere organisms are mycorrhizae, rhizobium bacteria, plant growth promoting rhizobacteria (PGPR), and biocontrol microbes. Gans, Wolinsky [14] projected that one gram of soil could harbor more than a million distinct bacterial genomes. İnceoğlu, Al-Soud [15] reported 55,121 OTUs (operational taxonomic unites) from the potato rhizosphere. Among the prokaryotes in the rhizosphere, the most frequent bacteria are within the Acidobacteria, Proteobacteria, Planctomycetes, Actinobacteria, Bacteroidetes, and Firmicutes [3,16]. In some studies, no significant differences were reported in the microbial community composition between the bulk soil (soil not attached to the plant root) and rhizosphere soil [17,18]. Certain bacterial groups (e. g. Actinobacteria, Xanthomonadaceae) are less abundant in the rhizosphere than in nearby bulk soil [3].

Mycorrhizal fungi are abundant members of the rhizosphere community, and have been found in over 200,000 plant species, and are estimated to associate with over 80 % of all plants [19]. These mycorrhizae–root associations play profound roles in land ecosystems by regulating nutrient and carbon cycles. Mycorrhizae are integral to plant health because they provide up to 80 % of N and P requirements. In return, the fungi obtain carbohydrates and lipids from host plants [20]. Recent studies of arbuscular mycorrhizal fungi using sequencing technologies show greater between-species and within-species diversity than previously known [21].

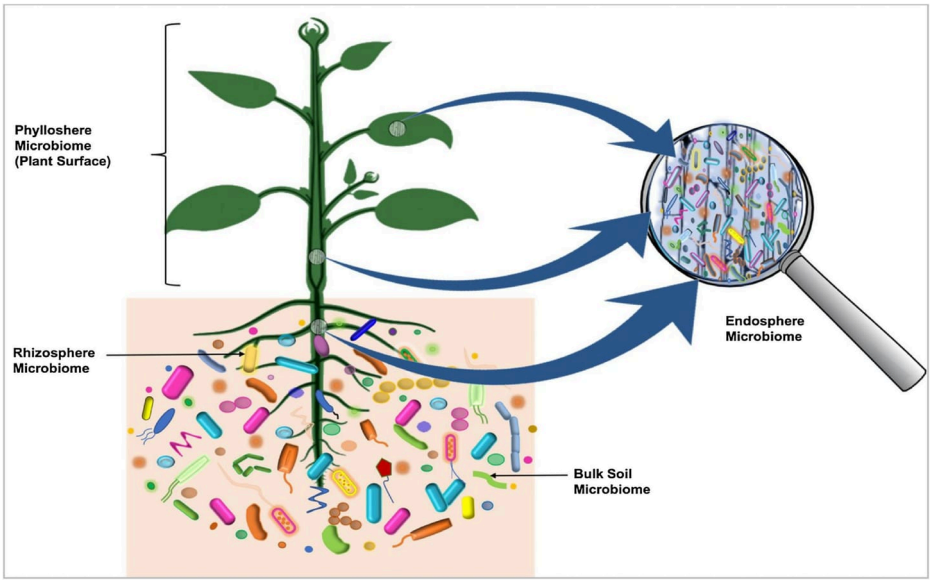
Phyllosphere microbiome

The aerial surface of a plant (stem, leaf, flower, fruit) is called the phyllosphere and is considered comparatively nutrient poor when compared to the rhizosphere and endosphere. The environment in the phyllosphere is more dynamic than the rhizosphere and endosphere environments. Microbial colonizers are subjected to diurnal and seasonal fluctuations of heat, moisture, and radiation. In addition, these environmental elements affect plant physiology (such as photosynthesis, respiration, water uptake etc.) and indirectly influence microbiome composition. Rain and wind also cause temporal variation to the phyllosphere microbiome [22]. Overall, there remains high species richness in phyllosphere communities. Fungal communities are highly variable in the phyllosphere of temperate regions and are more diverse than in tropical regions [23]. There can be up to 10^7 microbes per cm^2 present on leaf surfaces of plants, and thus the bacterial population of the phyllosphere on a global scale is estimated to be 10^{26} cells [24]. The population size of the fungal phyllosphere is likely to be smaller [25]. Phyllosphere

microbes from different plants appear to be somewhat similar at high levels of taxa, but at the lower levels taxa there remain significant differences. This indicates that microorganisms may need finely tuned metabolic adjustment to survive in phyllosphere environment [24]. Proteobacteria seems to be the dominant colonizers, with Bacteroidetes and Actinobacteria also predominant in phyllospheres [26]. Although there are similarities between the rhizosphere and soil microbial communities, very low similarity has been reported between phyllosphere communities and those in open air [27].

Endosphere microbiome

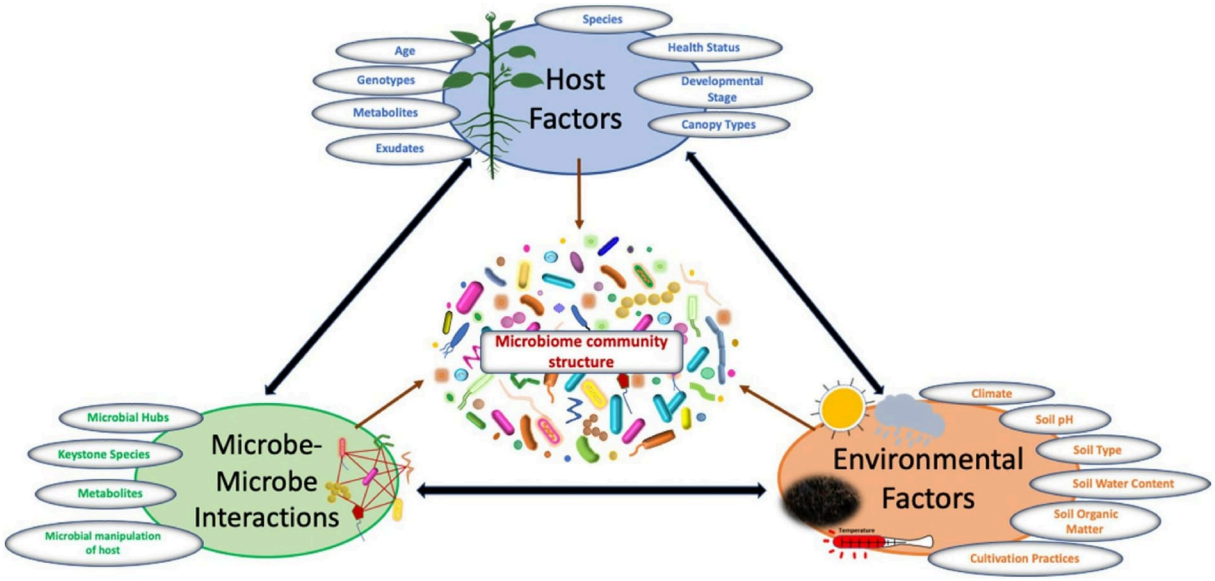
Some microorganisms, such as endophytes, penetrate and occupy the plant internal tissues, forming the endospheric microbiome (Fig. 1). The AM and other endophytic fungi are the dominant colonizers of the endosphere [28]. Bacteria, and to some degree Archaea, are important members of endosphere communities. Some of these endophytic microbes interact with their host and provide obvious benefits to plants [[29], [30], [31]]. Unlike the rhizosphere and the rhizoplane, the endospheres harbor highly specific microbial communities. The root endophytic community can be very distinct from that of the adjacent soil community. In general, diversity of the endophytic community is lower than the diversity of the microbial community outside the plant [18]. The identity and diversity of the endophytic microbiome of above-and below-ground tissues may also differ within the plant [28].



The ‘Plant Microbiome’ consists of diverse microbial communities on the outside surface and in internal tissues of the host plant. The rhizosphere, endosphere, and phyllosphere constitute the major compartments of plant microbiome. The soil microbiome is an important source of the plant microbiome.

Drivers of plant microbiome composition

Plant microbiome structure is influenced by complex interactions between hosts, microbes, and associated environmental factors such as climate, soil, cultivation practices etc. (Fig. 2). Below, we provide an assessment of current knowledge of these factors, providing insight to plant-microbe interactions in a broader-sense.



A simple schematic representation of various factors that shape microbiome community structures. The host, microbe, and environment all factors are interconnected and together build the microbiome community in plants.

Host factors that influence plant microbiome community composition

Plant species

The identity of the host plant has a significant influence on the identity of its microbiome. Different plant species growing adjacent to one another can harbor distinct microbiomes. A comparative survey of root microbiomes in maize, sorghum, and wheat showed different community composition among these plants [32]. Samad et al. [33] investigated the microbiome compositions of roots and rhizospheres using 16S rRNA gene from grapevines and some weed species growing in the same field, and their findings suggested that these species hosted significantly different microbiomes in the roots and rhizosphere, with the more pronounced difference in the root communities. Plants that are distantly-related phylogenetically show greater variation in associated microbiome compositions, suggesting a role of plant phylogeny in structuring root microbiomes [32]. Plant species also influences the identity and diversity of endophytic communities. Manter et al. [34] reported differences in endophytic community composition in potato and *Eucalyptus* plants. The most abundant bacterial root endophytes in potato were rare or absent in *Eucalyptus* and vice-versa [34] suggesting that the host plant selects its endophytic microbes. Analysis of endophytic fungi of three native Australian *Nicotiana* species revealed that they are host-specific but not plant organ- or host location-specific [28]. In addition to the rhizospheric and endophytic microbiomes, phyllosphere community composition also depends on plant identity [24]. Kembel et al. [35] showed that the leaf microbiome community is highly correlated with plant evolutionary relatedness similar to the endospheric microbiome.

The effects of host plant species in recruiting microbes from the surrounding environment indicate that plants have evolved traits that govern root microbiome assemblages [36]. For example, endosphere, rhizosphere community composition are correlated with host taxonomy [36]. Xiao et al. [37] found that the rhizosphere and root microbiomes are mostly influenced by soil type, and the nodule and root endophytes are influenced by plant species. Differential microbiome assembly in different plant species is attributed to variation in plant resource consumption [36]. Plant traits such as leaf permeability, wettability and topography and physicochemical properties, cuticle chemistry, root exudates, antibiotic production, and inherent plant immunity to invasion by microbes may also to play a role.

Plant genotypes

Evidence suggests a difference in microbe community composition between genotypes of a particular species [17,26,38]. Genetics of the host is one of the factors that shape the plant-microbiome structure. For example, OTUs in three different potato varieties were cultivar-specific [36]. Similarly, cultivar-dependent effects have been reported for the bacterial communities in young potato rhizospheres [15]. Peiffer et al. [39] demonstrated that OTU richness and β-diversity are influenced by plant genotypes in maize. Bulgarelli et al. [38] reported that genotype contributed to about 6% of the variation of the microbiome composition in the rhizosphere region. A larger influence of host genotype on community composition has been reported [40].

Genotype-dependent microbiome community structuring has been reported for sweet potato, wheat, pea, and oat [9,41]. Bacteria such as *Acinetobacter, Chryseobacterium, Pseudomonas, Sphingobium,* and *Stenotrophomonas* were more abundant in low-starch cultivars than those having high-starch contents [41]. The rhizosphere communities of different genetic clones of wild-type and transgenic lines have been reported to be distinct in *Populus* [42]. Within-species genetic variability can influence microbiome composition in leaf tissues [43]. Wagner et al. [44] conducted an extensive field experiment to unravel drivers of community composition of bacteria associated with leaves and roots of *Boechera stricta*. Their findings suggested that the host genotype influences leaf community, but the root microbiome was variable at different collection sites.

Agler et al. [45] proposed that host genotype influences on keystone microbes, which then pass these effects onto the total microbiome by changing microbe–microbe interactions and altering plant fitness [3]. The host specificity of plant microbiome could also be attributed to the nutrient preferences of plants [46]. However, whether the observed host influences are heritable, how strong the effect is, and whether these associations will be actionable for plant breeding is yet to be established.

Plant organ

Different plant tissues host distinct microbiome communities. Edwards et al. [47] demonstrated that each surface and internal tissue of plants may harbor distinct microbial communities and that the role of tissue-type was greater than host type and the microbiome of the soil. This may be because the adaptation strategies of various tissues may affect the microbes in colonizing them for community composition. For instance, surface tissues are exposed to constant fluctuations of weather and have relatively poor nutritional status compared to the root or internal tissues. Therefore, microbes colonizing the leaf surface need to be adapted in these conditions [25]. Other studies found very little or no effect of plant organ in community composition of fungi and bacteria [28].

Study with agaves determined that prokaryotes are largely influenced by the plant compartment, whereas the rhizosphere, the phyllosphere, and endosphere communities are clearly different from each other and from adjacent soils [48]. Many studies have reported that fungal communities show a different pattern, where the biogeography of host were the major influencing factor [48]. This may be explained by the dispersal limitation in fungi [49], because fungi are eukaryotes like plants and animals, but bacteria are different in this respect.

Plant age and developmental stage

In the cases of interactions between plants and pathogens, ontogenic resistance (age-related resistance) is widely reported and correlated with plant developmental stage [50]. Symbiosis research has also indicated that plant age and developmental stage are important factors affecting microbial communities [51]. Analysis of the bacterial rhizosphere community of *Arabidopsis* revealed that the seedling stage selects distinct microbiomes at developmental time points. Plants produce mixtures of compounds and specific phytochemicals in the root exudates. Some of these chemicals are indeed distinct at plant developmental stages and appear to shape microbiome community assemblages [52]. The effect of the plant age on microbiome using DGGE fingerprint analysis revealed that it significantly influences bacterial community composition of all groups investigated for all three sweet potato cultivars [41]. The effect of plant age on the composition of bacterial microbiome in the rhizosphere has been demonstrated in potato, maize and soybean [15,53,54]. Age-related microbiome differentiation may be associated with root growth, physiology, root architecture, root morphology, root exudate, and its composition [51,52]. However, further research is needed on the identity and effect of root exudates at different plant developmental stages to determine how plants communicate in the rhizosphere. This knowledge might offer a basis for augmenting agricultural crops by the application of rhizosphere microbes.

Plant canopy type

Plant canopy type also influences microbiome community composition. For example, bacterial communities in sugar maple leaf samples are correlated with canopy composition [55]. The microbial migration through rain runoff may be an important factor for variation in microbial colonization in different canopy types. Canopy structure influences the composition of endophytic community but not the rhizospheric community, indicating less effect of rain runoff, and there may be other mechanisms such as soil factors or some unknown factors involved in this variation [55].

Plant immunity and signaling

Plant health status may influence microbiome composition. Plants employ two layers of defense against pathogens: pattern-

triggered immunity (PTI), which is triggered by conserved molecular structures such as microbe/pathogen-associated molecular patterns (MAMPs/PAMPs), and damage-associated molecular patterns, which are recognized by plasma membrane-localized pattern recognition receptors [56]. It is unknown whether plants recognize non-pathogenic microbes in the similar way as they recognize pathogens and modulate their response. When plants are challenged with herbivory or pathogens they release hormones and exogenous volatiles that alter the composition of root exudates (for review, see [57]), and these in turn modify the microbiome community. Aphid infestation and pathogenic microbial infection increaseed populations of the non-pathogenic rhizobacterium *Bacillus subtilis* in the sweet pepper rhizosphere [58]. In *Arabidopsis thaliana* plants infected by *Pseudomonas syringae*, the expression of root malate transporter is altered, indicating a change in secretion of malic acid that increased the number of the beneficial rhizobacterium *Bacillus subtilis* [59,60]. Cucumber roots infected by *Fusarium oxysporum* f. sp. *cucumerinum* exhibited augmented secretion of fumaric and citric acid, which led to the formation of biofilms (aggregates of living bacteria in a slimy extracellular polymeric substances) of *Bacillus amyloliquefaciens*. Most investigations, however, have focused on one-to-one interactions (plant-microbe), although in reality, plants are subjected to attack by numerous microbial pathogens and insect pests. Therefore, it would be interesting to see how multiple herbivory and/or pathogens modify the community composition of plant microbiomes. Recent studies have reported a change in rhizosphere microbiome community composition as influenced by specific compounds such as sugars, sugar alcohols, or mixtures of various chemical compounds in root exudates [52]. Plants use various strategies in response to pathogenic infection and insect attack. One of them is activation of defense responses in roots, which may influence microbiome composition in the rhizosphere and roots [61]. When aphids feed on foliage both SAR (Systemic Acquired Resistance) and ISR (Induced Systemic Resistance) signaling are activated throughout the plants, which elicits sweet pepper plants to attract *B. subtilis* in the rhizosphere [58]. Again, increased JA signaling in plant either by injury or exogenously in *Medicago truncatula* caused higher colonization of beneficial mycorrhizae [62]. Different root and phyllosphere endophyte microbial communities have been reported when altered SA signaling was induced [63]. Plants lacking in jasmonate-mediated defense have shown more diverse epiphytic colonization [64]. It is evident from these studies that the role of plant defense systems on the microbial composition are inconstant, and that SAR is an important factor in regulating some bacterial community composition. Chemical signals released by plants for example, flavonoids, activate varied responses in plant rhizosphere microbiomes [65]. Branching in mycorrhizal hyphae is affected by strigolactones, which enhance and promote seed germination by parasitic plants [66].

Plant derived compounds

A diverse array of antimicrobial compounds are produced in plants [67]. Some of them, such as different alkaloids, phenolics, and terpenoids, are common in plants. Some are specific to particular groups [68], for instance, Brassicales produce glucosinolates. It was found that transgenic *Arabidopsis* producing an exogenous glucosinolate had different microbiomes in the rhizosphere and root tissues [69]. Voges et al. 2018 reported a significant role of plant derived coumarins in structuring the rhizosphere community. They suggested that iron-mobilizing coumarins are involved in redox reactions that can mobilize ferric iron and generate reactive oxygen species (ROS) with detrimental effects on microbial proliferation and thus selectively inhibit certain microbial growth while allowing proliferation other more beneficial partners. Triterpenoid saponins, which are known as avenacins, are found in oat (*Avena strigosa*), and have antifungal properties [70]. Oat plants lacking avenacin production attracted different culturable fungi in roots [71] and were more vulnerable to pathogenic infections than wild-type oat [72]. Interestingly, however, a recent comprehensive analysis of the rhizosphere community of these two genotypes reported little difference between the fungal communities. The effect of avenacins on the Amoebozoa and Alveolata was profound but has not been reported for bacterial communities [73]. This revealed that a small difference in plant genotype might exert multifaceted and unpredicted effects on the plant microbiome composition and diversity. These plants derived compound may affect microbiome assembly in different ways. For example, root exudates may be specific for host plant and can modulate rhizosphere community as well as selects specific root microbiome and thus contributing host specific plant microbiome. Also, antimicrobial compound may selectively enhance microbial growth by restricting certain microbes which is a kind of ‘balance’ in mutualism.

Microbial factors in shaping plant microbiome structure

Microorganisms play important roles in shaping microbial community structures in plants. However, our knowledge on how microorganisms influence microbiome structuring is limited.

Microbial manipulation of hosts

Microorganisms can affect host plants, for example host root exudations, which in turn affect the permeability of roots and root metabolism. Some microbes in soil where the plant if growing can also absorb certain compounds in root exudates and excrete other compounds. Soil microbes can produce compounds that affect plant signaling and metabolism, which lead to production of microbe-derived compounds in plants. Some microbes produce antibiotics (e.g., penicillin and polymyxin) which increase

the exudation of organic materials, altered cell permeability, and increased leakage [74] and results in a variable microbiome assembly.

Microbe-microbe interaction

The extent to which microbe–microbe interactions can play roles in the microbiome composition is not well understood. The outcome of microbe-microbe interactions could be explained as cooperation, parasitism, and competition. In cooperation, at least one species benefits, while others are not harmed. When both species benefit, the term mutualism is used, whereas, when one partner benefits while the other is not affected, the term commensalism is used. In contrast, parasitism and competition are harmful for at least one species [75].

We know from recent studies that microbial communities harbor highly connected taxa called keystone taxa [76]. These taxa independently or in a group show a substantial effect on microbiome composition and functions regardless of their spatial and temporal dynamics. They play a unique and vital role on microbiomes, and their absence could cause a significant alterations in microbiome composition and functioning [76]. They use various strategies to impact on host microbiome. For instance, they might cause changes in intermediate or effector groups which in turn regulate microbiome community composition and functioning [77]. Production of a secondary metabolite (2,4-diacetyl phloroglucinol) was reported for some strains of *Pseudomonas fluorescens* that suppress *Gaeumannomyces graminis* var. *tritici*, responsible for wheat take-all [78]. Similarly, many fungi (e.g. *Trichoderma* and bacteria (e.g. *Bacillus*) produce various secondary metabolites that suppress microbial growth [79,80]. The keystone taxa may produce bacteriocins to shift microbiota structure selectively. Again, by synergism, keystone taxa may alter the abundance of their partners, and influence community structure and performance. For example, certain species of *Burkholderia* are symbiotic with arbuscular mycorrhizae and may change abundance and community composition of AM fungi, thereby influencing plant community richness, diversity, and production [19]. Agler et al. [45] studied the roles of microorganisms (bacteria, fungi and oomycetes) in the community composition of phyllosphere microbiomes of Arabidopsis thaliana using a systems biology approach. They described an interkingdom interactions network with a profound influence on community structure. They identified a few taxa, termed “microbial hubs’, which are highly interlinked and have a significant impact on communities. They used two “hub” microbes (Albugo, an oomycete pathogen and Dioszegia, a basidiomycete yeast) in detail. Albugo strongly affected epiphytic and endophytic bacterial colonization. Many symbiotic microbes (including pathogens) produce effector proteins to suppress, activate, or alter host defense mechanisms [81], and some can entirely reprogram the host metabolism [82]. These host adjustments can lead to alterations of microbiome composition because some microorganisms and not others can benefit from altered conditions. Actually, the niches of some microorganisms is dependent on others. For instance, primary colonizers can aid subsequent colonizers against hazardous abiotic factors [83] or can enhance the competitive ability of following colonizers by producing secondary metabolic compounds [84]. There can be direct microbe-microbe interactions, such as the hyper-parasitism (parasite of parasite) of primary colonizers [85] and opportunists that utilize host’s compromised plant defenses to colonize them [86]. Such phenomena point out why some colonizers can affect the development of microbes on the host even if they may be distantly related [84] and highlight a crucial functions of such interactions in shaping microbiome composition and structure.

One of the major strategies by which PGPR augments plant growth is by its influence on rhizosphere microbes. For example, *Pseudomonas* sp. DSMZ 13134 alters the composition of dominant bacteria in barley roots [87]. In some cases, however, the effects of PGPRs on resident microbiome may not be prominent. For example, no substantial changes in rhizosphere community were noticed after the application of *Bacillus amyloliquefaciens* FZB42 [88]. Supporting results have also been reported in soybean with the application of *B. amylolique faciens* BNM122 [89]. The recent investigation on the effect of *B. amyloli quefaciens* on the lettuce microbiome using 454-amplicon sequencing revealed no or only transient and minor effects in the rhizosphere zone [90]. Interestingly, a decrease in the bacterial number was reported. In the field only 55 % of the inoculated bacterial DNA could be traced after a month [91]. The effects of *Bacillus subtilis* strain PTS-394 on the rhizosphere microbiome has been examined by metagenomic profiling. Similar to the results above for *B. amyloliquefaciens* FZB42 [90,91], only a minor effect on the composition was reported. However, up until now, the impact of *Bacillus* PGPR on other plant microbiota, such as fungi, has not been investigated, and investigation on this could reveal a more general effect of inoculated bacteria on resident microbiota and thus on host physiology and ecology.

Environmental factors as drivers of plant microbiome assembly

Environmental elements, such as soils, climatic conditions, geography, farming activities, and plant domestication, could result in the differences of plant associated microbial community composition [92]. A change in an environmental component results in plant phenotypic changes (e.g., [93], which consequently also change the assemblage of distinct microbiomes harboring plant compartments [94]. Plants grown under controlled conditions provide specific environments for microorganisms. For instance,

when lettuce was grown under a glasshouse, a distinct bacterial signature was found from those grown in open fields [95]. Whitaker, Reynolds et al. [96] reported the community composition of endophytic fungi local environment (i.e., site), but not by host ecotype, pointing that environmental factors are major drivers of the endophytic mycobiome of switchgrass.

Soil

Plants recruit root microbes mainly from the soils where they grow. Various soil factors viz. soil types, soil pH, and the C/N ratio, as well as available P and K are frequently reported to be the determinants of root microbial community composition by affecting plant growth and immunity [8,9]. Innumerable studies using high throughput sequencing have proved that soil type is a major factor for root microbiome structure, which is evident from the differential initial microbial inocula present in different soil types [18,47]. Dombrowski et al. [97] collected the arctic-alpine *Arabis alpine* samples from the native location as well as from those grown under controlled conditions and investigated the root microbiome by 16S rRNA amplicon sequencing analysis. They reported that soil type and length of time the plants remained in the soil are the most important drivers, causing variation of up to 15 % of root microbiota. In addition, in the same soil, the root microbiome of perennial *A. alpina* was similar to *A. thaliana* and *Cardamine hirsuta,* the annual relatives of *A. alpina*. The root microbiome communities are strongly influenced by the composition of the soil microbiome close to roots. A strong correlation between the soil and root bacterial communities in *A. thaliana* has been reported by various authors [3,18]. Similarly, the structure of fungal communities is influenced more predominately by soil type than by host plant [98]. The type of soil influenced the rhizosphere bacterial microbiota composition in lettuce [99], oak [16], *Arabidopsis* [3], and maize [100].

Several studies have shown that environmental variability, such as soil pH, C: N ratio, soil carbon, water content and biogeography may influence the microbiota composition [39]. Lauber et al. [101] described that the impact of soil pH on total community composition was obvious even at a very high taxonomic level. Analyses revealed that pH has substantial correlation with the structure of these microbiome phyla in all soil types studied. The effects of soil pH on soil bacterial community composition has also been reported in other studies using various methods [102]. Zarraonaindia et al. [103] reported that the composition of soil and root microbiome of grapevine significantly influenced by soil pH and C:N ratio but leaf- and grape-associated microbiota were mostly influenced by soil carbon. Hartman, Richardson et al. [104] reported from their study that pH was the most important factor in predicting the alteration of soil bacterial communities, and they detected changes in phylum-level abundances across the pH levels. However, contrasting results have been reported by Fierer et al. [105], where they noted soil carbon was more important than soil pH for Bacteroidetes, Betaproteobacteria, and Acidobacteria. This difference of the findings was possibly linked to sample sizes and number of soil types investigated as well as to differences in methodologies. The exact mechanism(s) of the role of soil pH on microbial community composition and diversity is unknown. Two general explanations have been given [101]. Firstly, soil pH may indirectly alter bacterial community structure with its influences on soil characteristics. Secondly, soil pH may directly impose a physiological limit on soil bacteria, changing outcomes of competition or reducing survival of taxa intolerable to condition. In addition, we hypothesize that soil pH may alter plant microbiome by its influence on plant growth and physiology, which also may influence soil microbiome composition. Other soil properties, for example soil temperature and contaminants in the soil, also influence microbiome composition. Heat disturbance of soil results in a shift in rhizobacterial microbiome composition [106]. Heat disturbances due to natural wildfires can cause a decrease in microbial activity and significant alterations in microbial communities [107]. Increasing petroleum hydrocarbon contamination levels results in the alteration of willow microbiome structure. These alterations were less extreme in the rhizosphere and plant tissues, but they were prominent in the bulk soil. These could be because plants provide more controlled conditions and shield microbes against an enhanced contamination gradient [108].

Cultivation practices

Land use and cultivation practices are the most important causes of declines in biodiversity, leading to undesirable consequences for the environment [109]. Changes in the vegetation influence the diversity and structure of soil microbiomes. Agricultural activities do not necessarily have negative consequences in soil bacterial community diversity and structure, but they may have positive or neutral feedback (effect not perceived) [110]. For example, the intensity of land use (LUI) has been reported to influence the pattern of bacterial communities. Estendorfer et al. [111] found that under low LUI, there remains a strong interaction between plants and adjacent soil. In contrast, no influence of LUI on microbial diversity has been found in the rhizosphere, which indicates that plant species have much more influence on the rhizosphere community than soil properties do [112]. However, Suleiman et al. [113] reported that plants may have robust core microbiome compositions that are less prone to alteration due to variation of land use, soil type or edaphic factors. It was found that microbiome of in relatively untouched deciduous forest and long-term mowed grassland soils were comparable, although there were significant differences in soil properties and vegetation [114], Continuous cultivation causes changes in soil properties, which in turn might affect the soil microbiome communities. As per the reports of Allison and Martiny [115], there are three potential impacts caused by land disturbance such as the microbial

structure might be affected, it might be changed but quickly return to the original composition (resilient), or might remain unchanged.

Climatic variables

Climate is an important driver of plant and soil microbiome composition. The role of climate in influencing plant microbiome community composition has to date been largely unheeded or found to be of little importance [116]. A recent study, however, across various ecosystems in Britain showed that rainfall and temperature gradients are two major climatic factors in shaping the bacterial community composition in plants [117]. Researchers de Vries et al. [118] reported that precipitation is an important driver of soil microbial community composition. The biomass of fungi and bacteria has been reported to increase with increasing mean annual precipitation (MAP), and the effect was more prominent for fungi, resulting in comparatively higher fungal abundance (increased F/B ratio) under higher precipitation levels. The above trends could be linked to higher soil organic matter contents in higher rainfall areas. In particular, in uplands where harsh climatic conditions prevail, a higher organic matter build-up is noticeable, which leads to fungi-dominated microbiome communities [119].

Conclusions and future perspective

The factors that influence microbiome assemblages and dynamics in plant and soil are now better understood, and research in this aspect is increasing. However, our knowledge on the underlying mechanism(s) of microbiome assemblages and how they influence the host plants is still lacking. Connecting the microbiome composition and diversity to their function is a great challenge for future research. For instance, to what extent could we use and manipulate the plant microbiome to boost sustainable agricultural production and environmental protection? We now know that that host genetic factor has a significant influence on microbiome diversity and structure, indicating that breeding and trait selection provide opportunities to select for desired microbiomes [45]. To have a more profound and broader knowledge on plant microbiome, there is a need to integrate novel molecular approaches (e.g., meta-omics), ecological models (e.g., food web theory, assembly of communities, or coexistence theory), and recent bioinformatics and statistical advances with a view to correlating community assemblages with ecological functions.

In the future, more emphasis should be placed on identifying the underlying mechanisms that drive microbiome community composition and assembly. We need to know the contributions of (1) the microbe-microbe interactions, (2) soil and other environmental variable and (3) various host traits in shaping community structure. Future research will direct toward solving some pertinent questions. For example, how stable are the drivers of microbiome community? To what extent do agricultural practices affect the microbiome of plant species? How predictable are these divers? With high throughput technologies, such as next-generation sequencing and metagenomics, we can begin to study endophyte microbiomes across hosts, environmental conditions, and at different time points and focus on the mechanisms of the plant-endophyte association.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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- What are the various types of plant-associated microbiomes and how does each affect plant health?
- How are the compositions of plant microbiomes influenced by the environment?
- What aspects of the host plant can shape its microbiome?
- In what ways can the plant microbiome be governed by microbe-microbe interactions?

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16.1.5.5: Pollution and Bioremediation

Pollution and Bioremediation

Achieving sustainable life, for humans, animals, and the environment, requires a plan of action to mitigate anthropogenically-induced damage and develop future practices to maintain planetary homeostasis. One of the biggest threats to ourselves and the environment is the buildup of human waste and pollution (e.g. plastics, oil, synthetic products, etc.) that take a tremendously long time to naturally breakdown. With the human population predicted to continually climb, continuing the same destructive practices will only result in more waste generation in a fraction of the time that it takes for decomposition. One alternative means to solve the pollution problem is to use specialized microbiomes for bioremediation. That is, a specially designed microbial consortia could clean up (i.e. breakdown and assimilate) various toxic molecules much more quickly. However, this will take time to understand how and which type of microbes could perform these tasks and if there are any associated (negative) effects.

Alternative Strategies for Microbial Remediation of Pollutants via Synthetic Biology

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Continuous contamination of the environment with xenobiotics and related recalcitrant compounds has emerged as a serious pollution threat. Bioremediation is the key to eliminating persistent contaminants from the environment. Traditional bioremediation processes show limitations, therefore it is necessary to discover new bioremediation technologies for better results. In this review we provide an outlook of alternative strategies for bioremediation via synthetic biology, including exploring the prerequisites for analysis of research data for developing synthetic biological models of microbial bioremediation. Moreover, cell coordination in synthetic microbial community, cell signaling, and quorum sensing as engineered for enhanced bioremediation strategies are described, along with promising gene editing tools for obtaining the host with target gene sequences responsible for the degradation of recalcitrant compounds. The synthetic genetic circuit and two-component regulatory system (TCRS)-based microbial biosensors for detection and bioremediation are also briefly explained. These developments are expected to increase the efficiency of bioremediation strategies for best results.

Introduction

The remediation processes aided by microorganisms present at the various contaminated scenarios constitute bioremediation (Basu et al., 2018; Kumar et al., 2019). Microbial remediation uses multiple metabolic pathways responsible for enzyme production (Sharma B. et al., 2018; Dangi et al., 2019). These enzymes mainly take part in the degradation pathways of xenobiotics (Junghare et al., 2019). There are different customary methods for bioremediation, primarily based on the site of bioremediation, *in* and *ex situ* (Tomei and Daugulis, 2013). *In situ* is applied to the site to minimize soil disturbance. This method is mostly adopted due to less expenditure from avoiding excavation and transport of contaminated soil (Khan et al., 2004). According to Khan et al., 2004 less disruption in *in situ* bioremediation causes less dust dispersion and hence better degradation (Joshi et al., 2016) of contaminant. Bioaugmentation, bioventing, biosparging, and engineered *in situ* bioremediation are main *in situ* bioremediation methods (Azubuike et al., 2016). *Ex situ* bioremediation methods are solid phase system (composting, landfarming, and biopiling) and slurry phase system (bioreactors) (Kumar et al., 2011). Transportation of soil to accelerate microbial degradation are done by solid and slurry phase systems, whereby treatments of domestic, industrial, and organic waste are done by *ex situ* bioremediation (Juwarkar et al., 2010). These traditional bioremediation methods take time and consume much cost expenditure, giving less result output. Traditional bioremediation (Duarte et al., 2017) processes showed the above limitations of extra time taking, less removal or dissimilation of pollutants, (Bharagava et al., 2019) disturbance to nature delicacy such as more land coverage for a long time, and a foul smell in the environment (Dangi et al., 2019; Kumar, 2019). Therefore, researchers are eager to discover new bioremediation technologies for best results. Dvoøák et al. (2017) described bioremediation via synthetic biology for boosting bioremediation strategies. This approach can catch the catabolic (Jacquiod et al., 2014) and metabolic complexities for reviewing the potential of the microbial population synthetically. The preliminary information for developing synthetic microbial models for bioremediation can be obtained by mining genes from the databases (Fajardo et al., 2019). The computer logics involvement can determine the microbial cell interactions with recalcitrant compounds (Kim et al., 2015). These strategies can together grasp the natural metabolic potential of microorganisms to transform into novel biological entities of interest (Dangi et al.,

2019). Furthermore, the regulation of metabolic pathways (Alves et al., 2018) in a controlled manner can also be achieved for bioremediation processes (Rochfort, 2005). This transition via synthetic biology application (Figure 1) for remediation purposes would improve the bioremediation processes via the involvement of potent (Zhu et al., 2017) dissimilating particular contaminants (Trigo et al., 2008). Synthetic biological systems mediate cellular modulations for efficient functioning and working of existing processes. They permit the modification of cellular processes *viz.* metabolic pathway acting for a particular chemical compound. The advancement of synthetic biology for bioremediation of various contaminants is attaining the focus of scientists and researchers. For instance, a sustainable synthetic microbial community's establishment for bioremediation is being investigated. Microbial interactions and quorum sensing within communities are vastly studied for application in the area of bioremediation with synthetic biology applications. Achievement of the synthetic genetic circuit of *Pseudomonas putida* proved to be the golden gadget for degradation studies. Besides this, genome editing by CRISPR-Cas, TALEN, and ZFNs adds knowledge for reviewing the progression in bioremediation studies. Synthetic microbial biosensors and metabolic engineering of cellular processes for utilization and detection of contaminant residues will remediate the environment from persistent recalcitrant pollutants. This review is focused on the above mentioned strategies and their elements (Figure 2) applicable for bioremediation purposes and research.

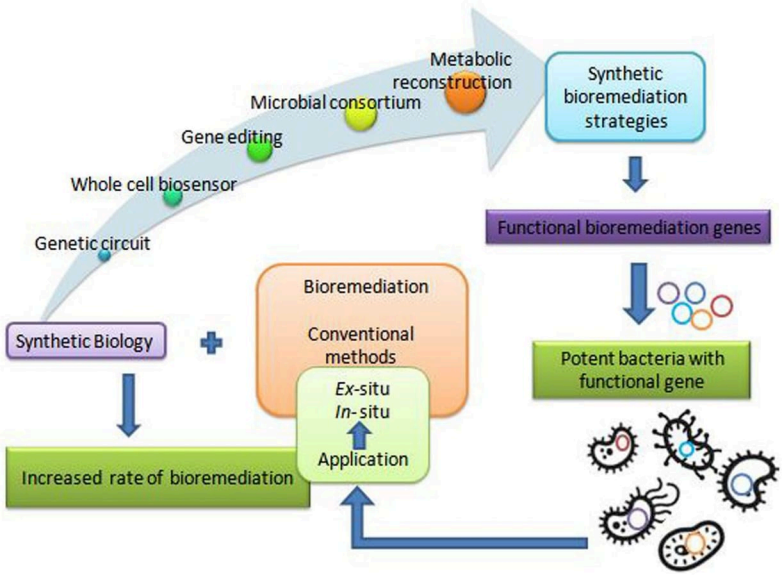


Figure 1. The strategies of synthetic biology applicable for bioremediation.

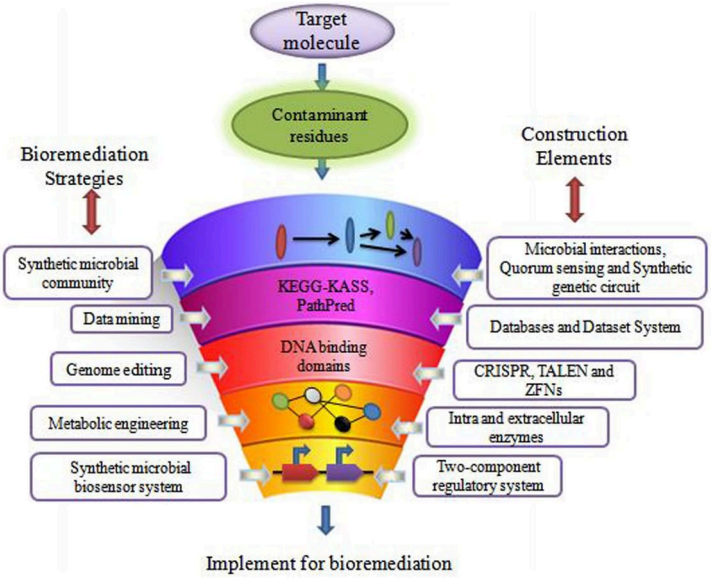


Figure 2. The components and their construction elements of synthetic biology for bioremediation studies.

Metabolic Reconstruction for Designing Synthetic Models

A computational platform is utilized for the reconstruction of cellular metabolism (Agapakis et al., 2012) via metabolic pathway analysis (MPA) (Banerjee et al., 2016). MPA mathematically represents the reactions of metabolism. This method is based on stoichiometric balance reactions so as to propose steady-state metabolic flux during cellular growth. The stoichiometry matrix imposes constraints of flux, making the consumption and production of the compound at a steady state (Bordbar et al., 2014). The maximum and minimum flux of a reaction can also be determined by providing the topper and least bound. This helps to define the extent of permissible flux supply (Richelle et al., 2016; Rawls et al., 2019). The next step is defining the objective according to the biological problem to be studied. This objective mathematically represents the reactions responsible for the phenotype appearance. The mathematical reactions and phenotype are combined with linear equations and solved by computational algorithms such as COBRA Toolbox11 and Matlab toolbox (Orth et al., 2010; Bordel, 2014). FBA is fundamentally simple, having immense applications in studying gaps, physiology, and genomes via systems biology approach (Kim et al., 2015; Hellweger et al., 2016). These gaps are missing metabolic reactions, making the genome partially known. FBA uses computational algorithms that can predict missing reactions *viz.* OptKnock and OptCom, which can knock out the genes responsible for producing the desired compound (Biggs et al., 2015). These approaches are beneficial for constructing microbial communities for bioremediation of particular contaminants (Khandelwal et al., 2013). However, MPA is the most challenging method when metabolic information is incomplete, making it difficult to obtain a real model (Covert et al., 2001). But this method shows cellular functions in the dynamic community, and thus is very useful for the prediction and exchange of metabolic flux in communities of microorganisms (Khandelwal et al., 2013). Recently, a metabolic model has been constructed by using two *Geobacter* species with parameterized electron transfer and metabolic exchange to characterize syntrophic growth dynamics. Such a system may have useful applications in the field of bioremediation and degradation of particular contaminants (Butler et al., 2010). A computational platform is also needed for better prediction of engineered genetic pathways for community dynamics. A graph-based tool Metabolic Tinker was developed by McClymont and Soyer to identify thermodynamically feasible biochemical routes for compounds deterioration (Johns et al., 2016). This may be applied to identify the routes for degradation of recalcitrant compounds by microbial consortia. These computational tools are utilized along with omics (Kim et al., 2014; El Amrani et al., 2015) and biological data for desired output (Berger et al., 2013) and toxicity prediction (i.e., META-CASETOX System) (Peijnenburg and Damborský, 2012). These are also applied for functional gene identification and their profile analysis, PCR analysis and drug discovery, etc (Dangi et al., 2019). Computer-aided drug discovery and development (CADDD) is used effectively with chemical and biological aspects, i.e., chemical structures accounting the biological role and its activity via ligand-based drug design, structure-based drug design, quantitative structure-property relationships, and quantitative structure-activity (Kapetanovic, 2008). Furthermore, Table 1 depicts similar methodologies applicable to bioremediation studies. De Jong (2002) analyzed the multicellular feedback control strategy in a bacterial consortium (Bruneel et al., 2011) to define the robustness conceivable under desired conditions.

S.no.	Purpose	Approach	Methodology	References
1.	Degradation study	Functional gene identification for bioremediation	PCR (Polymerase Chain Reaction) product sequence analysis	Jagwani et al., 2018
2.	Cell behavior study	Whole-cell simulation	A computer model for bacterial cell in response to the contaminated environment	O'Brien et al., 2015; Panigrahi et al., 2019
3.	Toxicity of chemicals	Analysis of chemical and biological properties	*In silico* toxicology (IST) protocols for toxicity assessment; QSAR (Quantitative Structure Activity Relationship) model	Pavan and Worth, 2006; Myatt et al., 2018
4.	Identification of functional bioremediating microbe	Target identification	Protein structure prediction, Protein – protein interaction (PPIs)	Shukla, 2017
5.	Remediation of textile dyes	Interaction of protein-ligand	Molecular docking	Sridhar and Chandra, 2014; Kumar et al., 2016
6.	Bioremediation of toxic pollutants	Structure prediction	Biodegradability evaluation and simulation system	Das et al., 2016

Table 1. The methodologies applied for bioremediation research.

They utilized an ordinary differential equations (ODE)-based model and agent-based simulation on a consortium (Hawley et al., 2014; Atashgahi et al., 2018) of interacting species population for increasing the efficacy of the proposed feedback control strategy. The application of bioinformatics (Arora and Bae, 2014) resources is a prerequisite dimension for obtaining the data to begin the microbial bioremediation studies of recalcitrant compounds (Gong et al., 2012; Ofaim et al., 2019). This involves the information related to the degradation of xenobiotics by microbes and their pathways for dissimilation (Dao et al., 2019; Salam and Ishaq, 2019; Thelusmond et al., 2019; Wei et al., 2019). The data related to end products and intermediate metabolites released throughout degradation pathways can also be retrieved (Dvoøák et al., 2017). An extended information source linked to degradation is MetaRouter, allowing data (Singh and Gothalwal, 2018) for life sciences laboratories to explore degradation possibilities of recalcitrant compounds (Mohanta et al., 2015). The information on oxygenic degradation of xenobiotics can be retrieved from OxDBase, a biodegradative oxygenase database (Chakraborty et al., 2014; Shah et al., 2018). Oxygenase is a class of enzyme which transfers the oxygen molecule for oxidizing the chemical compound. They play a role in the degradation of organic compounds by aromatic ring cleavage (Jadeja et al., 2014). OxDBase is very particular in providing knowledge of oxygenases-catalyzed reactions, and is a powerful tool applicable to bioremediation studies (Singh,

2018). Bioconversion and biodegradation of persistent and toxic xenobiotics (Desai et al., 2010; Bao et al., 2017) compounds catalyzed by oxygenases decrease the compound sustainability and toxicity in the environment (Kües, 2015; Kondo, 2017). Therefore, OxDBase is very helpful in acknowledging the degradation processes involved in bioremediation (Shah et al., 2012). The transcriptional characterization of genes responsible for the biodegradation and biodissimilation of a particular compound has great significance in proposing molecular methodologies. This can be done by the Bionemo (Biodegradation Network Molecular Biology) database (Libis et al., 2016a). Bionemo contains the entries for sequences of genes coding for biodegradation (Carbajosa and Cases, 2010). It also links the gene transcription and its regulation (Libis et al., 2016b). The data retrieved from Bionemo can be used for designing cloning experiments and primers (Arora and Shi, 2010). Garg et al. (2014) used eMolecules and the EAWAG-BBD PPS database for the prediction of pathways involved in the biodegradation of 1-naphthyl-N-methyl carbamate. These above findings empower the researchers to analyze and establish what prerequisites must be fulfilled for developing synthetic bioremediation models.

Designing the Synthetic Microbial Communities

Recent advancements in the field of synthetic biology for environmental issues have shown a great impact. The use of GMOs in environmental biotechnology for remediation (Malla et al., 2018) of toxic compounds, xenobiotics, and pesticidal compounds are being done. To design a synthetic community, it is important to understand natural microbial communities (Schloss and Handelsman, 2008). In a natural community, it is difficult to find out which species are actually taking part in bioremediation (Großkopf and Soyer, 2014). Thus, a synthetic microbial community is a promising method for constructing an artificial microbial community with function-specific species for bioremediation purposes. These communities may act as a model system for the study of functional, ecological, and structural characteristics in a controlled manner. Großkopf and Soyer (2014), defined synthetic community by the culturing of two microbial species under well-defined conditions on the basis of interaction and function (Bruggeman and Westerhoff, 2007). These factors determine the dynamics and structure of the community. It is based upon the identification of processes and patterns engaged in by bacterial species. These microbial interaction patterns are metabolism-driven and responsible for community interaction (Wintermute and Silver, 2010). Social-based microbial interactions (i.e., mutualism, cooperation, and competition, etc.) and the total outcome of these interactions between two microbial populations can be +/+ and –/+ or +/–, respectively (Foster and Bell, 2012). It is said that community structure and function majorly depends on cooperation. The effect of cooperation on community dynamics is determined by engineered cooperation resulting in the synthetic community. Engineered cooperation between two microbial strains (Singh et al., 2016) can be done by manipulation of environmental conditions, i.e., knocking the genes out and in Zuroff et al. (2013). Beyond this, other interaction patterns have been analyzed with engineered microbial species in the synthetic community. Such an application of engineered interaction is highly recognizable in bioremediation strategies (Sharma, 2012). Synthetic biology provides greater potential for the sustainable existence of microorganisms (Dellagnezze et al., 2014) acting together in a large population. Thus, synthetic microbial communities are proved as a key strategy for the bioremediation of contaminants, i.e., pesticides, petroleum (Kachienga et al., 2018), oil spill, acid drainage (Serrano and Leiva, 2017), etc. For building the synthetic microbial communities, the engineered interspecies and intraspecies interactions can make cellular functions robust and enhance the capabilities of microbial consortia in various contaminated scenarios. Quorum sensing is a bacterial signaling mechanism, which is a density-dependent phenomenon via cell-cell communication and population level behavior. The signaling is done by the release and reception of chemical compounds by microbial candidates in a population. This leads to multicellular behavior (Obst, 2007), offering engineerable tasks to design function specific synthetic communities. These synthetic models can also be exploited to obtain a rational design that can lose the function when subjected to competition with other species in the natural environment. With the evolution of genomic constituents and gene transfer, the possibility of the gradual extinction of genetic circuits is present. Thus, strategies are required to maintain the robustness of the synthetic community, achieved via the synthetic models by the development of synergistic and cooperative properties that reduce instability and loss of function (Johns et al., 2016). A recent study by Coyte et al. (2015) suggests that competition among species is significant in determining the stability of communities, acting as a limiting factor in the stability of the synthetic community. Thus, these dynamics must be accelerated in order to design particular function specific synthetic communities for bioremediation purposes (Coyte et al., 2015).

Genetic and Metabolic Engineering

Enríquez (2016) said that genome editing is an umbrella term that refers to “scientific technological advances that enable rational genetic engineering at a local (gene) or global (genome) level to facilitate precise insertion, removal, or substitution of fragments of Deoxyribonucleic acid (“DNA”) molecules, comprising one or more nucleotides into the cell(s) of an organism’s genome.” Transcription-activators like effector nucleases (TALEN), clustered regularly interspaced short palindromic repeats (CRISPR-Cas), and zinc finger nucleases (ZFNs) are major gene editing tools used (Table 2). The most efficient and simple technique of gene editing has been described as CRISPR-Cas (Kanchiswamy et al., 2016). These tools can boost the process of bioremediation.

TALEN has a DNA-binding modular which is sequence-specific for the host genome (Utturkar et al., 2013). TALEN binding to DNA creates a double stranded break (DSB) in the target sequence and leaves sticky ends for stability. Similarly, ZFNs is also a DNA-binding domain composed of 30 amino acids. It introduces DSB at the target site of the host genome by the Fok1 cleavage domain. A new sense of using hybrid nucleases containing TALENs and ZFNs nucleases came to act for solving the molecular complications. The CRISPR-Cas system, on the other hand, has unique action properties of high sequence specificity and multiplex gene editing. This unique property is derived from bacteria *Streptococcus pyogenes* as immunity against the virus. The CRISPR-Cas system consists of crisper derived RNA (crRNA) and trans acting antisense RNA (trcRNA) joined by guide RNA (gRNA). gRNA directs the Cas9 enzyme to introduce DSB in the target DNA sequence by recognizing it. These gene editing tools create the knock-in and knock-out and are under processing for implementation in bioremediation studies (Kumar V. et al., 2018). Recent reports indicate though that the CRISPR-Cas system is mostly adopted and performed by researchers in model organisms i.e., *Pseudomonas* (Karimi et al., 2015; Nogales et al., 2020) or *Escherichia coli* (Chen et al., 2018; Marshall et al., 2018; Pontrelli et al., 2018). Nowadays, the new insights toward CRISPR tool kits and designing gRNA for expression of function-specific genes related to remediation in non-model organisms (i.e., *Rhodococcus rube*r TH, *Comamonas testosteroni* and *Achromobacter* sp. HZ01) are also suggested in the field of bioremediation (Mougiakos et al., 2016; Jusiak et al., 2016; Hong et al., 2017; Stein et al., 2018; Tang et al., 2018; Liang et al., 2020). For gene editing and metabolic engineering, the contaminant-inhabited bacteria are the most suitable candidates because they are used to survive and harbor in stress conditions of various toxic, recalcitrant and non-degradable xenobiotics, as discussed above. Moreover, understanding metabolic pathways seems to be important in studying the microbial bioremediation (Plewniak et al., 2018), i.e., bioremediation of toxic pollutants by the haloalkane dehalogenases production pathway and decontamination of pyrethroid from the soil via the biodegradation pathway of fenpropathrin studied in *Bacillus* sp. DG-02 (Chen et al., 2014). Metabolic engineering leads to modification of the existing pathway for the betterment of the bioremediation process (Michel et al., 2007). This approach majorly covers the study of microbial enzymes, i.e., oxidases, esterases, monooxygenases, oxidoreductases, phenoloxidases involved at various degradation steps (Figure 3A; Mónica and Jaime, 2019; Mujawar et al., 2019). Enzyme-based bioremediation has many advantages because it is an eco-friendly process. The genetic approach increases the perspective of getting recombinant enzymes. There are research reports of extracellular enzymes having a role in enzymatic bioremediation. For instance, arsenic bioremediation (Andres and Bertin, 2016; Choe and Sheppard, 2016; Akhter et al., 2017; Biswas et al., 2019) (bioaccumulation and biotransformation) is achieved *via* arsenite oxidase coded by *aioA* gene of *Klebsiella pneumonia* (Mujawar et al., 2019); enzymes released by white rot fungi degrade PAHs (polycyclic aromatic hydrocarbon) (Zhao and Poh, 2008; Košnár et al., 2019), dyes, TNT (2,4,6- Trinitrotoluene) and PCBs (polychlorinated biphenyls) (Gupte et al., 2016; Kutateladze et al., 2018; Sadańoski et al., 2018). Esterase D enzyme acts on β-endosulfan (organochlorine pesticide), producing simpler compounds (Mehr et al., 2017; Chandra et al., 2019). *LiP*s encoding hemoproteins from *Phanerochaete chrysosporium* degrade PAHs. However, incomplete or partial degradation of contaminants lead to simpler non-toxic degradable compounds which can be consumed by microbes (Kumavath and Satyanarayana, 2014) as intermediates in biological pathways or substrate, i.e., *LiP* (lignin peroxidase) dissimilate benzopyrene to three compounds of quinine, namely 1,6- quinone, 6,12- quinine and 3,6- quinine (Gupta and Pathak, 2020). Furthermore, *MnP* (Manganese peroxidase) oxidizes organic compounds in the presence of Mn(II) (Xu et al., 2018; Singh et al., 2019). Laccase, MFO (mixed function oxidases), glutathione S transferase, cytochrome P_{450} also acts in biodegradation of recalcitrant compounds (Singh, 2019; Boudh et al., 2019). Catechol 1,2-dioxygenase (intracellular enzyme) from *Pseudomonas* NP-6 dissimilate catechol to muconate compounds (Guzik et al., 2011). Also, enzyme immobilization (Cavalca et al., 2013; Sharma B. et al., 2018) increases the half-life, stability, and enzyme activity at a notable level. The enzymatic bioremediation is an elementary, expeditious, and environmental friendly method for microbial removal and degradation of persistent xenobiotics compounds (Sharma B. et al., 2018). Isolation and characterization of microorganisms with enzymatic capabilities have been done with the limitation of less productivity (Rayu et al., 2012). Organophosphates (OP) and organochlorines (OC), major constituents of insecticides, accumulate in the agricultural soil (Panelli et al., 2017) and reach the water bodies via agricultural run-off. Effective bioremediation of γ-hexachlorocyclohexane (OC) and methyl parathion (OP) has been reported by genetically engineered microorganisms (Gong et al., 2016). Moreover, bioremediation of organophosphates and pyrethroids has been experimented with using genetically modified *P. putida* KT2440 (Zuo et al., 2015). With the advent of metabolic engineering, the catabolism and degradation of various persistent compounds has been reported. The degradation pathways of methyl parathion and γ-hexachlorocyclohexane in *Sphingobium japonicum* and *Pseudomonas* sp. WBC-3 witnessed the bioremediation strategy (Liu et al., 2005; Miyazaki et al., 2006). Furthermore, 1, 2, 3-trichloropropane, a persistent constituent of fumigant, is dissimilated into the environment (Techtmann and Hazen, 2016) via heterologous catabolism by the assembly of three enzymes from two different microorganisms in *E. coli* (Dvorak et al., 2014). A metabolic pathway (Bertin et al., 2011) degrading organophosphorus and paraoxon is engineered by inserting the organophosphorus hydrolase gene (opd) and pnp operon encoding enzymes that convert p-nitrophenol into β-ketoadipate in *P. putida* (de la Pena Mattozzi et al., 2006). A study showed *pobA* and *chcpca* gene clusters of *Rhodococcus opacus* R7 take part in the bioremediation of naphthenic acid; more specifically, expression *aliA1* gene codes for fatty acid CoA ligase for degrading long chains of linear as well as alicyclic naphthenic acid (Zampolli et al., 2020). To minimize the accumulation, the above-mentioned strategy is attained using microbes for partial or complete mineralization of persistent compounds (Miyazaki et al., 2006).

Features	Gene editing tools			References
	CRISPR	**TALEN**	**ZFNs**	
System	Adaptive immune system	Pathogenic *Xanthomonas*	Gene expression system	Kumar N. M. et al., 2018
Specificity	crRNA	TALE Domain	Zn finger Domain	Jaiswal et al., 2019b
Cleavage	Cas9	*Fok*I nuclease	Nuclease	Kumar V. et al., 2018; Jaiswal et al., 2019b
Nucleases per target per experiment	Single or more sgRNA; singleCas9	Single TALEN pair	Single ZFN pair	Hamilton et al., 2019
Activity	High	High	Moderate	Shanmugam et al., 2019
Designing and screening	Easy	Difficult	Difficult	Dangi et al., 2019
Multiple gene editing	Suitable	Not suitable	Not suitable	Sinha et al., 2019

Table 2. Comparative features of CRISPR, TALE, and ZFNs.

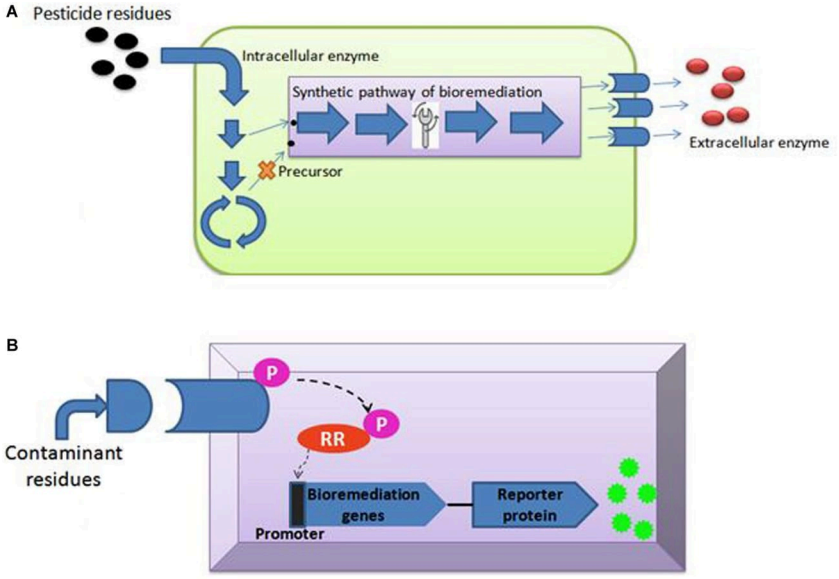


Figure 3. Schematic presentation (A) intracellular and extracellular enzymes production; (B) TCRS based biosensor.

Synthetic Genetic Circuit and Microbial Biosensor

The synthetic genetic circuit requires chassis for implantation. The *P. putida* is a HVB (Host Vector Biosafety) strain recognized as safe by the Recombinant DNA Advisory Committee. It is also referred to as GRAS (Generally Recognized as Safe) to release in the environment. It is ideal for the next generation of synthetic biology chassis panel because it can withstand high intolerant changing conditions including temperature, pH, solvents, toxins, osmotic, and oxidative stress. Also, *P. putida* has versatile metabolism and low nutrient requirements (Pabo and Nekludova, 2000). These qualities make this organism the best bacterial model for environmental bioremediation applications (Tanveer et al., 2018). Recently, the *P. putida* synthetic genetic circuit has been established for the designing of promoter genes and expression of the gene responsible for the degradation of persistent compounds (Adams, 2016). An extension of synthetic biology is the integration of genome with reporter system, and synthetic promoters of *P. putida* may be developed for synthetic bioremediation pathways. Elmore et al. use serine integrases for synthetic genetic circuit development. Microbial cells have the advantage of a cellular system, which controls cell growth and response to external factors like temperature, light, pH, and oxygen (Tropel and Van Der Meer, 2004). The external environment of microbes inhabiting the contaminated site will respond to concentrations of various persistent compounds present (Ray et al., 2018; Antonacci and Scognamiglio, 2019). Whole cell biosensors for checking the presence, detection and biodegradation potential of xenobiotics compounds (pharmaceutical residues, pesticides, paraffin, PAHs and PCBs, etc.) present (Adhikari, 2019) in environmental samples are attaining attention (Wynn et al., 2017; Heng et al., 2018; Patel et al., 2019). The reporter proteins acting microbe makes a color signal at the detection of particular contaminants *via* transducer (Zhang and Liu, 2016). A biosensor aiming for detection and bioremediation purposes must have enhanced contact between microbe and contaminant (Dhar et al., 2019). This helps the bacterium to adjust their cellular pathways in response to external environmental conditions and encodes the genes for utilizing the recalcitrant compounds as substrate (Bilal and Iqbal, 2019; Skinder et al., 2020). Synthetic biology strategies are feasible for removing a particular toxic compound because the genetic circuits can be developed against the exogenous environmental toxin (Checa et al., 2012; Tay et al., 2017). The synthetic genetic circuits are assembled via a two-component regulatory system (TCRS) in bacteria (Futagami et al., 2014; Uluşeker et al., 2017). This system acts upon environmental change, and thereby, cells respond to these changes. A prokaryotic TCRS has histidine kinase (HK) and response

regulator (RR). The HK is a sensor domain with an extracellular loop present as an integral membrane protein. HK also has a transmitter domain in the last cytoplasmic transmembrane, which is a highly conserved domain. Histidine phosphotransfer (DHp) and catalytic ATP-binding domain (CA) acts for molecular recognition of RR and ATP hydrolysis. The transmitter domain transmits the signal from periplasm to cytoplasm via PAS (Periodic circadian proteins, Aryl hydrocarbon nuclear translocator proteins, and single minded proteins), HAMP (HKs, Adenyltatecyclases, Methyltransferases, and Phosphodiesterases) and GAF (cGMP-specific phosphodiesterases, adenylyl cyclases, and formate hydrogenases) (Casino et al., 2010). Thus, HK senses the external environmental change and adds phosphate to conserved histidine. The HK also regulates RR by phosphorylating the aspartate residues. This promotes the promoter (Figure 3B) binding to activate the gene expression or vice-versa (Ravikumar et al., 2017). Therefore, TCRS-based synthetic biology application for biosensor development for cell-mediated detection and bioremediation can prove to be a new advancement.

Ecological Safety and Risk Assessment

The scientists and researchers are performing the experimental setup to study the bioremediation (Yergeau et al., 2012) potential against various pollutants like oil spill, plastics, synthetic dyes, organic hydrocarbons (Yadav et al., 2015), pesticides (Jaiswal et al., 2019a), heavy metals (Hemmat-Jou et al., 2018; Lebrazi and Fikri-Benbrahim, 2018), and other xenobiotics, etc (Rucká et al., 2017; Paniagua-Michel and Fathepure, 2018; Wu et al., 2020). Considering that bioremediation is performed in an open environment rather than in a closed fermentation tank, the ecological safety of bioremediation performing bacteria must be considered. Economic safety is justified by the metabolic aptness (Gillan et al., 2015) of microorganisms as compared to other traditional physical and chemical bioremediation methods. Besides, regulation for using genetically and metabolically modified bacteria is released to evaluate the possible risks (Khudur et al., 2019). The risk assessment is mainly done by regulatory agencies, i.e., Organization for Economic Cooperation and Development (OECD) at the application level for environmental safety (Russo et al., 2019; Alam and Murad, 2020; Pastor-Jáuregui et al., 2020). The possible risks are gene contamination in the native member of microbial consortium, leading to mislaying of the natural trait (Mills et al., 2019; Pineda et al., 2019; Rycroft et al., 2019). The competitiveness between natural and genetically modified species can give rise to selection pressure on non-target microflora (Kumar N. M. et al., 2018; Mohapatra et al., 2019). Moreover, environment and ecosystem risk assessments infer unpredictable and adverse effects, as discussed above (Cervelli et al., 2016; van Dorst et al., 2020). Particularly, the ecological risk assessment behind addition of GEMs (Genetically Engineered Microorganisms) (Benjamin et al., 2019; Ahankoub et al., 2020) to the native environment rather than a laboratory (Fernandez et al., 2019) is done mainly because of unnecessary delivery of antibiotic resistance marker along with recombinant genome of interest (Davison, 2002; Nora et al., 2019), and unintentional uptake or transfer of induced genes to other microorganisms (French et al., 2019; Janssen and Stucki, 2020). This phenomenon is definitely disturbing the microbial native genome entity (Gangar et al., 2019; Petsas and Vagi, 2019). Another aspect to consider is the change in microbial metabolism (Okino-Delgado et al., 2019), which may release uncertain toxic compounds into the environment, indirectly affecting (negatively) microbial candidates in this context (Myhr and Traavik, 2002). Under the TSCA (Toxic Substances Control Act) (Gardner and Gunsch, 2020), the Office of Pollution Prevention and Toxics (OPPT) programs (Pietro-Souza et al., 2020) of the United States Environmental Protection Agency (Leong and Chang, 2020; Saxena et al., 2020) monitors the environmental and health risks and releases premanufacture legal notice for the accreditation of field research outlines and prototypes (McPartland and McKernan, 2017; Khan et al., 2020). A magnificent example is given by University of Tennessee. In 1995, they gave application and suggested the risk evaluation of microbial bioremediation agents (mainly *Pseudomonas fluorescens* HK44) on the environment and health (Sayler et al., 1999; Khan et al., 2016; Sharma J. K. et al., 2018; El Zanfaly, 2019). Remarkably, the literature survey points toward a biowar weapon for humanity (Gómez-Tatay and Hernández-Andreu, 2019; Wang and Zhang, 2019), stating that gene editing tools left in bad hands could mislead ethical and moral duties (Khan, 2019; Thakur et al., 2019; Sharma et al., 2020).

Conclusion and Future Perspectives

The microbial bioremediation process for removal and detoxification of contaminants from the environment has now emerged as the best option. Synthetic biology is addressing the decontamination and remediation strategies for xenobiotics and related compounds from the environment. It has been observed that the requisite for understanding existing metabolic pathways is a must for developing synthetic models of bioremediation. Moreover, genomics reconstruction methods (Luo et al., 2014; Marco and Abram, 2019) and technologies made a solid platform for bioremediation studies. Satisfactory progress has been witnessed in the field of bioremediation among various contaminants with the role of specific genes and enzymes applicable via synthetic biology methodologies. Therefore, it is concluded that microbial synthetic biology remediation strategies not only increase the efficiency of microbial bioremediation processes for a particular contaminant, but also provide the best methodologies for researchers.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Check your Understanding

- Explain bioremediation and the roles that microorganisms can have in this process.
- What is synthetic biology and how can it be applied for bioremediation?
- What are some important considerations and challenges for designing a synthetic microbiome?
- Compare the major techniques for genetic and metabolic engineering.
- How could microbial biosensors contribute to bioremediation efforts?
- What aspects of ecological safety and risk assessment must be addressed for application of synthetic microbiomes for bioremediation in open environments? Why?

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16.1.6: OTHER MICROBIOME APPLICATIONS

16.1.6.1: Forensic Microbiomes

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16.1.6.1: Forensic Microbiomes

Forensic Microbiomes

Characterizing human and environmental microbiomes is not only important to maintain host and ecological health, but can have other far-reaching applications such as forensic science. Determination of unexplained situations and phenomenon can be quite challenging, and with advances in microbiomics, there is a possibility to generate sufficient data and evidence to provide viable answers and solutions.

Forensic Applications of Microbiomics: A Review

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The rise of microbiomics and metagenomics has been driven by advances in genomic sequencing technology, improved microbial sampling methods, and fast-evolving approaches in bioinformatics. Humans are a host to diverse microbial communities in and on their bodies, which continuously interact with and alter the surrounding environments. Since information relating to these interactions can be extracted by analyzing human and environmental microbial profiles, they have the potential to be relevant to forensics. In this review, we analyzed over 100 papers describing forensic microbiome applications with emphasis on geolocation, personal identification, trace evidence, manner and cause of death, and inference of the postmortem interval (PMI). We found that although the field is in its infancy, utilizing microbiome and metagenome signatures has the potential to enhance the forensic toolkit. However, many of the studies suffer from limited sample sizes and model accuracies, and unrealistic environmental settings, leaving the full potential of microbiomics to forensics unexplored. It is unlikely that the information that can currently be elucidated from microbiomics can be used by law enforcement. Nonetheless, the research to overcome these challenges is ongoing, and it is foreseeable that microbiome-based evidence could contribute to forensic investigations in the future.

Introduction

For over 100 years, microbiology has played a relatively diminutive role in forensic science (MacCallum and Hastings, 1899). In the early 1990s, the sequencing of amplified viral DNA was used to support a case alleging the transmission of Human Immunodeficiency Virus from a dentist to several patients in Florida, United States (Smith and Waterman, 1992). The emergence of PCR-mediated genotyping of bacteria was considered to be a valuable forthcoming tool in forensics—e.g., van Belkum (1994) suggested that forensic science would soon be a major area for the application of PCR-mediated genotyping due to the rapidity of technological advances at the time (van Belkum, 1994). In the mid-1990s, fungal and pollen spore analyses were also developed, allowing investigators to differentiate between soil types, which in turn allowed linking substrate items to particular sites (Bruce and Dettmann, 1996; Bryant and Mildenhall, 1998). However, it was not until the early 2000s and the rise of bioterrorism that *microbial forensics*—the "scientific discipline dedicated to analyzing evidence from a bioterrorism act, biocrime, or inadvertent microorganism/toxin release for attribution purposes"—emerged in response to the new threat (Budowle et al., 2003; Carter et al., 2017).

Many forensic applications have been limited to individual taxa analyses, and *microbial forensics* has, historically, been constrained by a lack of available and cost-effective sequencing technologies (Berglund et al., 2011; Kuiper, 2016). This approach has changed dramatically in the last decade as advances in genomic sequencing technology, and new methods for processing complex community datasets (and often low biomass samples) have led to the advent of a new field of microbiomics. The science and study of the microbiome (Statnikov et al., 2013; Capasso et al., 2019) combined with metagenomics (all genomes from a sample) have enhanced the development of the microbial forensic toolkit (Clarke et al., 2017; Hampton-Marcell et al., 2017).

As of March 2019, the conviction rate for homicides in England and Wales (United Kingdom) was only 79% (Office for National Statistics, 2019), slightly higher than in the US (~70%) (Bureau for Justice Statistics., 2019). Across the globe, there is also a high prevalence of wrongful convictions and often insufficient evidence to convict a perpetrator of a crime (Sangero and Halpert, 2007; Ingemann-Hansen et al., 2008; LaPorte, 2017; Walsh et al., 2017). According to the Innocence Project, a national litigation and public policy organization dedicated to exonerating wrongfully convicted individuals, to date, 375 people in the United States have been exonerated by DNA testing, including 21 who served time on death row (Innocent Project, 2020). There is thereby a

strong interest from the public, lawmakers, and the law enforcement system to augment and expand the forensic toolkit, including molecular methods. Microorganisms are abundant in and on the human body (microbial cells can outnumber or equal the total number of human somatic cells) (Noel et al., 2014; Sender et al., 2016; Vázquez-Baeza et al., 2018), in surrounding environments, and on objects associated with a crime (Desmond et al., 2018; Oliveira and Amorim, 2018). A growing body of evidence suggests that forensically relevant microbial profiles could be used as evidence or, at the very least, complement traditional investigative methods (Metcalf et al., 2017; Schmedes et al., 2017; Richardson et al., 2019; Phan et al., 2020). This use of microbial profiles as evidence is done using computational tools that are being developed alongside new approaches in bioinformatics, processing tools, and refined protocols. However, since the field is still in its infancy (Goudarzi et al., 2016; Komaroff, 2018) and historically underfunded (Morgan and Levin, 2019), there is much uncertainty as to the true potential of microbiomic tools in forensics.

In this review, we provide an overview of past, current, and future potential applications of microbiomics in forensics. Specifically, we will discuss the six most comprehensively researched themes (Figure 1): including geolocation (e.g., substrate analysis and different spatial dimensions and the power of machine learning), personal identification, biological sex determination, trace evidence, manner and cause of death (e.g., death by drowning), PMI, and other applications (e.g., localization through animal microbiomes).

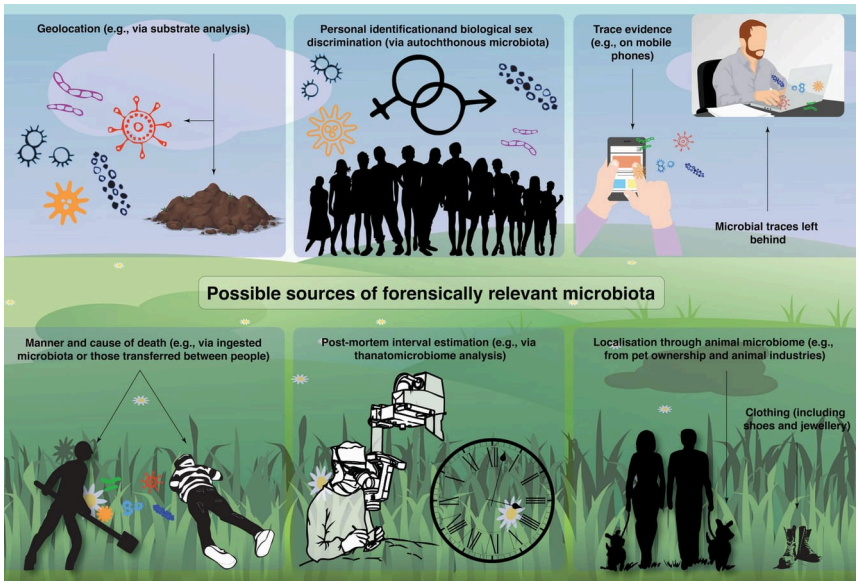


Figure 1. A summary of possible sources of forensically relevant microbiota identified by the literature review.

Major Themes in the Forensic Microbiology Literature

Geolocation

In the past few years, intensive work has been carried out to characterize environmental microbiome, particularly in urban environments and transit systems. These studies have demonstrated that unique community profiles may exist in certain areas of a city (Afshinnekoo et al., 2015; Rosenfeld et al., 2016), as well as “molecular echoes” of environmental events, and even a forensic capacity for geospatial microbiomic data (MetaSUB International Consortium, 2016; Danko et al., 2019a). In the following, we focus on two leading aspects of geolocalization.

Substrate Analysis

The potential of analyzing microbial profiles from the soil is increasingly being recognized in forensic microbiological research. Both the rhizosphere and bulk soil microbiomes exhibit a high level of heterogeneity between different sites. As such, with methodological refinement, soil microbiome samples could provide valuable biogeographic data to localize the origin of the soil sample. Another potential application is the acquisition of information to help determine the provenance of an item(s) associated with a crime.

Habtom et al. (2019) demonstrated distance-decay relationships between microbial samples from the soil at a local scale (25–1,000 m) (n = 5 sites, n = 2–4 soil types, and five replications). The results showed that the greater the distance between

the samples, the more they differed, suggesting that both soil type and geographic location are important factors in determining microbial community composition. Indeed, patch discrimination using the soil microbiome has previously been demonstrated (Macdonald et al., 2011), and Jesmok et al. (2016) correctly classified 95.4% of soil bacterial profiles to their location of origin using various methods including abundance charts, non-metric multidimensional scaling, analysis of similarity, and *k*-nearest neighbor. However, this was a feasibility study with a modest sample size (n = 19). Further studies with larger sample sizes and replications are needed to explore the full potential of this approach.

Evaluating the microbial communities in an assemblage of soil samples (e.g., soils from a crime scene or alibi site and other intermediary sites) could be useful in forensics. Samples originating from a mixture of different soil substrates have been correctly differentiated by using a combination of Ribosomal Intergenic Spacer Analysis and 16S rRNA gene sequencing (Demanèche et al., 2017). Recent evidence suggests that 18S rRNA gene sequencing can also provide greater discriminatory power over traditional Mid-Infrared spectroscopy at fine scales for eukaryotic species (Young et al., 2015). Furthermore, Sanachai et al. (2016) demonstrated that the site origin of soil, obtained from the sole of a shoe, could be elucidated by comparing the similarity of soil bacterial 16S rDNA profiles acquired by the denaturing gradient gel electrophoresis technique.

Despite the potential in this field, further limitations need to be identified and addressed. For example, Pasternak et al. (2019) identified several potentially limiting factors to consider when interpreting the results of microbiomic analyses. For instance, soil samples are incredibly complex and highly heterogeneous even at short spatial scales, which presents a major issue to using these in a forensic context, and microbiomes exhibit a high level of physical, chemical, and biological diversity in both space and time. Pasternak et al. (2013) showed that actinobacterial fingerprints significantly differed between two seasons (summer and winter) at the same sites—implying that temporally-associated issues could arise. Keet et al. (2019) have also pointed out that soil microbiome composition can change as a result of abiotic soil conditions and plant community patterns—which poses a considerable challenge to the accuracy of results.

Metagenomic analysis of gravesoil and the soil around human and non-human animal cadavers has been undertaken for forensic purposes. Carter et al. (2015) investigated microbial community succession in soils associated with swine cadavers across two seasons (summer and winter). They demonstrated that postmortem microbial communities changed in specific and reproducible ways, but decomposition effects on soil microbial communities differed significantly between seasons. The authors suggest that the ecological succession of microbial communities will be useful for forensic investigations, but future research should aim to gain a greater understanding of seasonality on decomposition. The sample size for this study was not explicitly stated, but according to the ordination plots, it appears to be modest ($n \leq 10$ per treatment). Therefore, results should be interpreted with caution.

Adserias-Garriga et al. (2017) investigated daily thanatomicrobiome changes in the soil as an approach to estimate PMI. They collected soil samples from around human cadavers (n = 1 male and n = 2 females) and demonstrated successional changes on a daily basis. Rapid growth of *Firmicutes* was observed from the bloat stage to advance decay (<5% relative abundance at day 1 to 75% relative abundance day 12), and the authors proposed a *Firmicutes* growth curve to estimate PMI. However, the authors state that the growth curve results may only apply under Tennessee summer conditions and that confirmatory research is needed using a larger number of cadavers and under different environmental conditions. The results do, however, corroborate those of Finley et al. (2016), who evaluated microbial communities associated with gravesoil human cadavers (n = 18). The researchers allowed the cadavers to decompose over a range of decomposition time periods (3–303 days) and showed increases in the relative abundance of *Firmicutes* in surface bodies over the decomposition period (from ~10% at 0–3 months to ~40% at 7–9 months).

Singh et al. (2018) investigated the spatial (0, 1, and 5 m) dynamics of human cadaver decomposition on soil bacterial community structure. They collected soil samples from each spatial buffer (n = 14 for the 0 m, n = 17 for both 1 and 5 m) and observed evidence of a predictable response to cadaver decomposition that varied over space. Bacterial community composition (beta diversity) at 0 m was significantly different from the 1 and 5 m communities, whereas there were no significant differences between the 1 and 5 m communities. The researchers also found that bacterial alpha diversity was significantly lower in the 0 m samples, suggesting that the additional nutrient input from the cadavers may reduce bacterial alpha diversity. This study provides additional spatial-compositional insights to complement the growing body of knowledge in this area of forensic microbiome applications.

Soil microbiome analysis has the potential to be used in forensics; however, additional research is required to validate the sensitivity and reproducibility of results (Young et al., 2017). Overall, to gain a greater understanding of both spatial and temporal dynamics associated with the microbiome and to develop techniques to mitigate similar pitfalls, further microbiome surveys are essential.

Different Spatial Dimensions and the Power of Machine Learning

The growing interest in sampling and predicting environmental microbiome profiles at different spatial scales and orientations (e.g., between households, cities, states, and altitudes) to provide information on the location and provenance of people and objects resulted in the development of a multitude of approaches. Chase et al. (2016) identified the three cities where nine offices were located with 85% accuracy based on analyzing office microbiome samples using sampling plates, and although this study suffers from a small sample size (n = 3 per office), it demonstrates potential with further refinement. Lax et al. (2014) analyzed samples from household occupants (n = 1625 from 18 participants in 10 houses) and their built environments. The authors matched feet microbiome samples to the house with 82.9% accuracy—a relatively low degree of accuracy from an evidentiary perspective but demonstrating the potential of such methods for fine-scale biolocalization. Walker and Datta (2019) analyzed whole-genome sequenced microbiota sampled from 12 cities in seven different countries as part of the 2018 CAMDA MetaSUB Forensic Challenge. The CAMDA dataset (n = 30) included three mystery samples. The authors applied machine learning techniques to identify the geographical provenance of the microbiome samples. Up to 90% of the samples were correctly classified, demonstrating the potential of machine learning applications to biogeography, although further evidence is necessary to employ these applications in an evidentiary context. In a related study, Ryan (2019) applied a random forest classifier built on a dataset of 311 city microbiome samples. Their method correctly classified 83.3% of the mystery samples. Grantham et al. (2019) presented a different algorithm for predicting the geolocation of fungal samples from dust (n = 1300) in the United States using deep neural network classifiers. Applied to a global dataset of samples from 28 countries, the authors state that their algorithms make "good point predictions" with >50% of the geolocation errors under 100 km for US-wide analysis and nearly 90% classification accuracy of a sample's country of origin for the global analysis. This particular field, combining microbiomics and machine learning, is in its infancy, and future studies would benefit from larger sample sizes and improved classification accuracy before such approaches can be used with confidence in a forensic context.

Another important spatial factor to consider is that microbiome compositions do not only differ in horizontal space. Skin microbiomes have also been shown to differ between humans living in high and low altitudes. For example, Zeng et al. (2017) collected skin microbiome samples from humans (n = 99) and pigs (n = 82) in Tibet. They found enrichments of several bacterial taxa (e.g., *Arthrobacter* sp., *Paenibacillus* sp., and *Carnobacterium* sp.) in samples collected from higher altitudes. Alpha diversity was also significantly lower in skin samples collected from individuals living at higher altitudes. This suggests a potential future route to determine geolocation based on altitudinal parameters via the analysis of skin microbiome samples in the future—although here too, methodological refinement will be essential. Furthermore, understanding how skin microbiomes may fluctuate throughout the life course will also be an essential factor to consider.

Overall, all the models prioritize classification over prediction abilities. To enable real-time prediction of geographical coordinates from sampling data, increasing the sample sizes geographically and temporally, and developing more rigorous methods is essential.

Personal Identification

A growing body of evidence suggests that human individuals may be uniquely identified based on stable autochthonous (i.e., native to a given environment) microbial profiles. This could have a substantial impact on forensic science—for example, in situations where the investigator cannot retrieve sufficient amounts of human DNA (i.e., from human somatic and germ cells). Yet it is unknown whether the variation in microbial communities between people is sufficient to identify individuals within large populations uniquely or stable enough to place them over time.

To answer some of these questions, Franzosa et al. (2015) tested different body site-specific microbial profiles and attempted to match them with 25–105 microbiome profiles during the person's first and second visits to the sampling site. The authors reported that these profiles were useful in distinguishing individuals at the initial sampling time point and that 30% of the individuals were still uniquely identified several months later. In this study, gut microbiome samples were used to pinpoint 80% of individuals (n = 120) up to a year later. These results are encouraging—particularly in shorter timescales—however, they still suffer from relatively high variability. As such, greater improvements, e.g., in methods and sampling effort, will be needed before such approaches can be useful in a forensic setting.

High resolution melting analysis that targeted the 16S rRNA gene from oral swab samples have also been used to demonstrate its potential in distinguishing between individuals (Wang et al., 2019), albeit with a very small sample size in this study (n = 5). Schmedes et al. (2018) demonstrated accurate identification of individuals (n = 12) based on skin swab samples from different body sites (n = 14). They achieved 97% accuracy by sampling shirts and 96% accuracy using palm samples based on 1-nearest neighbor classification on nucleotide diversity of the bacterial genome. In another recent study, the researchers utilized a similar approach to identify individuals (n = 51). They analyzed microbiome samples collected from three different body sites—the

manubrium (i.e., the upper-most segment of the sternum), the palmar surface of the hand, and the ball of the foot (Woerner et al., 2019). The researchers achieved 100% classification accuracy when conditioned on a maximum nearest neighbor distance for diversity, suggesting strong potential should these results be replicable in studies with much larger sample sizes.

Watanabe et al. (2018) suggested that minor taxa are one of the key factors for distinguishing between individuals. Their study analyzed microbiome samples (n = 66) from individuals (n = 11) over 2 years and achieved 85% accuracy in distinguishing individuals. They also used the same analytical methods to classify publicly available skin microbiome samples from individuals (n = 89) with a 78% identification accuracy. However, this level of accuracy is unlikely to be sufficient for forensic applications. The authors suggested that although personal identification is possible, the estimation of the accuracy decreases for larger cohorts due to increments of similar microbiome patterns. Overall, the use of microbiomics as a forensic tool to determine personal identification shows potential and technological viability and might be useful in situations where the investigator is unable to retrieve sufficient amounts of human DNA. Nonetheless, the findings fall short of the burden of proof. Improvements in the model's sensitivity and specificity are required, and a methodology to address potential contamination issues. Furthermore, a better understanding of the microbial dynamics across time and space is essential for the findings to have a forensics value.

Biological Sex Determination

Recent evidence supports another contribution of microbiomics toward personal identification –the discrimination of biological sex, which could be useful where sufficient quantities of human DNA are unable to be retrieved. For example, airborne bacteria communities have previously been characterized in indoor environments (Chan et al., 2009). Luongo et al. (2017) investigated airborne bacterial and fungal diversity (i.e., constituents of the "aerobiome") from different University dormitory rooms (n = 91). They used machine learning techniques and were able to predict the biological sex of room occupants with 79% accuracy based on relative abundances of the microbiota. Curiously, rooms occupied by males exhibited higher relative abundances of the microbiota. The authors suggested that it could be because males may shed more biological particles or use fewer cosmetic barriers such as skin lotions.

Biological sex-related differences in the human thanatomicrobiome—the microbial communities colonizing organs following death (*thanatos*, Greek for death) (Zhou and Bian, 2018)—have also been demonstrated by Bell et al. (2018). The authors compared amplicon signatures (using the 16S rRNA gene V1-2 and V4 regions) in the corpse heart tissue of 10 individuals and discovered key differences between males (n = 6) and females (n = 4). For example, *Streptococcus* sp. was found exclusively in male heart tissues, whereas females had a significantly higher prevalence of *Pseudomonas* sp. With refinement, such an approach could help to determine the biological sex of a corpse and the provenance of body parts.

In a study by Tridico et al. (2014), the authors "readily distinguished" male (n = 3) and female (n = 4) subjects based on the analysis of their pubic hair microbiomes. They identified *Lactobacillus* spp. that were unique to female participants. They also suggested that pubic hair is relatively insulated from the environment and colonized with niche-specific microbiota, which could be useful in forensic investigations. Unfortunately, the modest sample size of this study limits the conclusions that can be drawn from it. Nonetheless, the findings were supported by another small study by Williams and Gibson (2017), who identified individuals (n = 9) and their biological sex from pubic hair microbiota with an error ratio of 0.027 ± 0.058 and 0.017 ± 0.052, respectively. However, the sample sizes for all these studies are modest, and as such, further validation studies with larger sample sizes are needed before reliable conclusions can be drawn.

Interestingly, Phan et al. (2020) analyzed skin microbiome samples from both genders (n = 45) and found that the absence of the bacterial genus *Alloiococcus* could be useful in predicting female biological sex. The study showed a correlation between certain bacterial species and personal characteristics (e.g., biological sex). They specifically explored the presence/absence of microbiota from fingermarks left behind on surfaces and achieved a relatively modest 67% sex prediction accuracy using leave-one-out cross-validation analysis. Improvements in sample sizes and machine learning accuracy are necessary to explore the potential of this approach further. Additional research into whether certain bacteria (and other microorganisms) are distinct to females or simply related to external factors (such as cosmetic products on hands) would also be necessary.

Trace Evidence

There is an increasing interest in studying forensically relevant microbial profiles left behind on objects and surfaces. For instance, several studies showed that there is often a high level of bacterial presence on personal objects such as mobile phones (Koroglu et al., 2015; Kõljalg et al., 2017; Koscova et al., 2018; Kurli et al., 2018). Furthermore, human-associated items such as shoes and mobile phones have been shown to support distinct microbiomes (Lax et al., 2015; Coil et al., 2019).

Meadow et al. (2014) investigated the potential utility of mobile phones as "personal microbiome sensors." They selected 17

individuals and collected three samples (the cell phone's touch surface, their index finger, and their thumb). They demonstrated that bacterial communities sampled from mobile phones were more similar to their owners than other people. They found that about 22% of the taxa on participants' fingers were also found on their phones, whereas only 17% were shared with other people's phones. An individual's index finger shared approximately 5% more OTUs with their mobile phone than with everyone else's mobile phone in the study. Furthermore, 82% of the OTUs were shared between a person's index finger and their phone. Although promising, here again, the sample size and accuracy of results need to be increased in future studies.

Kodama et al. (2019) found that postmortem skin microbiomes could be associated with personal objects with a high degree of accuracy. Several of the objects in the study were associated with 100% accuracy (i.e., medical devices, eyeglasses, bottles, and steering wheels), whereas objects like computer devices, remote controls, and cell phones were associated with over 67% accuracy, suggesting that with refinement, skin microbiome samples could be reliably linked to objects at the scene. Furthermore, studies have found that the postmortem skin microbiomes were stable and similar to antemortem skin microbiomes for up to 60 h postmortem (Kodama et al., 2019).

Salzmann et al. (2019) investigated the microbial profiles of different bodily fluids (n = 22). They identified source-specific microbial signatures from various bodily fluids. For example, the phyla *Proteobacteria* was associated with skin and semen sources, whereas *Firmicute*s showed a higher prevalence in saliva and vaginal secretions. Dobay et al. (2019) suggest that even when body fluid is exposed to indoor conditions for 30 days, samples continue to harbor body-site-specific microbial signatures. Hanssen et al. (2017) also demonstrated promising results, albeit with a small sample size (n = 6), for the microbially-mediated classification of body fluids. They performed pattern recognition by fitting a linear discriminant analysis model using Principal Component scores and were able to classify saliva samples in 94% of the cases.

Neckovic et al. (2020) recently investigated the potential transfer of skin microbiomes between individuals and substrates (i.e., allochthonous microbiota). They found that skin microbiota has been reliably transferred through direct contact, that is, between individuals shaking hands. Microbiota also transmits through indirect contact, as demonstrated by individuals rubbing a substrate and then swapping substrates with another person. The authors suggested that such analysis could be useful to corroborate sexual assault cases or other contact-related crimes. They also suggested that further research should consider the relative surface area of contact, pressure, friction, and the duration of the contact.

Manner and Cause of Death

The 'manner of death' is a determination made by an expert following an investigation (e.g., a coroner, the police, or a medical examiner). Five manners of death are generally considered: natural, accidental, suicide, homicide, and undetermined (Advenier et al., 2016). Lutz et al. (2019) recently collected microbiome samples from 265 corpses from Finland, Italy, and the United States. The inspected cadavers differed in the manners of death: accidental death (n = 88), natural death (n = 106), homicide (n = 23), and suicide (n = 45). Their results suggested that *Lactobacillus, Enterobacteriaceae, Sediminibacterium, and Rhizobiale*s were associated with different manners of death. With further research, these associations could be developed into predictive markers that help to determine the manner of death. However, as noted by the authors, *Sediminibacterium* and *Rhizobiale*s bacteria may also represent environmental contamination, which needs to be controlled, and further validation through controlled experiments is needed to improve the reliability of their approach to determine the manner of death.

The potential of this microbiomics approach to determining the manner of death was corroborated in a recent study by Zhang et al. (2019) who, by obtaining samples during routine death investigations at the Wayne County Medical Examiner's Office (Detroit, Michigan, United States), found different biomarkers associated with the manner of death. In this study, *Xanthomonadaceae* was more prevalent in cases related to hospital deaths, whereas *Actinomyce*s sp. tended to be more prevalent in suicide cases. Increasing the numbers of samples generally increased the accuracy of the models. The authors cautioned that the prediction accuracy depends on the machine learning methods used and the number of anatomical sites analyzed. The authors suggest this study provides baseline information, and it could be possible to use machine learning to develop reference databases that allow microbially-mediated manner of death predictions in the future.

Kaszubinski et al. (2020) modeled beta-dispersion to test for manner and cause of death association using a microbiome data set of n = 188 postmortem cases (five body sites per case). The researchers demonstrated that beta-dispersion and demographic data could distinguish among manner and cause of death. In particular, they found that cardiovascular disease and drug-related deaths were correctly classified in 79% of cases. They found that binary logistic regression models were most effective at improving model success. This was an improvement over multinomial logistic regression models, which confirmed the manner and cause of death assessment only 62% of the time. The results of this study show promise for using postmortem microbiomes to indicate the manner of death. However, as the researchers' highlight, sample sizes need to be greater. Moreover, the development of large databases will likely be required to train models with high success rates prior to being used in practical

forensic contexts.

In terms of cause of death (i.e., the disease or injury that produces physiological disruption in the body leading to death), researchers such as Christoffersen (2015) have investigated the importance of microbiological testing. Studying autopsy results (n = 42), the author reported that the cause of death could be determined in 42% of the cases via microbiological analysis. The study highlighted factors indicative of a microbiologically related cause of death, such as a raised CRP measurements. Raised CRPs have also been implicated in SIDS as a cause of death (Rambaud et al., 1999; Szydlowski et al., 2013) and even for astronauts returning from space (Garrett-Bakelman et al., 2019). Deadly bacterial infections, such as infection or sepsis, may also occur following neonatal circumcision (Elhaik, 2016, 2019).

A specific forensic microbiome application for determining the cause of death is the diagnosis of 'death by drowning,' which is one of the leading causes of unnatural deaths worldwide (Domínguez et al., 2018; Cenderadewi et al., 2019). Analyzing the presence of diatoms (single-celled algae) has been the 'gold standard' for well over a decade; however, its reliability has been questioned (Kakizaki et al., 2009; Huys et al., 2012). Several studies have provided support for death by drowning diagnoses by designing real-time PCR assays with primers to detect bacterial species associated with aquatic environments, such as *Aeromonas* spp. (Aoyagi et al., 2009; Uchiyama et al., 2012; Rutty et al., 2015; Voloshynovych et al., 2019). These studies provided support for this cause of death diagnosis based on relatively high detection rates of microbiota, for example, 84% (n = 32), 75% (n = 20), and 84% (n = 43)—although to strengthen the cause of death diagnoses, the accuracy levels, and sample sizes could again be much improved. It has also been suggested that bioluminescent bacteria may be biomarkers for death by drowning in seawater. For example, Kakizaki et al. (2009) developed a simple assay targeting the 16S rRNA gene to identify bioluminescent colonies such as *Vibrio fischeri* and *Vibrio harveyi*. More recently, Lee et al. (2017) analyzed microbiome composition and pulmonary surfactant protein (SP-A) expression to develop a marker for diagnosis of death by drowning. They analyzed microbiota and histological appearance of both drowned and postmortem groups of experimental rats, comparing freshwater vs. marine water treatments. The authors found that 5513 and 5480 OTUs were unique to marine and freshwater, respectively. They also found that expression levels of SP-A were higher in the lungs of drowning victims compared to postmortem submersion. These findings could have important forensic value (e.g., determining both the type of environment and the timing of death) and demonstrate good potential for future applications. Marella et al. (2019) point out that other studies have focused on the presence of fecal bacteria, coliforms, and streptococcal bacteria to help determine the cause of death by drowning. These bacteria are sampled from the femoral artery and vein and the right and left ventricles. Fecal bacteria are considered to be always present in subjects who drowned compared with those with other cause of death diagnoses (Lucci et al., 2008; Marella et al., 2019). For example, Lucci and Cirnelli (2007) found fecal streptococcal presence in 100% of the freshwater drowning cases they studied (n = 22) and coliforms present in 90.91%. In this study, the control subjects (n = 30) uniformly showed an absence of fecal bacteria. In a later study, Lucci et al. (2008) assessed if the presence of these bacteria in the drowning medium could be detected in victims submerged after death. The researchers collected samples from drowned victims (n = 5 freshwater and n = 5 in seawater) and victims who were submerged after death (n = 3). Coliforms and streptococci were detected in all drowned victims but not in those submerged after death. These findings suggest that fecal coliforms and streptococci could be used as markers of drowning. However, the minuscule sample sizes must be interpreted with caution and increased considerably in future studies.

Postmortem Interval

The Thanatomicrobiome

Determining the PMI (the time elapsed since a person has died) is often an essential part of a criminal investigation. To improve PMI prediction accuracy, researchers have begun examining the thanatomicrobiome (Javan et al., 2016; Burcham et al., 2019). Postmortem, these communities overwhelm the immune system allowing for subsequent colonization (Javan et al., 2019). Preliminary studies suggest that these microbial communities may undergo important successional changes in organs that could aid in determining the PMI (Adserias-Garriga et al., 2017).

Early studies on model animals suggest that this is feasible. For over a 48-day period of decomposition, Metcalf et al. (2013) aimed to uncover a "microbial clock" to provide an estimate of PMI by sequencing the 16S rRNA gene for bacterial and archaeal communities and the 18S rRNA gene for microeukaryotes. Their model provided reliable PMI estimates (±3 days) (n = 223). However, the study was conducted in controlled conditions using experimental mouse models—thereby necessitating a degree of caution when extrapolating the data to 'real-life' situations. Another study investigated the decomposition of pig cadavers. Their model predicted the PMI within 2–3 h of the time of death with 94.4% accuracy (Pechal et al., 2014), demonstrating promise with further methodological refinement. Pechal et al. (2018) carried out a large-scale study of body microbiome samples (n = 188) that found postmortem microbiomes were stable, reflecting antemortem microbiomes 24–48 h after death. The researchers also found that specific bacterial taxa were important in predicting health status. For example, *Haemophilus* and *Fusobacterium*

were twice as abundant in healthy individuals, whereas *Rothia* was 0.09 times more abundant in heart disease cases. With further development, this could be used to indicate the state of human health during clinical investigations into a range of deaths, from chronic and natural to sudden and violent (Pechal et al., 2018). It is important to note that, although appropriate at the time, the bioinformatics approach used to process OTUs and to make functional predictions (e.g., QIIME 1.8 and PICRUSt 1) is now considered to be outdated. Furthermore, Amplicon Sequence Variants (ASV) may provide a richer taxonomic picture (Callahan et al., 2017).

Studying human subjects, Johnson et al. (2016) sampled the skin microbiome of decomposing human cadavers and developed an algorithm to estimate PMI. The authors achieved low error rates for skins samples and a PMI estimation accuracy of ±2 days (n = 144 from 21 cadavers), a substantial improvement compared to prior efforts (e.g., via entomological analysis). Belk et al. (2018) used 16S rRNA amplicon sequencing and found that creating models with the class or phylum taxonomic levels provided the most accurate predictions of PMI. This finding corroborated the study by Johnson et al. (2016) and illustrated its potential usefulness for forensics.

Another study using 454 pyrosequencing to determine abundances and diversity of the postmortem microbiome in several key organs such as the brain, heart, liver, and spleen found varying PMIs ranging from 29.5 to 240 h (Can et al., 2014). This study revealed that the most abundant taxa in postmortem microbial communities were the anaerobic, spore-forming Firmicute bacteria, *Clostridium* sp. Javan et al. (2017) confirmed that *Clostridium* sp. dominated at long PMIs, adding evidence to support the use of microbiomics in PMI determination in the future.

Localization Through Animal Microbiomes

Several studies have shown that animals from different taxonomic groups and environments possess unique microbial profiles. For example, Tibetan chickens *Gallus gallus*, Chinese Rhesus macaques *Macaca mulatta*, and plateau sheep *Ovis* spp. have unique gut microbiomes (Zhou et al., 2016; Huang et al., 2017; Zhao et al., 2018) shaped by genetic, geographical, and altitudinal factors. It has been demonstrated that the skin microbiomes of Estrildid finches, amphibians, bats, cetaceans, and dogs *Canis lupus familiaris* are unique (McKenzie et al., 2012; Avena et al., 2016; Erwin et al., 2017; Torres et al., 2017; Engel et al., 2018; Russo et al., 2018). Interestingly, Song et al. (2013) found that humans share microbial communities with their dogs.

With further investigations and methodological refinement, such capabilities point to the potential feasibility of linking a person with a site based on shared microorganisms with animals. Although further studies are needed, there is potential for forensic pathways to associate trace microbial profiles obtained from other species (unique to the given species) to a given environment and/or occupation (e.g., animal industries) or to pet ownership. For example, non-human animal-specific microbiota could potentially be detected on the body or clothing of a suspect or victim, which may be useful in the absence of sufficient animal DNA (i.e., from somatic and germ cells) evidence. This profile could then conceivably be traced to the point of contact with an animal or animal-based environments such as equine stables, pet shops, or zoos, thus complementing other traditional forensic evidence. However, this approach is mostly theoretical at the moment, and future research will be needed to test its feasibility.

Discussion

As of today, microbiome-based forensics are almost absent from criminal investigations and courts. To explain why this is so, we may divide the different possible applications of microbial forensics into two groups: first, reconstruction issues such as the cause of death and PMI, which ask “what happened?” and help elucidate the circumstances of the crime; and second, comparison issues such as geolocation and personal identification, which ask “how similar are these two DNA profiles?” and may (dis)connect a suspect from an object or a place (e.g., murder weapon or crime scene). Reconstruction applications for forensic use are easier to develop since competing propositions are usually well-defined and limited in number; if sufficient research is invested in ascertaining the microbial characteristics associated with each combination of possible environmental, spatial and temporal conditions, then reconstruction becomes straight-forward. For example, if a cadaver is found buried at a depth of 1 m in a desert in summertime, and the temporal succession of the gut microbial community for these environmental conditions has previously been established, then PMI can be inferred with a high degree of accuracy and certainty. Thus, reconstruction microbiomics can readily pass the *Daubert* standard set by the US supreme court (Daubert v. Merrell Dow Pharmaceuticals Inc, 1993) to be recognized as admissible evidence bearing sufficient scientific foundation, including general acceptance in the scientific community, known and acceptable rate of error, and so on.

Comparison microbiomic tools, on the other hand, may provide greater benefit to the criminal investigation but are harder to develop to a level that would satisfy the *Daubert* standard. The most beneficial way to employ such tools would be in a “one-to-many” configuration, similar to forensic human DNA analysis: a DNA profile from trace evidence is compared to all the profiles

(from known persons and locations) in a database, and if it exists in the database, its frequency in the relevant population (e.g., of soils) is calculated to enumerate the probability of encountering this profile by chance (i.e., originating from a location or person unrelated to the crime). At this time, however, there are hardly any relevant forensic databases of microbiomes that can be compared to trace evidence. In their absence, the only way to proceed in a forensic context is in a "one-to-one" configuration. For each criminal case, questioned samples (e.g., from a suspect's shoe) are compared to context samples from the crime scene, alibi area, and other relevant sites. This approach provides less benefit to the investigation because it can only give conclusions of exclusion, that two samples do not share the same origin, or relative conclusions, such as "sample A is more similar to sample B than it is to sample C." Inclusionary conclusions such as "sample A is very similar to sample B; the probability of a different sample, from another place, person or time, being this similar to sample B at random is 1 in X Million" is impossible without either an extensive database (which is costly to build and maintain) or thorough theoretical knowledge (which we do not have yet) regarding the factors that shape microbiomes. However, even for "one-to-one" analyses, we can provide a statistical evaluation of the evidence (Habtom et al., 2019) based on the Likelihood Ratio framework as recommended by the European Network of Forensic Science Institutes (Willis et al., 2015).

There are three more major hurdles to forensic tools of comparative microbiomics. The first one involves samples of mixed origins, containing substrates or DNA from different locations or persons. DNA analysis of mixtures is difficult even with simple human DNA profiles, and certainly more so with microbiomic DNA profiles which are far more complex. It is often impossible to tell with certainty which, or even how many, disparate microbiomes are present in the mixture, let alone accurately infer the DNA profile of each one. The famed 2016 report of the US President's Council of Advisors on Science and Technology [President's Council of Advisors on Science and Technology (US), 2016] found that the prevalent subjective analysis of complex human DNA mixtures by forensic experts is not a reliable methodology. Consequently, several computer programs were developed to interpret complex human DNA mixtures in an objective manner, and these are slowly being validated and accepted for routine forensic use. Software for objective analysis of microbiomic DNA mixtures may be built on this basis, but these are still years in the future. The second major hurdle is temporal variation. Contrary to human DNA, which can remain unchanged for years, microbial communities (both on the body and deposited as trace evidence) can fluctuate over time, often in correlation with changes in environmental parameters like moisture and pH (e.g., Pasternak et al., 2013). In cases where two samples for comparison are obtained at different times when markedly different environmental conditions prevail, mitigating the temporal changes in community structure is needed before analysis can ensue. So far, only a few studies have addressed this topic experimentally, mainly by applying various carbon sources to force the different microbial communities to "converge" (Pasternak et al., 2019), but so far with limited success. The third, and perhaps most challenging hurdle, is the problem of DNA transfer. In the past decade, human DNA evidence gained widespread credibility and acceptance in the courts so that the identification of a DNA profile from trace evidence as originating from a specific person is rarely disputed nowadays. Instead, it is becoming more and more common for the defense to challenge the method of deposition of the DNA, suggesting that it reached the crime scene by a legitimate activity (before or after the crime occurred) or by DNA transfer (e.g., when the innocent suspect shook the hand of the real perpetrator). This hurdle can sometimes be overcome by using the likelihood-ratio approach with activity-level propositions (Mayuoni-Kirshenbaum et al., 2020); however, similar to the former hurdles, this one is also very much still an open question, and it will take more time, effort, and research before microbiomics is ready to be employed and accepted within the legal system.

Conclusion

Over the last decade, advances in genomic sequencing and bioinformatics have given rise to microbiomics, which fructified in a growing compendium of tools seeking to explore the panoply of microorganisms present in our bodies and environment. The evidence examined in this review indicates that microbiomics could be a forensically relevant and promising discipline with a multitude of applications—from determining substrate provenance and acquiring trace evidence to identifying individuals and estimating PMI. These advances may allow various microbiomic data, like those obtained from thanatomicrobiome analysis, to be used by forensic scientists to address questions related to criminal investigations, or at least be used alongside other forensic methods.

Throughout their life-course, humans and their microbiomes undergo complex interactions and co-adaptation processes involving nutrient intake and resulting in the production of decomposition products such as metabolites. Following a person's death, these interactions change dramatically, and the microbiome composition and dynamics fluctuate accordingly. Understanding these colonizations and fluctuations represent major conceptual, methodological, and computational challenges—as do antemortem microbial dynamics. Related microbiome-based research in a forensics context and greater exploration of fungal and viral communities may also lead to an important enhancement in the forensic toolkit in the future.

Many challenges remain to overcome, such as contamination issues, modest study sample sizes, model over-specification and misspecification, prediction accuracies of machine learning techniques, understanding complex spatial and temporal variations in environmental microbiome dynamics, as well as risks and ethical concerns (Shamarina et al., 2017). Notably, even human DNA-

based evidence, which is far better understood, is not error-proof, as indicated by the Phantom of Heilbronn case (Daniel and van Oorschot, 2011). Moreover, the vast majority of published work used 16S or targeted sequencing approaches, which have known limitation for taxonomic resolution and could likely benefit from metagenomics methods (Ogilvie and Jones, 2015; McIntyre et al., 2017) and/or methods that utilize longer reads (Danko et al., 2019b; Foox et al., 2020). Also, more field-based testing and deployment of these sequencing methods could benefit from rigorous, titrated standards for ensuring accuracy (McIntyre et al., 2019). Given this, many of the applications reported in the literature should be considered proof of concepts rather than full-fledged forensic applications. Nonetheless, as Ogilvie and Jones (2015, p. 1) have summarized: "*it is clear that we remain in a period of discovery and revelation, as new methods and technologies begin to provide [a] deeper understanding of the inherent ecological characteristics of this [microbial] ecosystem.*"

Author Contributions

EE initiated the study. JR carried out the review. EE, JR, ZP, and CM wrote the manuscript. All authors approved the manuscript.

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Conflict of Interest

EE consults the DNA Diagnostics Center. CM is a co-founder of Biotia, Inc.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Abbreviations

PCR, polymerase chain reaction; MetaSUB, metagenomics and metadesign of subways and urban biomes; PRISMA, preferred reporting items for systematic reviews and meta-analyses; CAMDA, critical assessment of massive data analysis; PMI, postmortem interval; OUT, operational taxonomic unit; CRP, C-reactive protein; SIDS, sudden infant death syndrome.

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Zhou, W., and Bian, Y. (2018). Thanatomicrobiome composition profiling as a tool for forensic investigation. *Forensic Sci. Res.* 3, 105–110. doi: 10.1080/20961790.2018.1466430

PubMed Abstract | CrossRef Full Text | Google Scholar

Zhou, X., Jiang, X., Yang, C., Ma, B., Lei, C., Xu, C., et al. (2016). Cecal microbiota of Tibetan Chickens from five geographic regions were determined by 16S rRNA sequencing. *Microbiologyopen* 5, 753–762. doi: 10.1002/mbo3.367

PubMed Abstract | CrossRef Full Text | Google Scholar

Quick Quiz

Query 16.1.6.1.1

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Check your Understanding

- What types of microbiomes can be analyzed in regards to geolocation for forensic science?
- How could microbiome analytical techniques be improved for personal identification?
- How are various microbiomes different between biological sexes?
- What are some common objects that can have microbiomes applicable for trace evidence?
- What is the thanatomicrobiome and how can it be used to determine postmortem interval?
- What are the major difficulties with comparative microbiomes concerning forensic applications?

Media Attributions

- Figure 1 – A summary of possible sources of forensically relevant microbiota identified by the literature review by Robinson et al., 2021 licensed under the terms of the Creative Commons Attribution License (CC BY).

References

1. Robinson, J. M., Pasternak, Z., Mason, C. E., & Elhaik, E. (2021). Forensic Applications of Microbiomics: A Review. *Frontiers in Microbiology*, *11*. https://www.frontiersin.org/article/10.3389/fmicb.2020.608101

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16.1.7: JOURNAL CLUB

16.1.7.1: Journal Club Articles

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16.1.7.1: Journal Club Articles

The following 'Journal Club' articles can be used as supplementary information for various microbiome topics and included in group discussions:

1. Microbiome definition re-visited: old concepts and new challenges by Berg et al., 2020 under a Creative Commons Attribution 4.0 International License
2. Role of the gastrointestinal tract microbiome in the pathophysiology of diabetes mellitus by Sohail et al., 2017 under a Creative Commons Attribution 4.0 International License
3. The Firmicutes/Bacteroidetes ratio: a relevant marker of gut dysbiosis in obese patients? by Magne et al., 2020 under a Creative Commons Attribution 4.0 International License
4. The trans-kingdom battle between donor and recipient gut microbiome influences fecal microbiota transplantation outcome by Kazemian et al., 2020 under a Creative Commons Attribution 4.0 International License
5. Saliva microbiome changes in patients with periodontitis with and without chronic obstructive pulmonary disease by Lin et al., 2020 under a Creative Commons Attribution 4.0 International License
6. The human oral microbiome in health and disease: from sequences to ecosystems by Willis and Gabaldon, 2020 under a Creative Commons Attribution 4.0 International License
7. The lung microbiome: new principles for respiratory bacteriology in health and disease by Dickson and Huffnagle, 2015 under a Creative Commons Attribution 4.0 International License
8. Viral and bacteriome characterization of children with pneumonia and asthma in Mexico City during winter seasons 2014 and 2015 by Romero-Espinoza et al., 2018 under Creative Commons Attribution 4.0 International License
9. New insights into the intrinsic and extrinsic factors that shape the human skin microbiome by Dimitriu et al., 2019 under Creative Commons Attribution 4.0 International License
10. Probiotics and vaginal microecology: fact or fancy? by Buggio et al., 2019 under Creative Commons Attribution 4.0 International License
11. Human breast milk bacteriome in health and disease by Ojo-Okunola et al., 2018 under Creative Commons Attribution 4.0 International License
12. Synergies of systems biology and and synthetic biology in human microbiome studies by Ezzamouri et al., 2021 under Creative Commons Attribution 4.0 International License
13. Microbiomes associated with foods from plant and animal sources by Jarvis et al., 2018 under Creative Commons Attribution 4.0 International License

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16.1.8: CASE STUDIES

16.1.8.1: Case Study #1 - Human Health
16.1.8.2: Case Study #2 - Environment
16.1.8.3: Case Study #3 - Synthesis (Create Your Own)

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16.1.8.1: Case Study #1 - Human Health

Case study #1 – The Farmer's Flu

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Part I – Background and Problem

During one week at the end of January of 2019, a high number of flu-like cases have appeared in the small city of Bogart, Iowa which has a population of approximately 50,000 people. 157 individuals were hospitalized over a two-week period, and large proportion included children under the age of 5 years old. Many common symptoms were initially observed in the majority of the patients, however, other less common symptoms manifested in some ill patients after about a week and earlier in those who were immunocompromised and with co-morbidities.

Common symptoms included:

- fever
- headache
- muscle pain or body aches
- shortness of breath
- vomiting
- diarrhea
- cough
- congestion or runny nose
- fatigue

Less common symptoms included:

- stiff neck
- lethargy
- chest pain
- swelling of the throat
- severe joint pain
- green, yellow, or bloody mucus production
- facial redness and swelling

YouTube Video

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Article 1: Respiratory Viral Infection-Induced Microbiome Alterations and Secondary Bacterial Pneumonia

Article 2: Allergic inflammation alters the lung microbiome and hinders synergistic co-infection with H1N1 influenza virus and Streptococcus pneumoniae in C57BL/6 mice

Initial epidemiological data showed that diseased individuals all were at or were in contact with someone who visited the farmer's

market the previous weekend. The market was established more than 20 years ago, and each weekend merchants open their stalls selling everything from pottery, jewelry, and linens to produce, homemade jams, and even livestock. The market is considered to be the staple of town commerce and entertainment, giving Bogart its cozy home-town feel, and even many consumers and merchants come in from the smaller surrounding towns to benefit from the commerce.

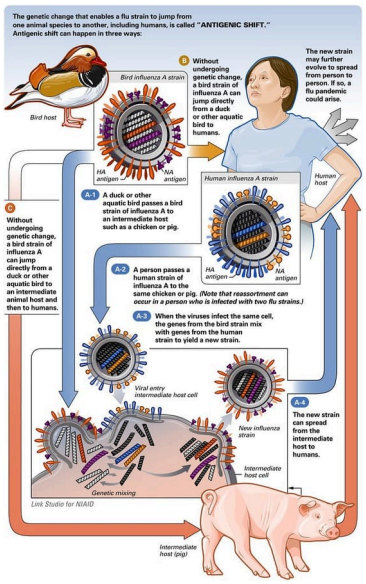


Figure 1. Antigenic shift of the Flu Virus. The genetic change that enables a flu strain to jump from one animal species to another, including humans, known as "antigenic shift." This process can happen in 3 ways: (A) strain is passed to an intermediate host from both human and animal where genetic recombination occurs, creating new strain that can spread to other animals. (B) without undergoing genetic change, the flu jumps directly from animal to human. (C) Without undergoing genetic change, the flu jumps to an intermediate host, then to humans.

Questions

1. What specific pathogens could be responsible for the observed symptoms and why would there be differences in the observed effects in different individuals?
2. Which microbiomes may be implicated in this disease and why?
3. Do you think this situation is a major public concern? Why or why not?

Attributions

- Video 1 – Raising temperatures: the immunology of influenza by British Society for Immunology under a Creative Commons Attribution License (reuse allowed)
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Case study #1 – The Farmer's Flu

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Part II – Approach, Implementation, Reasoning

Medical personnel took nasopharyngeal (NP) swabs of sick patients for testing. For children and older adults and those who were averse to NP swabs, nasal and throat swabs or aspirate specimens were collected (Flu specimen collection – CDC). Physicians prescribed various antiviral medication; either two doses per day of oral oseltamivir, four oral doses per day of umifenovir, or inhaled zanamivir for 5 days, and for patients in the hospital, one dose of intravenous peramivir or oral baloxavir for one day. They also prescribed prophylactic antimicrobials, including quinolones (moxifloxacin), cephalosporins (ceftriaxone and cefepime), or macrolides (azithromycin), or a glycopeptide (vancomycin). Other over the counter drugs were suggested to treat symptoms like fever and headache. Public health officials advised the community to get the flu vaccine as well.

YouTube Video

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Over the next few weeks, the number of cases increased and symptoms began to worsen for many. The initial assumption is a seasonal flu outbreak. Interestingly, more cases began to pop up in surrounding rural towns, and many patients were transported to the larger hospitals in the city to be put on ventilators. As mortality rates also began to rise, the CDC declared this situation a flu epidemic.

Article 1 – The respiratory microbiome and susceptibility to influenza virus infection

Article 2 – Secondary Bacterial Infections in Patients With Viral Pneumonia

Article 3 – Patterns in the longitudinal oropharyngeal microbiome evolution related to ventilator-associated pneumonia

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Questions

1. What types of laboratory tests and analytical techniques do you think were being conducted? What problems could have arisen with the analysis of the patient's samples?
2. Why do you think both antibacterial and antiviral medication was prescribed? How would you explain the difference between treatments of a viral and a bacterial infection to a patient?
3. What reasons or factors could cause a high mortality rate in those infected with the influenza virus?

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Part III – Discussion

After several weeks of patient study and a rising number of mortality and cases, infections were confirmed to be from a mutated variant of influenza A (H1N1; i.e. swine flu). Medical officials believe the high mortality rate and other severe cases may be due to a secondary bacterial infection caused by a pathogen that is resistant to antimicrobials.

Further epidemiological analysis shows that the initial original cases were specifically in individuals who visited the livestock section of the farmer's market for an extended period of time.

Article 1 – The distribution of microbiomes and resistomes across farm environments in conventional and organic dairy herds in Pennsylvania

Article 2 – Antimicrobial use and production system shape the fecal, environmental, and slurry resistomes of pig farms

Article 3 – Influence of Pig Farming on the Human Nasal Microbiota: Key Role of Airborne Microbial Communities

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Apologies, the video and audio are a bit glitchy.

Last line of defense antibiotics, polymixin (colistin) and carbapenems, were prescribed for patients not responding to the initial antibiotics. These patients were also put under quarantine in ICU wards as their symptoms began to worsen, which additionally included abdominal pain, bloody stool, and severe diarrhea that persisted in patients even after being discharged from the hospital.

Article 4 – Incidence, outcome, and risk factors for recurrence of nosocomial Clostridioides difficile infection in adults: A prospective cohort study

YouTube Video

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Questions

1. How do you think antibiotic resistance of the secondary bacterial pathogen came about?
2. How could chemotherapy affect various microbiomes and potentially contribute to pathogenesis and other disease symptoms?
3. How would you inform the public about this situation, and what measures would you suggest to prevent transmission or

recurrence?

Attributions

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Part IV – Resolution

Research scientists, medical professionals, and epidemiologists finally pieced the 'Farmer's Flu' epidemic puzzle together using next generation sequencing technology and keeping detailed records of observational data.

Two farmers from a nearby rural town contracted the novel swine flu variant. They then brought the pigs to market in Bogart, where the flu spread. However, they not only spread the flu variant, but also a highly contagious antibiotic-resistant strain of *Haemophilus influenza* type B (Hib). One of the farmers was sick the week prior and therefore immunocompromised which allowed the development of this secondary infection. It is likely that this strain of *H. influenza* acquired antibiotic resistance via horizontal gene transfer from *Haemophilus parasuis,* which is commonly found in pigs.

As this respiratory disease was treated with multiple ineffective prophylactic antimicrobial drugs, patients' resident microbiomes became depleted and allowed for another infection by opportunistic pathogens. In the case of those who were hospitalized, many developed another secondary infection by *Clostridioides difficile*, resulting in gastrointestinal distress.

After a few months, with the use of both old and new treatment options, outreach to the public with information about the diseases, and proper community compliance, the epidemic came to an end. Bogart resumed as a quiet cozy town, and still holds its locally famed farmer's market.

Reading 1: *H. influenza* – CDC – Epidemiology and Vaccine-Preventable Diseases

YouTube Video

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Article 1 – Basic Characterization of Natural Transformation in a Highly Transformable Haemophilus parasuis Strain SC1401

Article 2 – The Gut-Lung Axis in Health and Respiratory Diseases: A Place for Inter-Organ and Inter-Kingdom Crosstalks

Article 3 – Translating Lung Microbiome Profiles into the Next-Generation Diagnostic Gold Standard for Pneumonia: a Clinical Investigator's Perspective

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Questions

1. How is the gut microbiome linked with the oral and lung microbiomes? Explain how both of the secondary infections by *H. influenza* and *C. difficile* in this case could be related by their respective microbiomes.
2. What other diseases, conditions, or treatments have similar multi-microbiome effects?
3. What are some examples of novel microbiome diagnostic and treatments that could work to restore the affected microbiomes?

Attributions

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16.1.8.2: Case Study #2 - Environment

Case study #2 – The Land is Sick

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Part I – Background and Problem

Coffee production in South America has drastically decreased in the 2021-23 growing seasons. Specifically, the major farms in Columbia and Brazil which collectively contribute over half of each countries coffee (both specialty and commercial) production, have had severe crop failures. As a result, the price of a cup of coffee has noticeably increased, putting financial strain on suppliers and businesses.

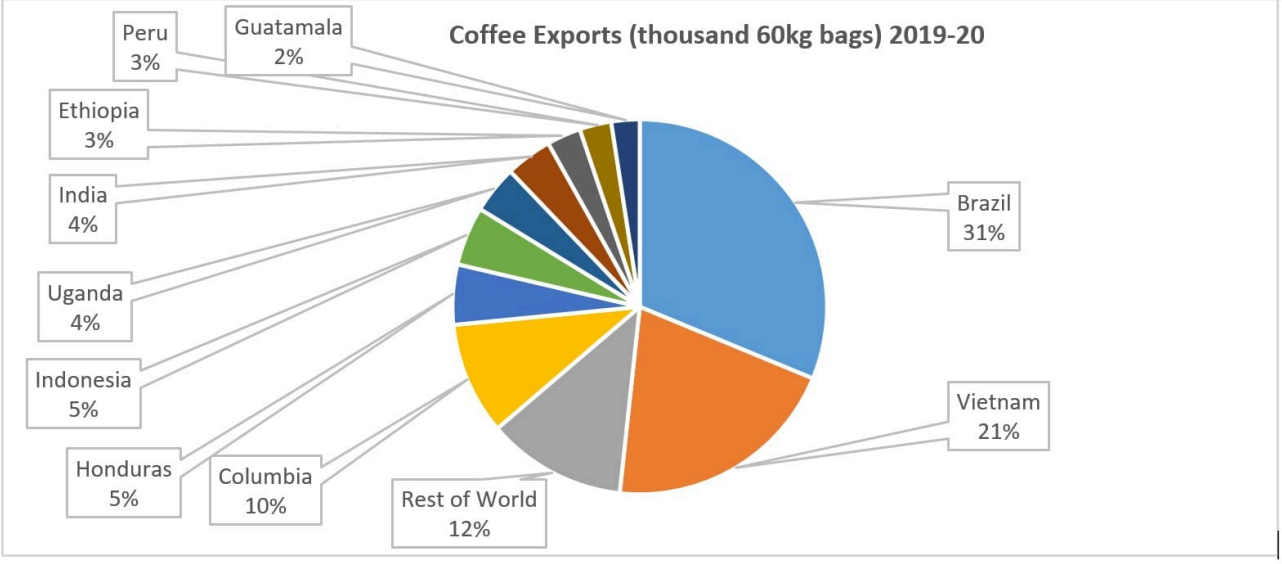


Figure 1. Coffee exports by country 2019-20. Source: International Coffee Organization

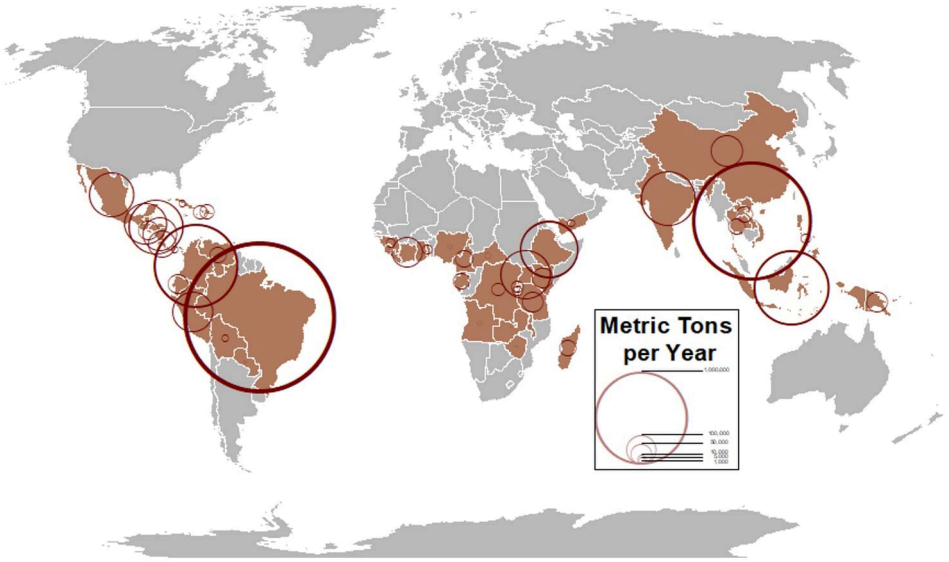


Figure 2. A world map of countries by coffee production, 2019.

Interestingly, the few years prior to this decline, coffee production was at an all-time high, with more coffee in the market than demanded. This dropped the price of coffee, and in many cases original farmers were not fairly compensated.

The International Coffee Organization (ICO) has tasked a team of researchers to identify potential problems to South American coffee plant failure and provide quick and efficient resolution.

Article 1 – The Bacterial Microbiome of *Meloidogyne*-Based Disease Complex in Coffee and Tomato

Article 2 – A review of three major fungal diseases of *Coffea Arabica* L. in the rainforests of Ethiopia and progress in breeding for resistance in Kenya

Article 3 – Structure and Dynamics of the Gut Bacterial Community Across the Developmental Stages of the Coffee Berry Borer, *Hypothenemus hampei*

Video 1 – The biggest threats to the coffee industry

Video 2 – #1 Specialty coffee and the price crisis | Producer Crossover 2019

Questions

1. As a scientific researcher, what are some factors you would take into consideration when addressing this problem?
2. What type of environmental microbiomes could be implicated in coffee plant crop failure and why?
3. Should other coffee farms in countries besides those in South America be worried about similar failure in their crops? Why or why not?

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Case study #2 – The Land is Sick

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Part II – Approach, Implementation, Reasoning

Upon initial inspection, the unhealthy coffee plants exhibited yellowing of leaves, appearance of red-brown lesions, abnormal shape, damaged coffee berries, and little new growth or production. Researchers decided to take samples of healthy and unhealthy leaves and berries, as well as soil and root samples.

Article 1 – Prokaryotic diversity in the rhizosphere of organic, intensive, and transitional coffee farms in Brazil

Article 2 – A metagenomics approach in the evaluation of the soil microbiome in coffee plantations under organic and conventional production in tropical agroecosystems

Video 1 – #2 Producer Crossover 2019

Video 2 – How countries farm and make coffee differently

Over the next year, other plantations in Columbia and Central American begin to experience similar declines in coffee plant health. Farmers were questioned about any changes in practices, and while there have been some adjustments do to the fluctuating coffee prices, traditional farming techniques have remained the same for the most part in smaller plantations. Larger plantations with intensive farming made more changes due to trader suggestions on improving yields including application of different fertilizers and hiring less experienced workers.

Questions

1. What type of analytical techniques do you think were or should be performed on the samples taken?
2. How could the observed symptoms of the unhealthy plants be connected to an associated microbiome?
3. How could human intervention exacerbate or ameliorate this situation?

Attributions

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Part III – Discussion

Analysis of the negatively affected plantations' soil showed a decline in plant growth promoting bacteria and mycorrhizae and an increase in bacterial and fungal pathogens like *Pseudomonas syringae* and *Cercospora coffeicola*.

Over the next few years (2022-24) coffee plants still struggle to grow in Central and South America. Other parts of the world, such as Vietnam and other Asian countries, are seeing a decline in crop health also, further contributing to global coffee market troubles. Many of these farms switched from shade-grown to intense sun-grown coffee to try to meet needs for demand. Larger corporations and roasters have purchased many of the smaller family farms to try to recoup losses and implement 'new and improved' growing strategies for increased production. This included switching to primarily sun-grown coffee, and application of large amounts of synthetic nitrogen fertilizer.



Figure 1. Shade grown coffee in Guatemala



Figure 2. Sun-grown coffee plantation in Brazil

Video 1- #3 The future of the price crisis

Video 2 – How coffee destroys the environment

Article 1 – Root endophytes of coffee (*Coffea Arabica*): Variation across climatic gradients and relationships with functional traits

Article 2 – Brazilian Coffee Production and the Future Microbiome and Mycotoxin Profile Considering the Climate Change Scenario

Article 3 – Effects of environmental factors on microbiota of fruits and soil of *Coffea arabica* in Brazil

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Questions

1. What factors could cause these changes in the soil microbiomes?
2. Why do you think coffee plantations across the globe are beginning to fail as well?
3. How does natural biodiversity benefit ecosystem health on both a micro and macro scale?

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Part IV – Resolution

In 2030, most varieties of coffee are extinct, and only small amounts of coffee are produced on shade grown farms further from the equator. It appears that coffee plantations were severely impacted by increasing global temperatures, which altered ecosystem dynamics and promoted pathogen and pest invasion. Fungi, bacteria, and arthropods devastated already struggling coffee farms and with a major switch to sun-grown coffee, soil microbiomes were depleted and disease spread rapidly through monoculture crops. This switchover was prompted by an energy drink corporation, KAPOW!, which wanted to corner the caffeine market and boost production, though their expertise in growing coffee was lacking and the excessive use of synthetic fertilizers on already sun baked land which requires much more watering further doomed plantations. At least they now produce a cheap "coffee" flavored energy drink. It tastes terrible.

Article 1 – Coffee Microbiota and Its Potential Use in Sustainable Crop Management. A Review

Article 2 – Soil fungal communities differ between shaded and sun-intensive coffee plantations in El Salvador

Article 3 – One health relationships between human, animal, and environmental microbiomes: A mini-review

Video 1 – Teaching coffee farmers about the birds and the bees

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Questions

1. In what ways are environmental microbiomes impacted by changing environmental factors and how can this promote diseases within an ecosystem?
2. How could various environmental microbiomes be utilized to improve sustainable practices and technology?
3. How are environmental and human microbiomes interconnected?

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16.1.8.3: Case Study #3 - Synthesis (Create Your Own)

Develop your own case study related to microbiomes!

Group members (4-5) will develop and write an original case study involving a microbiome and health or environmental condition. Topics must be approved by the instructor beforehand. The case study should consist of 3 parts: (i) background and problem/issue, (ii) approach to solve, implementation, and reasoning, (iii) discussion of progression of the case study. The final part, (iv) resolution and conclusion will be completed by another group and presented over. The case study should have an interesting title, include references, images, figures, etc. from relevant resources (be sure to use in-text citations and include references at the end), and 3 critical thinking questions concluding each part (9 total).

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16.1.9: ADDITIONAL RESOURCES

16.1.9.1: The Integrative Human Microbiome Project
16.1.9.2: BMC Microbiome Open Collections

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16.1.9.1: The Integrative Human Microbiome Project

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The Integrative Human Microbiome Project

The Integrative HMP (iHMP) Research Network Consortium

Abstract

The NIH Human Microbiome Project (HMP) has been carried out over ten years and two phases to provide resources, methods, and discoveries that link interactions between humans and their microbiomes to health-related outcomes. The recently completed second phase, the Integrative Human Microbiome Project, comprised studies of dynamic changes in the microbiome and host under three conditions: pregnancy and preterm birth; inflammatory bowel diseases; and stressors that affect individuals with prediabetes. The associated research begins to elucidate mechanisms of host–microbiome interactions under these conditions, provides unique data resources (at the HMP Data Coordination Center), and represents a paradigm for future multi-omic studies of the human microbiome.

Main

Although the 'omics era has accelerated all aspects of biological research, its effects have been particularly apparent in studies of microbial communities and the human microbiome. In the 18 years since the publication of the first human genome, studies of the microbiome have grown from culture-based surveys of the oral cavity and gut to molecular profiles of microbial biochemistry in all ecological niches of the human body[1,2,3]. Epidemiology and model systems have been used to identify associations between changes in the microbiome and conditions ranging from autism[4] to cancer[5,6,7], and microbial and immunological mechanisms have been identified that affect, for example, the efficacy of drugs used to treat cardiac conditions[8] or survival during graft-versus-host disease[9].

Contemporary studies of the human microbiome have also been a source of basic biological and translational surprises, exposing a compelling range of novel findings and open questions. Every human being appears to carry their own, largely individual, suite of microbial strains[10,11], which are acquired early in life[12,13,14], differ between environments and populations[15,16], and can persist for years[17] or undergo relatively rapid transitions[18]. Microbial diversity manifests differently in different ecological niches of the body; for example, greater diversity is generally expected in the gut, but can be associated with dysbiotic states and risk of adverse events in the female reproductive tract. The microbiome can be perturbed by conditions such as inflammatory bowel disease and diabetes, but a variety of microbiome-linked health states, and the underpinnings of these links, remain unexplored. How dynamic is the microbiome during processes such as pregnancy or viral infection? Which changes in the microbiome represent causes rather than effects of changes in health? Which molecular elements of a personalized microbiome might be responsible for health outcomes, and how do they integrate with and maintain physiological processes such as the immune system and metabolism? And what ecological elements dictate the success of a microbiota transplant, and why are they successful in treating some individuals and conditions, but not others?

The National Institutes of Health Human Microbiome Project was one of the first large-scale initiatives to address a subset of these questions[19] (Fig. 1). Launched in 2007[20], the first phase of the program sought to determine whether there were common elements to 'healthy' microbiomes, in the absence of overt disease. Studies of both a baseline adult population[21,22,23] and 'demonstration' populations with specific disease states established typical ranges (for some populations) of microbial membership and enzymatic repertoires across the body, combinations of metabolic functions that were either prevalent or strain-specific, and some of the host factors (such as race or ethnicity) that determine this variation. Studies of targeted populations identified ecological states of niches such as the vagina[24,25], skin[26,27,28], and gut[29,30,31,32,33], among many others (https://www.hmpdacc.org/health/projectdemos.php). This first phase of the HMP (HMP1) thus yielded a wealth of community

resources: nucleotide sequences of microorganisms and communities from a large number of isolates, individuals, and populations (http://hmpdacc.org)[34,35,36,37]; protocols to support reproducible body-wide microbiome sampling and data generation[38,39,40]; and computational methods for microbiome analysis and epidemiology[41,42,43,44,45,46,47].

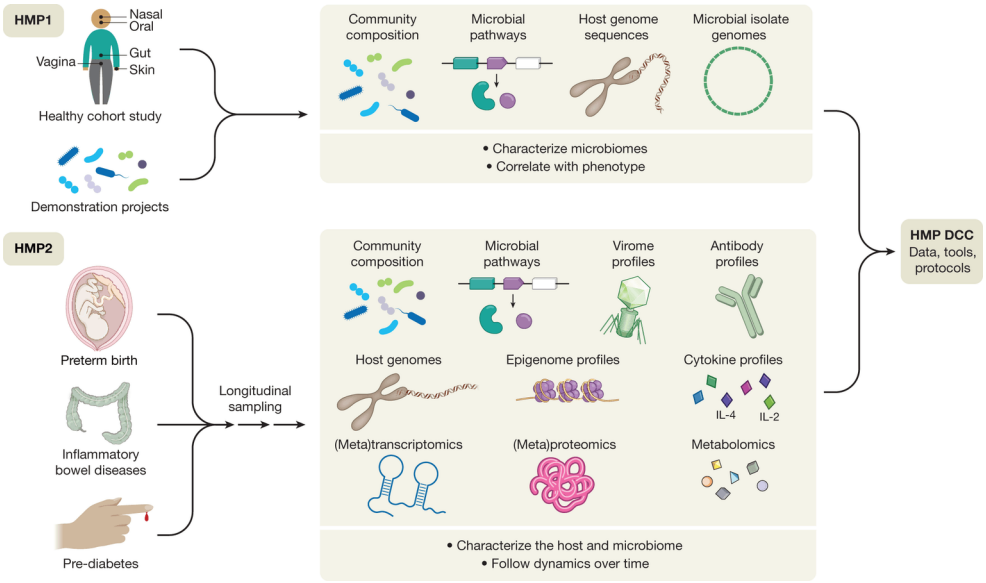


Fig. 1 The first and second phases of the Human Microbiome Project. The ten-year NIH Human Microbiome Project (HMP) program, organized into two phases (HMP1 and HMP2), developed reference sequences, multi-omic data sets, computational and statistical tools, and analytical and clinical protocols as resources for the broader research community. The HMP1 focused on the characterization of microbial communities from numerous body sites (oral, nasal, vaginal, gut, and skin) in a baseline study of healthy adult subjects, and included a set of demonstration projects that focused on specific diseases or disorders. The HMP2 expanded the repertoire of biological properties analysed for both host and microbiome in three longitudinal cohort studies of representative microbiome-associated conditions: pregnancy and preterm birth (vaginal microbiomes of pregnant women), inflammatory bowel diseases (gut microbiome) and prediabetes (gut and nasal microbiomes). These studies followed the dynamics of these conditions through multi-omic analyses of multiple measurement types over time, including changes in microbial community composition, viromics, metabolomic profiles, gene expression and protein profiles from both host and microbiome, and host-specific properties such as genetic, epigenomic, antibody, and cytokine profiles, along with other study-specific features. All sequences and multi-omic data, clinical information, and tools from both HMP1 and HMP2 are housed in the HMP Data Coordination Center (DCC) or referenced public or controlled-access repositories to serve as a central resource for the research community.

One of the main findings of the HMP1 was that the taxonomic composition of the microbiome alone was often not a good correlate with host phenotype—this tended to be better predicted by prevalent microbial molecular function or personalized strain-specific makeup[21]. This finding served as the foundation for the development of the second phase of the HMP, the Integrative HMP (iHMP or HMP2)[48], which was designed to explore host–microbiome interplay, including immunity, metabolism, and dynamic molecular activity, to gain a more holistic view of host–microbe interactions over time. This multi-omic program sought to expand the resource base available to the microbiome research community, to begin to address the relationship between host and microbiome mechanistically, and to address the questions introduced above. Disease-targeted projects within the HMP2 were therefore encouraged to use multiple complementary approaches in order to assess the mechanisms of human and microbial activity longitudinally and to provide protocols, data, and biospecimens for future work. These projects included three studies that followed the dynamics of human health and disease during conditions with known microbiome interactions, thus addressing important health outcomes directly while also serving as models of 'typical' microbiome-associated conditions of broad interest to the research community. These comprised pregnancy and preterm birth (PTB); inflammatory bowel diseases (IBD); and stressors that affect individuals with prediabetes. These studies, which have now reached the first stage of completion[49,50,51], together provide a wealth of information and insights about not only microbial dynamics, but also associated human host responses and microbial inter-relationships. A collection of more than 20 manuscripts to date describe some of these results at https://www.nature.com/collections/fiabfcjbfj, and together they provide a rich multi-omic data resource to be mined by future work (http://www.ihmpdcc.org).

The vaginal microbiome, pregnancy and preterm birth

Preterm birth can have devastating consequences for newborn babies, including death and long-term disability. In the United

States, approximately 10% of births are premature[52], and the incidence is even greater in lower-resource countries. Environmental factors, including the microbiome of the female reproductive tract, are important contributors to prematurity. Notably, these factors have a greater effect in women of African ancestry, who also bear the highest burden of PTB[53]. Infant mortality has been reduced in recent decades, but the incidence of PTB has not decreased[54], and progress in predicting individual risk of PTB has stalled. During pregnancy, the maternal immune system maintains a delicate balance of pro- and anti-inflammatory effectors[55], and contributors to PTB include breakdown in maternal–fetal tolerance, vascular disorders, stress, cervical insufficiency, premature rupture of the fetal membranes, and intra-amniotic infection[56]. Microbial ascension into the uterus is thought to precipitate PTB by disrupting the maternal immune balance, leading to spontaneous preterm labour, and/or by the release of microbial products (for example, collagenases, proteases or toxins) that compromise the integrity of fetal membranes and lead to premature rupture of the membranes[57].

The Multi-Omic Microbiome Study: Pregnancy Initiative (MOMS-PI) research group, as part of HMP2, characterized the microbiomes of pregnant women to gauge their effects on risk of PTB (Fig. 2). The project followed 1,527 women longitudinally through pregnancy and involved the collection of 2006,437 specimens, including maternal vaginal, buccal, rectal, skin and nares swabs, blood, urine, and birth products, as well as infant cord and cord blood, meconium and first stool, buccal, skin and rectal swabs. Subsets of these specimens underwent 16S rRNA gene taxonomic analysis, metagenomic and metatranscriptomic sequencing, cytokine profiling, lipidomics analysis, and bacterial genome analysis. The MOMS-PI team analysed 12,0039 samples from 597 pregnancies to investigate the dynamics of the microbiome and its interactions with the host during pregnancy leading to PTB[50].

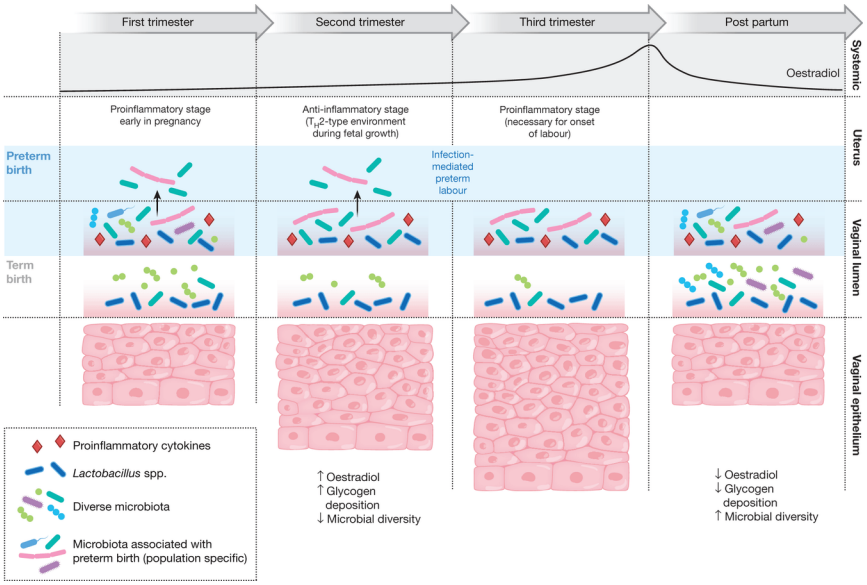


Fig. 2. The vaginal microbiome and its relationships with host factors in pregnancy and preterm birth. The MOMS-PI project followed 1,527 pregnancies longitudinally and involved the collection of 2006,437 biospecimens for analysis of host and microbial factors (16S amplicon, metagenomic, and metatranscriptomic sequencing; cytokine profiling; metabolomics; proteomics; genomics; and microbial isolate culture). Around 600 pregnancies were analysed in depth to assess features that lead to preterm birth; this analysis identified both host (for example, cytokine) and microbial (for example, ecological and specific strain) factors. As pregnancy progresses, with predictable changes in systemic oestradiol levels, the uterine and vaginal environments undergo various changes. The uterus switches from an early pro-inflammatory condition to an anti-inflammatory condition in the second trimester, and then back to a pro-inflammatory condition before the onset of labour. Meanwhile, specific changes in the microbiome of the vaginal lumen can be associated with preterm birth, possibly through mechanisms involving microorganisms travelling from the vagina to the uterus. The figure depicts an overview of longitudinal changes in the vaginal mucosal ecosystem and uterus during pregnancy.

These multi-omic investigations identified temporal changes in the vaginal microbiome associated with full-term pregnancies. Women who often began pregnancy with a vaginal microbiome of greater ecological complexity generally converged towards a more homogeneous *Lactobacillus*-dominated microbiome by the second trimester[58]. Interestingly, this trend was most pronounced in women of African ancestry with lower socioeconomic profiles. Although the overall MOMS-PI cohort was demographically diverse, most women who experienced spontaneous PTB at less than 37 weeks of gestation were of African ancestry. The MOMS-PI team (http://vmc.vcu.edu/momspi) also identified signatures of higher risk for PTB in women who experienced spontaneous preterm birth at less than 37 weeks of gestation[50]. Women who went on to experience spontaneous

PTB were less likely to exhibit a vaginal microbiota dominated by *Lactobacillus crispatus*, as previously reported in other populations[59,60,61,62], and were more likely to exhibit an increased proportional abundance of several taxa including *Sneathia amnii*, *Prevotella*-related clades, a Lachnospiraceae taxon known as BVAB1, and a *Saccharibacteria* bacterium known as TM7-H1. Notably, these taxa were also associated with low levels of vitamin D[63], suggesting that the vaginal microbiome might mediate a link between PTB risk and vitamin D deficiency[64]. The signatures of PTB were also reflected in metagenomic and metatranscriptomic measurements, and vaginal pro-inflammatory cytokines (including IL-1β, IL-6, MIP-1β and eotaxin-1) were positively correlated with PTB-associated taxa. Conveniently for future possible interventions, the vaginal microbiomes of mothers who experienced PTB were most distinct from those of control mothers early in pregnancy, and a preliminary model to predict risk of PTB was most sensitive and specific using vaginal microbiome profiles from samples collected before 24 weeks of gestation.

The MOMS-PI research group identified intriguing associations between the vaginal microbiota, host response, and pregnancy outcomes that are consistent with the involvement of microorganisms ascending from the vagina in at least some cases of spontaneous PTB. As an essential next step, the contribution of racial and demographic background to the vaginal microbiome in pregnancy with relation to pregnancy outcomes must be fully explored through harmonized, large-scale studies[50]. It is clear that PTB has a complex aetiology[56]. The relative contributions of fetal and maternal genetics and epigenetics, particularly as related to genetic variation of the innate immune system, should be explored. Harmonized large-scale studies would permit the development of population-specific risk assessment algorithms using vaginal microbiome profiles, features from genetic and prenatal (fetal) genetic screens, biomarkers such as cytokines and metabolites, and key clinical features from classic markers of risk including maternal age, body mass index, pregnancy history (including history of PTB), cervical length, and measures of stress and other environmental exposures. With the addition of new data from the microbiome, other environmental factors, and multi-omic inputs, new algorithms promise to improve our ability to predict risk of PTB early in pregnancy, to facilitate clinical trials by identifying high-risk patients, and ultimately to stratify patient populations into treatment groups.

The gut microbiome and inflammatory bowel disease

Studies of the gut microbiome in gastrointestinal disease have a particularly long and detailed history, especially in complex chronic conditions such as the inflammatory bowel diseases (IBD). IBD, including Crohn's disease and ulcerative colitis, affects millions of individuals worldwide, with increasing incidence over the past 50 years or more coinciding with multiple factors such as westernization, urbanization, shifts in dietary patterns, antimicrobial exposure, and many more that could influence host–microbiome homeostasis[65]. The microbiome has long been implicated in IBD, potentially as a causative or risk factor[66,67], as an explanation for heterogeneity in treatment response (that is, some individuals respond well to relatively benign aminosalicylates or corticosteroids whereas others still experience severe inflammation even after surgical intervention)[68], or as a novel point of therapeutic intervention (for example, by transplantation of faecal microbiota[69,70]). Although meta-omic techniques have been used to identify functionally consistent microbial responses that help to explain the gut microbiome's role as part of a pro-inflammatory feedback loop in the gut during disease[71], and a few strains of microorganisms have been shown to be IBD-specific[72], no comprehensive model of specific microbial, molecular, and immune interactions yet exists to explain the disease's onset and dynamic progression.

Therefore, to better characterize mechanisms of host–microbiome dysregulation during disease, the Inflammatory Bowel Disease Multi'omics Database (IBDMDB) project followed 132 individuals from five clinical centres over the course of one year each as part of HMP2 (Fig. 3). Integrated longitudinal molecular profiles of microbial and host activity were generated by analysing 1,785 stool samples (self-collected and sent by mail every two weeks), 651 intestinal biopsies (collected colonoscopically at baseline), and 529 quarterly blood samples. To the extent possible, multiple molecular profiles were generated from the same sets of samples, including stool metagenomes, metatranscriptomes[73], metaproteomes, viromes, metabolomes[74,75], host exomes, epigenomes, transcriptomes, and serological profiles, among others, allowing concurrent changes to be observed in multiple types of host and microbial molecular and clinical activity over time. Protocols and results from the study, further information about its infrastructure, and both raw and processed[76,77] data products are available through the IBDMDB data portal (http://ibdmdb.org), from the HMP2 Data Coordination Center (DCC; http://ihmpdcc.org), and in the accompanying manuscript[49].

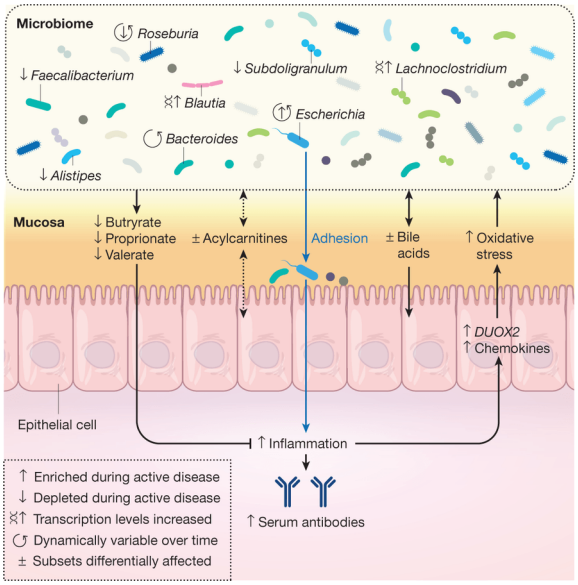


Fig. 3. Host-microbiome dynamics in IBD. The IBDMDB followed more than 100 participants with IBD (Crohn's disease or ulcerative colitis), as well control individuals without IBD, for one year each to assess host and microbial molecular activity during changes in disease activity and gastrointestinal inflammation. Nearly all measured host–microbiome properties showed changes in either activity or stability during disease, including those shown here—not only microbial taxa and microbial transcription, but also host- and microbiota-derived small molecules in the gut, epithelial transcriptional responses at multiple points along the colon, and circulating antibody levels in peripheral blood serology.

This unique study design allowed the IBDMDB to identify a variety of differences in the microbiome and host immune response over time during the course of the disease. Indeed, these dynamic changes were of much greater magnitude than were cross-sectional differences among clinical phenotypes, which have been emphasized by previous studies[67,71,78,79]. This was due in part to the prospective nature of the cohort, which recruited patients with Crohn's disease or ulcerative colitis during both active and quiescent periods of disease, showing that microbial compositions in patients with IBD often revert to more control-like, 'baseline' configurations when the disease is not active. By identifying the gut microbial configurations that were most different from baseline—regardless of specific disease state—the study defined a dysbiosis score that called out highly divergent microbial compositions, which share many features common to an overall inflammatory response (for example, tolerance to oxidative stress). This dysbiosis was not unique to the microbial response to inflammation, however, and was associated with other host and biochemical alterations, pointing to new potential directions for management of systemic dysregulation in IBD. These included large shifts in acylcarnitine pools and bile acids, increased serum antibody levels, and alterations in transcription for several microbial species. Concurrent transcriptomics and 16S amplicon mucosal community profiling from biopsies also identified potential host factors that might be able to shape the microbial community, in particular several chemokines, highlighting these as being involved in a potentially dysregulated interaction during periods of disease activity[49].

The study's longitudinal multi-omic profiles further allowed researchers to characterize the stability and dynamics of host–microbiome interactions during disease, in particular highlighting ways in which community state and immune responses are distinctly less stable in participants with IBD than in control, healthy individuals. In numerous cases, the microbiome of a participant with IBD changed completely over the course of only weeks (measured as maximal Bray–Curtis dissimilarity to earlier samples from the same subject), whereas such shifts were rare in individuals without IBD. The main microbial contributors to these large-scale shifts from one time point to the next largely mirrored the differences observed in dysbiosis, and the shifts frequently marked the entrance into or exit from periods of dysbiosis. Finally, the study's long-term, complementary molecular measurements enabled the construction of a network of more than 2,900 significant host and microbial cellular and molecular interactors during IBD, ranging from specific microbial taxa to human transcripts and small molecule metabolites. This network of mechanistic associations identified several key components that are central to the alterations seen in IBD, highlighting octanoyl carnitine, several lipids and short-chain fatty acids, the taxa *Faecalibacterium*, *Subdoligranulum*, *Roseburia*, *Alistipes*, and *Escherichia*, some at both the metagenomic and metatranscriptomic levels, and host regulators of interleukins[49]. Networks of mechanistic associations such as this may provide the key to disentangling the complex system of interactions that results in chronic inflammation in IBD and in other systemic microbiome-linked immune diseases.

Multi-omics profiling in prediabetes

Type 2 diabetes mellitus (T2D) affects more than 10% of the adult US population, and another 30% show early signs of the

disease (referred to as prediabetes)[80]; 70% of the latter will develop diabetes in their lifetime. T2D is characterized by complex host–microbiome interactions[81,82], but little is known about systemic alterations during prediabetes, their effects on biological processes, or the critical transition to full-blown T2D. Prediabetes and T2D are often associated with insulin resistance, and thus studies of individuals with prediabetes or insulin resistance offer unique opportunities to investigate the earliest stages of diabetes. It is essential to create a global and simultaneous profile of both host and microbial molecules in individuals with prediabetes over time, in order to fully understand the molecular pathways that are affected in people with prediabetes and/or insulin resistance and how these conditions affect both biological responses to environmental challenges (for example, viral infections[83,84]) and the onset of T2D.

To better understand T2D at its earliest stages, as part of iHMP, the Integrated Personal 'Omics Project (IPOP)[85] followed 106 healthy and prediabetic individuals during quarterly periods of health, respiratory viral infection (RVI) and other perturbations over about four years[51] (Fig. 4). In one such perturbation, a subset of 23 individuals underwent a directed weight gain followed by weight loss[86]. In total, 1,092 collections across all participants were profiled. For each visit, blood was assayed for host molecular 'omics profiling and two types of samples, nasal swabs and faeces, were collected for microbial profiling. Each participant's exome was sequenced once; otherwise, for each visit, 13,379 transcripts were profiled from peripheral blood mononuclear cells, 722 metabolites and 302 proteins from plasma, and 62 cytokines and growth factors from serum. In addition, thousands of gut and nasal microbial taxa and computationally predicted genes were profiled using 16S rRNA amplicons. All visits were also intensively characterized by 51 clinical laboratory tests. In addition, because of the focus on T2D, a number of glucose dysregulation tests were performed, including measurements of fasting glucose and haemoglobin A1C levels, oral glucose tolerance tests, and tests of insulin resistance.

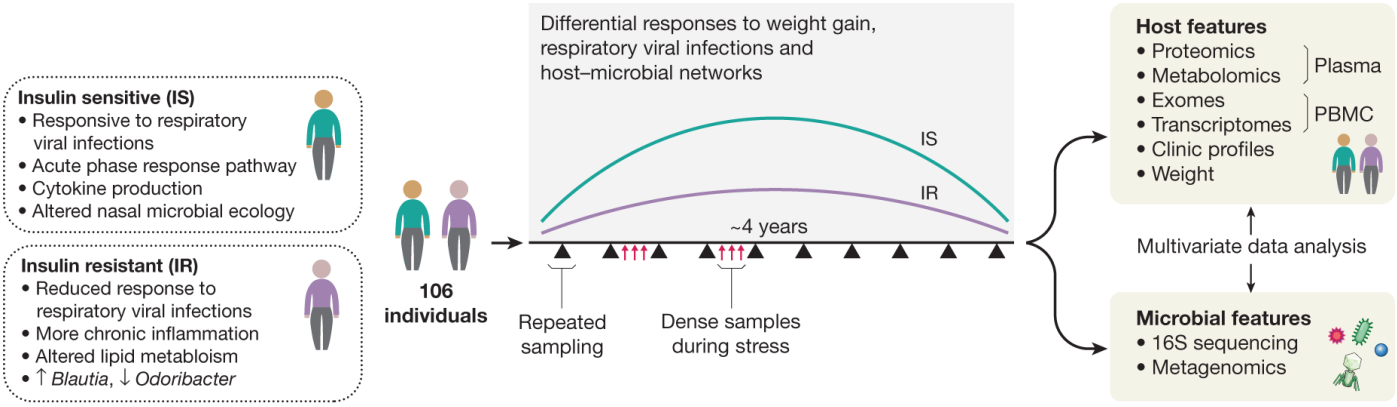


Fig. 4. Differential host and microbial responses to dietary perturbations and infectious disease in individuals with prediabetes. For integrated personal 'omics profiling of the microbiome during prediabetes, 106 participants were followed for up to four years, with samples (primarily blood and stool) collected quarterly and additional samples collected during periods of RVI and other stresses. The genomes of the participants were sequenced and measurements of transcriptomes, proteomes, metabolomes, and microbiomes taken at each visit, in addition to clinical details. Insulin-resistant individuals showed differences from insulin-sensitive participants in various measurements, both at baseline and in response to the stresses such as weight loss and RVI.

Baseline measurements were generally stable within individuals, even for long periods of time, with only some analytes changing significantly over time[51]. However, many analytes, such as clinical laboratory measurements, cytokine profiles, and gut microbial taxa (mostly those of low abundance) were highly variable between individuals. Participants who were ultimately insulin-resistant had distinguishable molecular and microbial patterns at baseline from those who were ultimately insulin-sensitive, and an analyte test was devised as part of the study in order to differentiate them. Notably, individuals undergoing RVI or changes in weight showed thousands of specific molecular and microbial changes during these perturbations, and insulin-resistant and insulin-sensitive individuals responded very differently to perturbations. For example, during RVI, insulin-resistant participants showed substantially decreased and delayed inflammatory responses (for example, the acute phase response and IL-1 signalling) and altered gut microbial changes when compared with insulin-sensitive participants (for example, in Lachnospiraceae and Rikenellaceae but not bacilli). Accordingly, there were fewer changes in nasal microbiota in insulin-resistant participants, and both the richness and the diversity of nasal microorganisms decreased during RVI in insulin-sensitive but not insulin-resistant participants. Furthermore, global co-association analyses among the thousands of profiled molecules revealed specific associations in insulin-resistant individuals that differ from those seen in insulin-sensitive participants and vice versa, indicating different patterns of host–microbiome interactions in the two groups[51].

Another important goal of the study was to assess how host–microbiome multi-omics and related emerging technologies can

be used to better manage patients' health. We found that taking millions of measurements per individual over time enabled the early detection of potential disease states[51,87]. These included early detection of T2D, which developed differently among participants and was better detectable with varied assays; for example, some individuals first exhibited measurements in the diabetic range on tests of fasting glucose, whereas others did so on tests of haemoglobin A1c, oral glucose tolerance tests, or even continuous glucose monitoring. These results, together with detailed characterization of glucose dysregulation over time, illustrate the heterogeneity of T2D development. Overall, the data led to microbially linked, clinically actionable health discoveries in a number of diseases in addition to T2D, including metabolic disease, cardiovascular disease, haematological or oncological conditions, and other areas; these signs were often present before symptom onset, demonstrating the power of using big data, including the microbiome, to better manage human health.

Resources from the HMP2

Together, the HMP1 and HMP2 phases have produced a total of 42 terabytes of multi-omic data, which are archived and curated by the DCC at at http://ihmpdcc.org and in public and/or controlled-access repositories such as the Sequence Read Archive (SRA; https://www.ncbi.nlm.nih.gov/sra), the Database of Genotypes and Phenotypes (dbGaP; https://www.ncbi.nlm.nih.gov/gap/), Metabolomics Workbench (https://www.metabolomicsworkbench.org/), and others (Fig. 5). All data on the DCC is available for unrestricted use, with a subset of project metadata also being shared when permitted by institutional review boards (IRBs), and other restricted data (for example, human genome sequences and protected metadata) available through controlled access at dbGaP (projects PRJNA398089, PRJNA430481, PRJNA430482, PRJNA326441, phs001719, phs000256, phs001626, phs001523, and others). The formal data models and associated entity relationship schemas produced by all phases of the HMP are freely available at https://github.com/ihmpdcc/osdf-schemas. The DCC website allows users to find, query, search, visualize, and download data from thousands of samples with associated metadata. Once a user has identified a set of files, conditions, subjects, or phenotypes of interest, he or she can add this set to a shopping cart for further operations. Files can then be directly downloaded for use at the user's local site or in the cloud. The HMP DCC efforts are thus by design consistent with the NIH's stated goals to make all data generated from NIH funding findable, accessible, interoperable, and reusable[88]. The success of these efforts is evidenced by a consistently high rate of user access to the web resources, with 9,000–12,000 user sessions each month, and a greater throughput anticipated after the publication of these resources here.

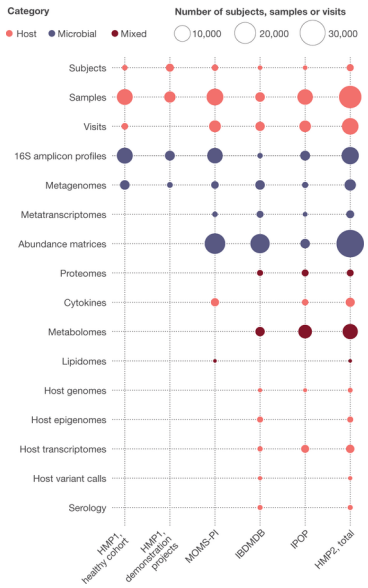


Fig. 5. Resources from HMP1 and HMP2 available at the DCC. The HMP DCC (http://ihmpdcc.org) hosts raw and processed data from both phases of the Human Microbiome Project, comprising in total more than 42 Tb of multi-omic data. From the HMP1, these include 16S rRNA gene amplicons and metagenomes from the healthy human subjects (HHS) baseline cohort, as well as resources from demonstration projects (https://www.hmpdacc.org/health/projectdemos.php) and genomes of associated microbial isolates. From the HMP2, these include data that IRBs gave permission to be made publicly available from the pregnancy and preterm birth (MOMS-PI), inflammatory bowel disease (IBDMDB), and prediabetes (IPOP) projects, with links to raw data in other repositories. Additional data deposited elsewhere including microbial reference genomes, HMP1 human genomes, and controlled access data for all HMP2 projects is also linked from the DCC. Categories of data are colour coded, and the number of items in each dataset is indicated by the size of the circles.

Complementary host–microbiome interactions

Although each of the three HMP2 studies revealed new biology within their respective areas of health and disease, a surprising range of host–microbiome immune and ecological features were common among them. The combination of shotgun metagenomics, untargeted metabolomics, and immunoprofiling was particularly effective, as in all projects this subset of molecular measurements tended to efficiently capture interpretable host and microbial properties that are linked to disease. Conversely, genetic variants were generally difficult to link to the microbiome in such small populations, which were necessary in order to deeply profile multi-omics over time, and we anticipate host sequencing to be more useful when integrated into larger cross-sectional surveys. Another notable property was that, as in most microbiome studies, changes that occurred within individuals, populations, or phenotypes were often much smaller than baseline variation between individuals. This is particularly true at microbiome-relevant time scales, for which repeated measures as rapid as days to weeks were necessary to capture the most specific host–microbiome interactions. Health-associated microbiome interactions can thus manifest in extremely diverse ways among individuals, making a combination of large-scale population surveys with within-subject longitudinal profiles essential for understanding the mechanisms of microbiome-linked disease.

As a result, other aspects of host–microbiome interactions were highly localized and subject-specific within each of the three studies. In all three conditions, microbial changes and associated host responses were strongest when captured at the time the changes occurred, and often within the tissue of origin. It is thus clear from these and other studies that host–microbiome interactions have both localized and systemic effects. Strong local perturbations initiated from either the host or microbial side can induce subsequent spatiotemporal responses that can continue over time and/or in other tissues, presumably with signals carried spatially by circulating small molecules and/or temporally by gene regulation or microbial growth, and involving regulatory circuits with both host and inter-microbial components. Continued coordinated efforts to measure the diverse host and microbial properties involved in each condition will thus be important for developing targeted and, when necessary, personalized therapies for microbiome-associated conditions, as well as for uncovering general principles that govern host–microbiome interactions. Other dynamic interactions that were not measured in all studies, such as an individual's first microbial exposures near birth and subsequent immune development, may also represent key contributors to baseline microbiome personalization and help to explain disease-linked dynamics based on events that took place years or even decades earlier.

Next steps in microbiome multi-omics

The collective results of the NIH HMP projects, alongside many other studies, show that the microbiome is an integral component of human biology, with a major role in health and well-being. Inter-individual variability and highly diverse host–microbiome responses over time have driven the development of new methods for population microbiome studies using multiple, complementary longitudinal measurements, as well as highlighting the need to follow such studies up with mechanistic models in order to validate causative associations. The successful close of the HMP program itself has left an enduring legacy of multiple scientific generations of trained human microbiome investigators; provided the resulting community with a wealth of data, analytical, and biospecimen resources; and positioned the NIH and other funding agencies to continue work in a broad range of microbiome-linked conditions[89]. Funding for microbiome science, human and otherwise, is now being coordinated among NIH Centers and Institutes (https://www.niaid.nih.gov/research/trans-nih-microbiome-working-group); other US government agencies including the National Science Foundation, Environmental Protection Agency, Department of Energy, National Institute of Standards and Technology, Department of Agriculture, National Oceanographic and Atmospheric Administration, National Aeronautics and Space Administration, and Department of Defense (https://commonfund.nih.gov/hmp/programhighlights); philanthropic organizations including the Bill and Melinda Gates Foundation, the March of Dimes, the Burroughs Wellcome Fund, the Sloan Foundation, the Keck Foundation, the Juvenile Diabetes Research Foundation, the Crohn's and Colitis Foundation, and others; and industry and public–private partnerships. Moreover, as complex global projects are launched to tackle aspects of personalized medicine, it is now obvious that it is informative to include components focused on the effect of the human microbiome.

As with any large study, the HMP2 has raised more new questions than it has answered. The aetiologies of baseline inter-individual differences in the microbiome, and of its dynamic changes over time, were not apparent even from the wide range of measurement types incorporated into these three studies and populations. Many immune and biochemical responses appear to be associated with specific strains that are unique to one or a few individual hosts, but it is not clear whether such strains are sufficient or necessary for their associated disease phenotypes. A few mechanisms were identified by which signals in the gut can be transmitted to systemic conditions such as diabetes, but not the specific small molecules or immune cell subsets by which they are likely to be transmitted—particularly in other health conditions that have not yet been studied in such detail. Finally, each HMP2 study was necessarily carried out within a geographically and genetically constrained population, and global differences in early life events, infectious disease exposure, or diet may change how microbiome dynamics contribute to human disease.

Human-associated microbiology now clearly extends beyond infectious and gastrointestinal diseases to areas barely imaginable a few decades ago, including metabolism, neoplasia, maternal and child health, and central nervous system function. As the NIH HMP comes to an end, it is clear that its results have revealed a multitude of new avenues of research and technologies for future investigation, and we look forward to new discoveries based on resources from the program and exciting findings yet to come.

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Contributions

All authors contributed manuscript text and created or edited figures. Individual HMP2 projects discussed were implemented and managed by J.M.F., G.A.B. and J.F.S. (PTB); J.L.-P. and C.H. (IBD); W.Z., M.P.S. and G.M.W. (T2D); H.H.C., A.M. and O.W. (DCC).

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Ethics declarations

Competing interests

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Additional information

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16.2: INFECTIOUS DISEASES AND SEXUALLY TRANSMITTED INFECTIONS

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16.2.1: Levels of Disease Prevention

Prevention includes a wide range of activities — known as “interventions” — aimed at reducing risks or threats to health. You may have heard researchers and health experts talk about three categories of prevention: primary, secondary and tertiary. What do they mean by these terms?

Primary prevention aims to prevent disease or injury before it ever occurs. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviours that can lead to disease or injury, and increasing resistance to disease or injury should exposure occur. Examples include:

- legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos) or to mandate safe and healthy practices (e.g. use of seatbelts and bike helmets)
- education about healthy and safe habits (e.g. eating well, exercising regularly, not smoking)
- immunization against infectious diseases.

Secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems. Examples include:

- regular exams and screening tests to detect disease in its earliest stages (e.g. mammograms to detect breast cancer)
- daily, low-dose aspirins and/or diet and exercise programs to prevent further heart attacks or strokes
- suitably modified work so injured or ill workers can return safely to their jobs.

Tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often-complex health problems and injuries (e.g. chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Examples include:

- cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
- support groups that allow members to share strategies for living well
- vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.

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16.2.2: Sexually Transmitted Infections

What are some types of sexually transmitted diseases or sexually transmitted infections (STDs/STIs)?

Approximately 20 different infections are known to be transmitted through sexual contact. Here are descriptions of some of the most common and well known:

- Chlamydia
- Gonorrhea
- Genital Herpes
- HIV/AIDS
- Human Papillomavirus (HPV)
- Syphilis
- Bacterial Vaginosis
- Trichomoniasis
- Viral Hepatitis

Chlamydia

Figure 16.2.2.1. Cervicitis and mucopurulent endocervical discharge in female chlamydial infection.

Chlamydia is a common STD/STI caused by the bacterium *Chlamydia trachomatis*. Chlamydia can be transmitted during vaginal, oral, or anal sexual contact with an infected partner. While many individuals will not experience symptoms, chlamydia can cause fever, abdominal pain, and unusual discharge of the penis or vagina.

In women, whether or not they are having symptoms and know about their infection, chlamydia can cause pelvic inflammatory disease (PID). In PID, the untreated STD/STI progresses and involves other parts of the woman's reproductive system, including the uterus and fallopian tubes. This progression can lead to permanent damage to the woman's reproductive organs. This damage may lead to ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

Additionally, if the woman is pregnant, her developing fetus is at risk, because chlamydia can be passed on during her pregnancy or delivery and could lead to eye infections or pneumonia in the infant. If chlamydia is detected early, it can be treated easily with an antibiotic taken by mouth.

Gonorrhea

Gonorrhea is caused by the bacterium Neisseria gonorrhoeae, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract. The most common symptoms of gonorrheal infection are a discharge from the vagina or penis and painful or difficult urination.

As with chlamydial infection, the most common and serious complications of gonorrhea occur in women and include pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and the potential spread to the developing fetus if acquired during pregnancy. Gonorrhea also can infect the mouth, throat, eyes, and rectum and can spread to the blood and joints, where it can become a life-threatening illness.

In addition, people with gonorrhea can more easily contract HIV, the virus that causes AIDS. HIV-infected people with gonorrhea are also more likely to transmit the virus to someone else.

Syphilis

Syphilis infections, caused by the bacterium Treponema pallidum, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres. Between 2001 and 2009, the Centers for Disease Control and Prevention (CDC) data show that the syphilis rate increased each year. Those people at highest risk for syphilis include men having sex with both men and women and people residing in the south. The first sign of syphilis is a chancre, a painless genital sore that most often appears on the penis or in and around the vagina. Beyond being the first sign of a syphilis infection, chancres make a person two to five times more likely to contract an HIV infection. If the person is already infected with HIV, chancres also increase the

likelihood that the virus will be passed on to a sexual partner. These sores typically resolve on their own, even without treatment. However, the body does not clear the infection on its own, and, over time, syphilis may involve other organs, including the skin, heart, blood vessels, liver, bones, and joints in secondary syphilis. If the illness is still not treated, tertiary syphilis can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.

Expectant mothers harboring the bacterium are at an increased risk of miscarriage and stillbirth, and they can pass the infection on to their fetuses during pregnancy and delivery. Infants that acquire congenital syphilis during pregnancy may suffer from skeletal deformity, difficulty with speech and motor development, seizure, anemia, liver disease, and neurologic problems.

STD/STI Data

CDC FACT SHEET

Reported STDs in the United States

2015 National Data for Chlamydia, Gonorrhea, and Syphilis

Many cases of chlamydia, gonorrhea, and syphilis continue to go undiagnosed and unreported, and data on several additional STDs — such as human papillomavirus, herpes simplex virus, and trichomoniasis — are not routinely reported to CDC. As a result, the annual surveillance report captures only a fraction of the true burden of STDs in America. However, it provides important insights into the scope, distribution, and trends in STD diagnoses in the country.

STDs are a substantial health challenge facing the United States. CDC estimates that nearly **20 million new sexually transmitted infections** occur every year in this country, half among young people aged 15–24, and account for almost $16 billion in health care costs. Each of these infections is a potential threat to an individual's immediate and long-term health and well-being. In addition to increasing a person's risk for acquiring and transmitting HIV infection, STDs can lead to chronic pain and severe reproductive health complications, such as infertility and ectopic pregnancy.

Figure 16.2.2.2. How STD's Affect Populations in the United States

Figure 16.2.2.3. Ages affected by chlamydia and gonorrhea infections

Genital Herpes

Genital herpes is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2. When symptomatic, HSV-1 usually appears as fever blisters or cold sores on the lips, but it can also infect the genital region through oral-genital or genital-genital contact. Symptomatic HSV-2 typically causes painful, watery skin blisters on or around the genitals or anus. However, substantial numbers of people who carry these viruses have no or only minimal signs or symptoms.

Neither HSV-1 nor HSV-2 can be cured, and even during times when an infected person has no symptoms, the virus can be found in the body's nerve cells. Periodically, some people will experience outbreaks in which new blisters form on the skin in the genital area; at those times, the virus is more likely to be passed on to other people.

Pregnant women, especially those who acquire genital herpes for the first time during pregnancy, may pass the infection to their newborns, causing life-threatening neonatal HSV, an infection affecting the infant's skin, brain, and other organs.

HIV/AIDS

HIV, or the human immunodeficiency virus, is the virus that causes AIDS (acquired immunodeficiency syndrome). HIV destroys the body's immune system by killing the blood cells that fight infection. Once HIV destroys a substantial proportion of these cells (CD4 cells), the body's ability to fight off and recover from infections is compromised. This advanced stage of HIV infection is known as AIDS.

The CD4 count is like a snapshot of how well your immune system is functioning. CD4 cells (also known as CD4+ T cells) are white blood cells that fight infection. The more you have, the better. These are the cells that the HIV virus kills. As HIV infection progresses, the number of these cells declines. When the CD4 count drops below 200 due to advanced HIV disease, a person is diagnosed with AIDS. A normal range for CD4 cells is about 500-1,500. Usually, when a person with low CD4 cells starts HIV

medicines, the CD4 cell count increases as the HIV virus is controlled. Most, but not all, people will experience an increase in CD4 cells with effective HIV treatment.

People whose HIV has progressed to AIDS are very susceptible to opportunistic infections that do not normally make people sick and to certain forms of cancer.

AIDS can be prevented by early initiation of antiretroviral therapy in those with HIV infection. Transmission of the virus primarily occurs during unprotected sexual activity and by sharing needles used to inject intravenous drugs, although the virus also can spread from mother to infant during pregnancy, delivery, and breastfeeding.

In 2013, NIH-supported researchers reported that a 2-year-old child who was born with HIV and was treated starting in the first few days of life has had her HIV infection go into remission. This appears to be the first case of functional cure of HIV.

Human Papillomavirus (HPV)

HPV is the most common STD/STI. More than 40 HPV types exist, and all of them can infect both men and women. The types of HPVs vary in their ability to cause genital warts; infect other regions of the body, including the mouth and throat; and cause cancers of the cervix, vulva, penis, and mouth.

Although no cure exists for HPV infection once it occurs, regular screening with a Pap smear test can prevent or detect at an early stage most cases of HPV-caused cervical cancer. (A Pap smear test involves a health care provider taking samples of cells from the cervix during a standard gynecologic exam; these cells are examined under a microscope for signs of developing cancer).

A newly available vaccine protects against most (but not all) HPV types that cause cervical cancer. The American Academy of Pediatrics recommends this vaccine for school-aged boys and girls.

Bacterial Vaginosis

Bacterial vaginosis is a common, possibly sexually transmitted, vaginal infection in women of reproductive age. While it is healthy and normal for a vagina to have bacteria, just like the skin, mouth, or gastrointestinal (GI) tract, sometimes changes in the balance of different types of bacteria can cause problems.

Bacterial vaginosis occurs when problematic bacteria that are normally present only in small amounts increase in number, replace normal vaginal lactobacilli bacteria, and upset the usual balance. This situation becomes more likely if a woman douches frequently or has new or multiple sexual partners. The most common sign of a bacterial vaginosis infection is a thin, milky discharge that is often described as having a “fishy” odor. However, some women will have no symptoms at all.

Regardless of symptoms, having bacterial vaginosis increases the risk of getting other STDs/STIs and is also associated with pelvic inflammatory disease (PID), an infection of the female reproductive organs, including the uterus and the fallopian tubes (which carry eggs to the uterus), and postoperative infections. Preterm labor and birth are also possibly more common in women with bacterial vaginosis.

Trichomoniasis

Trichomoniasis infection is caused by the single-celled protozoan parasite Trichomonas vaginalis and is common in young, sexually active women. The parasite also infects men, though less frequently. The parasite can be transmitted between men and women as well as between women whenever physical contact occurs between the genital areas.

Although *Trichomonas* infections do not always cause symptoms, they can cause frequent, painful, or burning urination in men and women as well as vaginal discharge, genital soreness, redness, or itching in women. Because the infection can occur without symptoms, a person may be unaware that he or she is infected and continue to re-infect a sexual partner who is having recurrent signs of infection. As with bacterial STDs/STIs, all sexual partners should be treated at the same time to avoid re-infection.

NICHD-sponsored research has shown that during pregnancy, Trichomonas infection is associated with an increased risk of premature birth and infants with low birth weight. Moreover, infants born to mothers with Trichomonas infection are more than twice as likely as infants born to uninfected women to be stillborn or to die as newborns.

Viral Hepatitis

Viral hepatitis is a serious liver disease that can be caused by several different viruses, which can be transmitted through sexual

contact.

- Hepatitis A virus (HAV) causes a short-term or self-limited liver infection that can be quite serious, although it does not result in chronic infection. While there are other ways the virus can be transmitted, HAV can be spread from person to person during sexual activity through oral-rectal contact. Vaccination can prevent HAV infection.
- Hepatitis B virus (HBV) causes a serious liver disease that can result in both immediate illness and lifelong infection leading to permanent liver scarring (cirrhosis), cancer, liver failure, and death. HBV spreads through both heterosexual and homosexual contact as well as through contact with other bodily fluids, such as blood, through shared contaminated needles used for injecting intravenous (IV) drugs, tattooing, and piercing. Pregnant women with HBV can transmit the virus to their infants during delivery. HBV infection is preventable through vaccination.
- Hepatitis C virus (HCV) can cause an immediate illness affecting the liver, but it more commonly becomes a silent, chronic infection that leads to liver scarring (cirrhosis), cancer, liver failure, and death. HCV is most commonly transmitted through sharing needles or exposure to infected blood. However, it can spread through sexual contact or from mother to fetus during pregnancy and delivery. There is no vaccine for HCV, and treatments are not always effective.

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16.2.3: STD/STI Treatments

Treatments for Specific Types of Sexually Transmitted Diseases and Sexually Transmitted Infections (STDs/STIs)

- Gonorrhea and Chlamydia
- Genital Herpes
- Human Papillomavirus (HPV)
- Syphilis
- Bacterial Vaginosis
- Trichomoniasis
- Viral Hepatitis
- HIV/AIDS
- During Pregnancy

Gonorrhea and Chlamydia

Gonorrhea and chlamydia are bacterial STDs/STIs that can be treated with antibiotics given either orally or by injection. Because the infections often occur together, people who have one infection are typically treated for both by their health care provider. Recent sexual partners should be treated at the same time.

Genital Herpes

Genital herpes outbreaks can be treated with antiviral drugs. Although this medication can limit the length and severity of outbreaks, it does not cure the infection. In addition, daily suppressive therapy (daily use of antiviral medication) for herpes can reduce the likelihood of transmission to partners. A pregnant woman known to have the infection must take additional care because she can pass the infection to her infant during delivery. Women who first acquire genital HSV during pregnancy are at highest risk of transmission to their infants. If a pregnant woman has an outbreak when she goes into labor, she may need to have a cesarean section (C-section) to prevent the infant from getting the virus during birth.

Human Papillomavirus (HPV)

A person who has an HPV infection cannot be cured. However, many HPV infections can be prevented with vaccination. Furthermore, a health care provider can treat genital warts caused by the virus as well as monitor and control a woman's risk of cervical cancer through frequent screening with Pap smear tests.

Syphilis

If recognized during the early stages, usually within the first year of infection, syphilis can be treated with a singular intramuscular injection of antibiotic. A person being treated for syphilis must avoid sexual contact until the chancre sores caused by the bacteria are completely healed to avoid infecting other people.

If a person does not recognize the infection early, or does not seek treatment immediately, longer treatment with antibiotics may be required. If left untreated, the infection can progress even further and potentially cause death. Although antibiotics can prevent the infection from getting worse, they cannot reverse damage that has already occurred.

Bacterial Vaginosis

Bacterial vaginosis can be treated with antibiotics, typically metronidazole or clindamycin. Generally, male sexual partners of women with bacterial vaginosis do not need to be treated because treatment of partners has not been shown to reduce the risk of recurrence. Treatment during pregnancy is recommended primarily for women at risk for preterm labor or having a low birthweight infant.

Trichomoniasis

Trichomoniasis can be treated with a single dose of an antibiotic, usually either metronidazole or tinidazole, taken by mouth. Often, *Trichomonas* infection recurs, so it is important to make sure that both you and your sexual partners are treated if you are diagnosed with this infection.

Viral Hepatitis

- Hepatitis A virus (HAV) infects the liver and may cause abdominal pain, nausea, and vomiting. Usually the infection gets better on its own without requiring treatment. In some cases, however, individuals may have lasting damage to their livers or may have such severe nausea and vomiting that they must be admitted to the hospital.
- Hepatitis B virus (HBV) can cause a lifelong infection but can be treated with antiviral medications. People with HBV infection will need to see a liver specialist with experience treating individuals with chronic liver disease. These individuals need to take special care not to pass on the virus to their sexual partners, and sexual partners should receive hepatitis B vaccine if not already immune.
- Hepatitis C virus can cause immediate illness affecting the liver or, more commonly, it can be a silent, chronic infection. As with hepatitis B, individuals with HCV may have a lifelong infection and will always be at risk of passing the virus on to their sexual partners. New treatments are available that can clear the infection in some individuals.

More information about hepatitis A, B, and C can be found on the Centers for Disease Control and Prevention website.

HIV/AIDS

There is no cure for HIV/AIDS. However, research into new treatments has improved outcomes for people living with the disease. A combination of antiretroviral drugs can be given in highly active antiretroviral therapy to control the virus, promote a healthy immune system, help people with the virus live longer lives, and reduce the risk of transmission.

During Pregnancy

Pregnant women who have certain types of STDs/STIs may pass them on to their infants during pregnancy or delivery. Therefore, it is important for women to be tested for such STDs/STIs as part of their early prenatal care to help ensure delivery of a healthy infant. The specific treatment will depend on which STD/STI is involved.

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16.2.4: STD/STI Prevention- How to Prevet STI's

Every year, there are an estimated 20 million new sexually transmitted infections in the United States. Anyone who is sexually active can get an STI. Some groups are disproportionately affected by STI's:

- Adolescents and Young Adults
- Gay, Bisexual, & other Men who have Sex with Men
- Some Racial and Ethnic Minorities

The Good News: STI's ARE preventable. There are steps you can take to keep yourself and your partner(s) healthy. Here's How You Can Avoid (or reduce the risk of) giving or getting an STI:

Practice Abstinence

The surest way to avoid STI's is to not have sex. This means not having vaginal, oral, or anal sex.

Use Condoms

Using a condom correctly every time you have sex can help you avoid STI's. Condoms lessen the risk of infection for all STI's. **You still can get certain STI's, like herpes or HPV, from contact with your partner's skin even when using a condom.**

Most people say they used a condom the first time they ever had sex, but when asked about the last 4 weeks, less than a quarter said they used a condom every time.

Step by step male condom instructions

Have Fewer Partners

Agree to only have sex with one person who agrees to only have sex with you. Make sure you both get tested to know for sure that neither of you has an STI. This is one of the most reliable ways to avoid STI's.

Get Vaccinated



Figure 16.2.4.1. Get Vaccinated!

The most common STI can be prevented by a vaccine. The HPV vaccine is safe, effective, and can help you avoid HPV-related health problems like genital warts and some cancers.

Who should get the HPV vaccine?

- Routine vaccination for boys & girls ages 11 to 12

Catch-up vaccination for:

- Young women ages 13 to 26 and young men ages 13 to 21
- Gay, Bisexual, & other Men who have sex with Men up to age 26
- Men with compromised immune systems up to age 26

Talk With Your Partner

Talk with your sex partner(s) about STI's and staying safe before having sex. It might be uncomfortable to start the conversation, but protecting your health is your responsibility.

Get Tested

Many STI's don't have symptoms, but they can still cause health problems.

- Talk with your health care provider
- Search for CDC recommended tests
- Find a location to get tested for STDs

The only way to know for sure if you have an STI is to get tested.

If You Test Positive...

If either you or your partner is infected with an STI that can be cured (remember, some STI's cannot be cured), both of you need to start treatment immediately to avoid getting re-infected.

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16.2.5: What are infectious diseases?

Infectious diseases are distinguished from other illnesses and disorders because they can be transmitted from someone who is ill either directly or indirectly to other individuals, who then develop the same infectious disease and are also able to pass it on. A familiar example is the 'common cold' which almost everyone has experienced at some time in their lives (Figure 16.2.5.1). Non-human animals and plants also suffer from infectious diseases, which cause massive losses to food crops and livestock, but our focus in this course is on infection in humans.

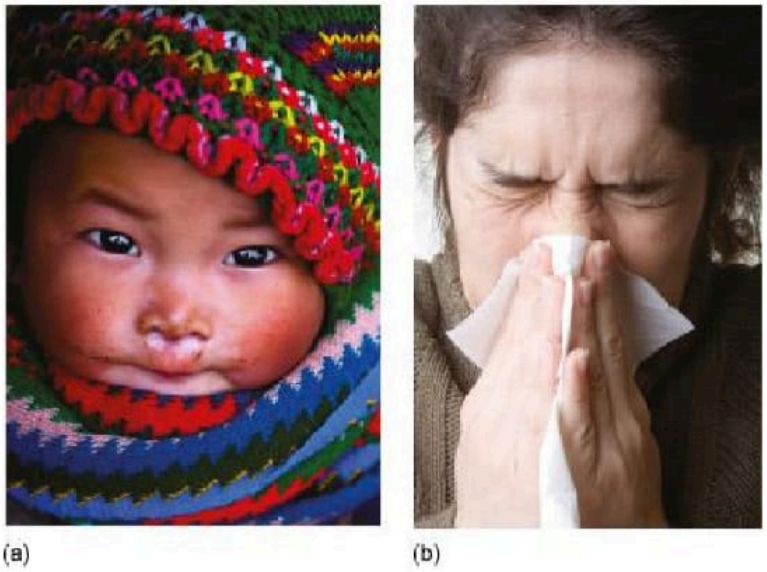


Figure 16.2.5.1. The common cold affects children and adults all over the world: (a) a child from Vietnam. (b) an adult in the United States

By contrast, health problems that cannot be transmitted between individuals, such as heart disease, diabetes, lung cancer, arthritis and depression, are known as non-communicable diseases (or NCDs). However, a few NCDs also have an infectious component, for example:

- in most cases of cervical cancer there is evidence of infection with a specific virus (the human papilloma virus, or HPV)
- hepatitis viruses cause liver disease and cancer of the liver
- a bacterium (Helicobacter pylori) causes stomach ulcers.

These examples illustrate the point that there is some overlap between some infectious and non-communicable diseases. For completeness, we should mention here that the third major category of diseases, disorders and disabilities is termed injuries, i.e. physical damage to the body caused by accidents or violence.

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16.2.6: Symptoms and signs of infection

Symptoms are sensations in the body that only the person who is unwell can experience; for example, a headache, pain in the abdomen, blurred vision and nausea are all symptoms, because no one but the sufferer can experience them. Lay people, including children, can usually describe their symptoms accurately or report them if asked the right questions, but symptoms are subjective experiences that others cannot observe or verify.

By contrast, the signs of a disease are indicators of illness that other people can observe (e.g. a runny nose and frequent sneezing). Considering the symptoms and signs together may give enough information for a trained health care worker to make a diagnosis, i.e. identify the underlying cause of the illness and give it a definite name.

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16.2.7: What causes infectious diseases?

Infectious diseases are transmitted between individuals by infectious agents, known as pathogens [path-oh-jens], from the Greek word *pathos* (to suffer) and *genès* (to produce). Pathogens produce a lot of human suffering and disability across the world, including in relatively wealthy nations like the United States. Most people have heard of at least some types of pathogen, for example bacteria or viruses.

The wider causes of infectious diseases range from insanitary living conditions in impoverished communities, to inadequate hygiene in the high-tech environments of modern hospitals (Figure 16.2.7.1). The impact of infectious diseases is therefore unequally distributed around the world, not only between countries, but also between individuals and groups within the same population.



Figure 16.2.7.1. Infectious diseases are a threat everywhere: (a) A shanty settlement without piped water or sanitation in Indonesia. (b) Testing for pathogens in a hospital laboratory in England.

Human biology is another factor to consider in explaining the cause of infectious diseases. Infancy and old age, inadequate nourishment, other illnesses and some types of medication can all create conditions in the body in which infection is more easily established. In addition, there are individual human behaviors, habits and traditional practices that contribute to the causes of infectious diseases by spreading pathogens from one person to another. These behaviors give some clues about the routes by which pathogens can be transmitted, as the next section describes.

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16.2.8: Direct person-to-person transmission of pathogens

A new infection begins when pathogens leave the body of their host – the infected individual in which the pathogens are multiplying – and enter a new host. They may be repelled by defense mechanisms (i.e. skin) in the new host, or they may survive and reproduce in sufficient numbers to cause an infectious disease.

Transmission of pathogens can occur directly between people, or indirectly in the air, water or food, or via other animals to humans, or from sources in the environment. In this section we explore direct transmission.

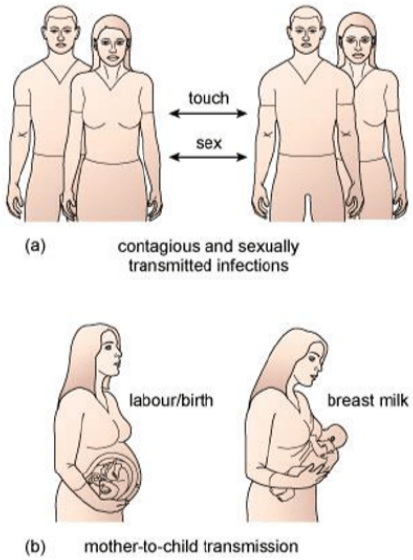


Figure 16.2.8.1. Direct person-to-person transmission of infection. (a) Contagion and sexual transmission. (b) Mother-to-child transmission.

Figure 16.2.8.1 represents the three ways in which pathogens can be transmitted by direct person-to-person contact. They are:

- Contagious infection, when touch, such as a handshake, transfers pathogens to a susceptible person; they may enter the new host through a cut or graze, or be transferred from hand to mouth.
- Sexually transmitted infection (or STI) involving infected semen, vaginal secretions, saliva or blood transmitting pathogens to the infected individual's partner during unprotected sex. This is the most common route for the worldwide spread of HIV (the human immunodeficiency virus), which causes AIDS (acquired immune deficiency syndrome). Sexual transmission is more likely if the partner's genitals, mouth or rectum are inflamed, for example, by another STI such as gonorrhea [gonn-or-ree-ah] or syphilis [siff-ill-iss].
- Mother-to-child transmission, when pathogens pass from mother to baby during labor and delivery, or via breast milk.

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16.2.9: Indirect person-to-person transmission of pathogens

Indirect person-to-person transmission occurs when the original host sheds pathogens into the air, water, food or objects in the environment, which then infect someone else (Figure 16.2.9.1).

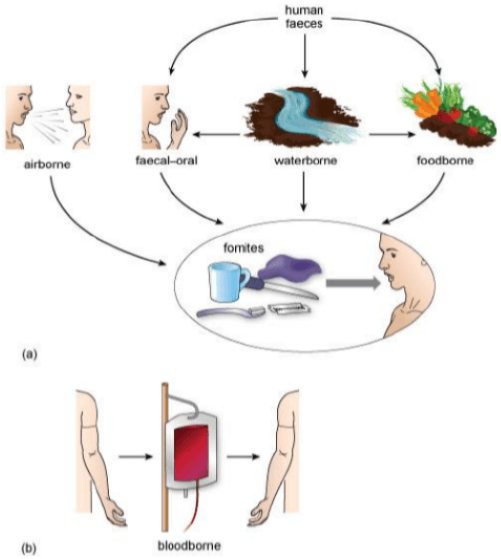


Figure 16.2.9.1. There are many routes for indirect person-to-person transmission of infection. Most airborne infections are transmitted when a cough or sneeze expels fine droplets of water (known as an aerosol) containing millions of bacteria or viruses. The aerosol droplets may be inhaled by a susceptible person, or settle on surfaces where the pathogens contaminate hands, utensils, clothing, water or food, which are then touched or consumed by someone else.



Figure 16.2.9.2. Coughs and sneezes spread diseases!

Waterborne infections are particularly common in parts of the world where large numbers of people don't have access to clean drinking water or safe disposal of sewage. Infected urine and feces from humans and animals can wash into lakes and streams, where the pathogens multiply and re-infect people when they drink or bathe in contaminated water. Some pathogens (including the bacteria that cause cholera, a serious diarrheal disease) live naturally in environmental water sources, so they will always pose a threat to health.

Fecal–oral infections (refer to solid waste, or excrement) occur when pathogens from feces enter the mouth and multiply in the

gut. Transmission occurs when unclean hands, dirty cooking utensils or food contaminated by feces enters the mouth. Flies can transfer pathogens from feces to food via their feet. Contact with feces is unavoidable when people are forced to defecate in the open because there is no sanitation. In these cases, people can get contaminated soil on their hands and the pathogens are easily transmitted from hand to mouth if there is no clean water or soap for hand washing.

Diarrheal diseases are often transmitted via the fecal–oral route, and some (e.g. cholera) are mainly waterborne. But they may also be due to foodborne infections caused by pathogens that originated in food components, for example, pathogenic bacteria in raw meat, eggs and on salad leaves.

Non-living objects in the environment, such as cups, spoons and door handles that people routinely touch, can also transmit infection and are known collectively as fomites [fohmytz]. Clothing can also act as a fomite, which is why hospital doctors rarely wear neckties that could drape across a patient during a medical examination and pick up infection that the next patient might acquire.

Medical procedures can also transmit bloodborne infections; for example, before the transmission of HIV was understood, thousands of infections occurred from HIVcontaminated blood transfusions. Bloodborne pathogens can also spread via shared needles and syringes among people who inject illegal drugs, such as heroin.

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16.2.10: Animal-to-human transmission of pathogens

Pathogens are often transmitted from animals to humans 'accidentally', for example via infected meat or water contaminated with animal feces. But there are two transmission routes in which the animal is an essential agent in the transfer of pathogens to humans. An example of zoonosis that may be familiar is influenza originating in pigs (swine flu) or poultry (bird flu). The influenza viruses that cause these diseases can sometimes be transmitted from animals to humans during the slaughter or handling of livestock. Some zoonotic influenza viruses pose a much greater health risk than the airborne seasonal influenza viruses that commonly circulate in human populations every winter.

Another route of transmission from animals to humans results in vector-borne infections. They differ from zoonoses in that they are transmitted by an invertebrate animal (without a backbone), mainly biting insects and ticks. The term 'vector' [vek-torr] comes from the Latin word for 'carrier', so in this context it means a carrier of an infectious disease. The pathogen must complete part of its life cycle in the vector, so transmission to humans may be prevented if the vectors can be killed. For example, Lyme disease is caused by a bacteria transmitted from birds or small mammals (such as deer) to humans by a type of tick.

There are many other vector-borne infections, including bubonic plague transmitted by rat fleas, typhus transmitted by ticks, and yellow fever transmitted by mosquitoes. In 2014, the World Health Organization– the branch of the United Nations responsible for coordinating and directing international policy and actions on health – devoted its annual 'World Health Day' to publicize the risk from vector-borne infections.

Emerging infectious diseases

Emerging infectious diseases (EIDs) is the collective term for a group of conditions that pose new threats to human health. EIDs can be distinguished into three types:

- New infectious diseases caused by previously unknown pathogens: Many of the diseases in this category are caused by zoonotic viruses, i.e. the viruses originated in other vertebrate animals, but at some point in the past they changed in ways that made them infectious to people. The best known 'new' infectious disease is AIDS but the virus that causes AIDS (HIV) may have originated in monkeys. Since HIV was identified in 1984, several other new infectious diseases caused by potentially fatal viruses have been identified. They include SARS (Severe Acute Respiratory Syndrome,), which may have originated in poultry, MERS (Middle East Respiratory Syndrome), which may have originated in camels, and zoonotic strains of influenza (swine flu and bird flu).
- Infectious diseases that have spread far outside their original range: One example is Ebola virus disease (EVD), a 'haemorrhagic' [hemm-orr-adj-ik] fever, which means it causes severe internal bleeding, among other symptoms. Cases have occurred from time to time in remote villages in West Africa, but the first urban cases were detected in the capital of Guinea in February 2014 and from there Ebola quickly spread to neighbouring Liberia and Sierra Leone. A few travellers or health workers caring for Ebola patients developed the disease in other countries, including Nigeria, Mali, Senegal and the USA. By October 2015, over 11 000 deaths had occurred from over 28 000 suspected, probable and confirmed cases (Centers for Disease Control and Prevention, 2015). Many of these cases have not been confirmed in a laboratory, so the 'case fatality rate' (the proportion of confirmed infected people who die) is unknown; however, it is likely to fall within the range of 30 to 60 per cent.

Previously declining infectious diseases that have resurged: Tuberculosis and some other infections caused by bacteria are a growing health concern because the causative pathogens are becoming increasingly resistant to antibiotics, which previously treated them successfully. So-called 'hospital super-bugs' are bacteria that have developed resistance to antibiotics in health care facilities, where antibiotics are heavily prescribed. An additional factor in countries where HIV/AIDS is common is that infection with HIV suppresses the body's immune defenses, so people with AIDS are more susceptible to other infections, including TB.

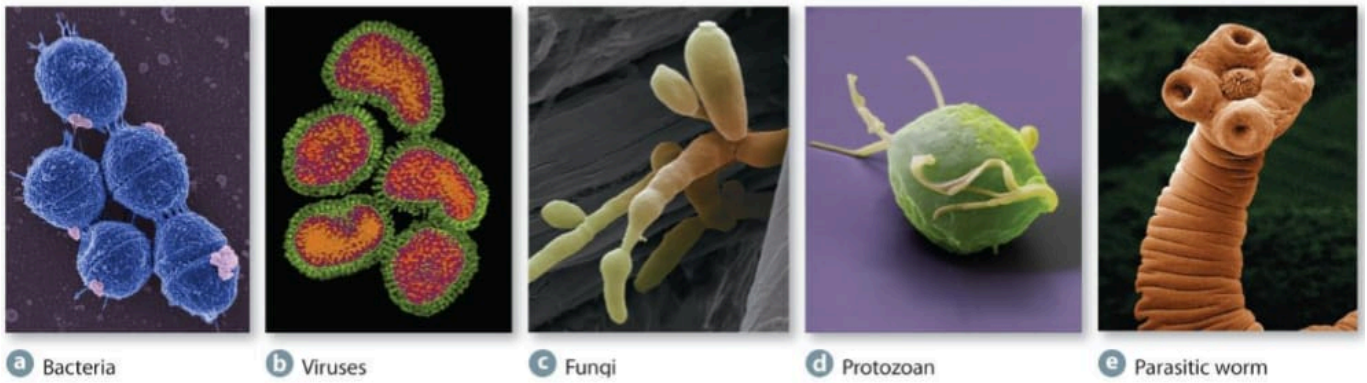


Figure 16.2.10.1. Examples of Five Major Types of Pathogens

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16.2.11: Immune Defenses Against Infectious Diseases

Natural barriers against pathogens

The physical and chemical barriers that prevent pathogens from getting into our body tissues in the first place are often overlooked. As Figure 6 shows, the most comprehensive barrier is the waterproof layer of skin that covers the body's surface. Human skin keeps most pathogens out as long as it remains intact. The speed with which a cut or graze can become infected is a reminder of the protection we normally get from our skin.

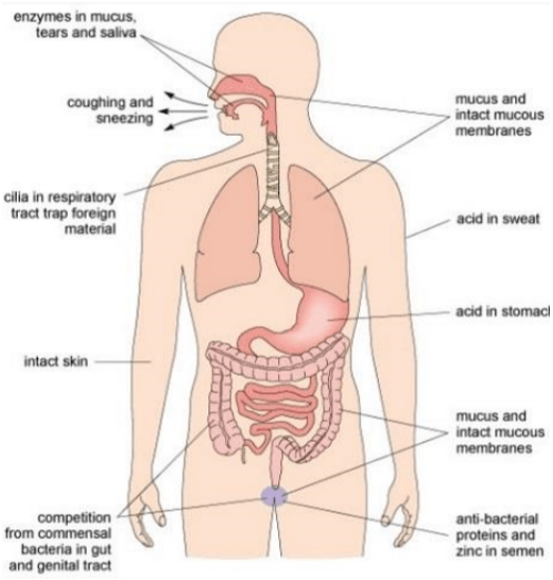


Figure 16.2.11.1. Physical and chemical barriers against infection

Vector-borne infections (e.g. malaria) are transmitted by biting invertebrates (e.g. mosquitoes) penetrating the skin when taking a blood meal. Humans are also vulnerable to invasion by pathogens in the air, food, water and soil, or during physical contact with infected people, some animals (e.g. pigs, dogs, poultry) or their feces. As Figure 16.2.11.1 illustrates, the inner surface of the respiratory system (nose, throat, airways and lungs), stomach, intestines, bladder and reproductive tract are lined with membranes that secrete jelly-like mucus, presenting a barrier against pathogens entering our tissues via these routes. Microscopic hairs called cilia [sill-ee-ah] line the respiratory system and 'beat' in unison to shunt mucus containing trapped pathogens towards the nose and mouth, where they can be expelled by coughing and sneezing, or swallowed into the stomach where acid destroys them.

Chemical barriers against infection include enzymes in tears, saliva and mucus that break down the surface of bacteria. The acid in sweat and in the stomach kills cellular pathogens and there are anti-bacterial proteins in semen (the fluid that contains male sperm). The more complex mechanisms of the immune system are only needed if pathogens breach these physical and chemical barriers.

The immune response to infection

The human immune system is an extremely complex network of interacting cells and biological molecules. The aim here is simply to give you an overview of how an immune response to infection develops, without going into too much detail. It occurs in three overlapping stages, the first of which is triggered when body cells are damaged. When tissues are injured, the damaged cells release chemicals that trigger the sequence of events described as inflammation. It occurs in response to any type of injury, such as a blow or a cut, an insect bite, or damage caused by pathogens multiplying in body tissues. Inflammation has four characteristic effects at the site of an injury, the first two of which are visible around the splinter shown in Figure 16.2.11.2:

- swelling

- redness
- heat
- pain



Figure 16.2.11.2. Inflammation of the tissues around a splinter

The inflamed area shows these signs because the local blood vessels dilate (get wider), increasing blood flow into the injury site, so it looks red as well as feeling warmer than the surrounding tissue. The walls of the blood vessels near the injury become leaky, allowing fluid, defensive proteins and immune system cells (described shortly) to flood into the area, which becomes swollen as a result. One of the proteins released during the inflammatory response also makes the area more sensitive to painful stimuli, so inflamed tissue is sore to touch.

Sites of tissue injury are vulnerable to invasion by pathogens so the benefits of inflammation generally outweigh the discomfort it causes. Flooding the area with fluid dilutes any pathogens that are already present, and the local concentration of immune system cells and defensive proteins enables an immune response to begin more quickly.

Leukocytes: the cells of the immune system

Once the barriers to infection have been breached and inflammation has begun, the active agents of the immune system, the *leukocytes* [loo-koh-sites], get to work. Leukocytes are often described as 'white blood cells' to distinguish them from the red blood cells that transport oxygen around the body; however, calling them 'blood' cells is misleading because leukocytes roam throughout the body tissues and only spend part of their lives in the bloodstream. In fact, they spend more time in the lymphatic system (Figure 16.2.11.3), the network of fine tubules that collect tissue fluid from all over the body and return it to the bloodstream.

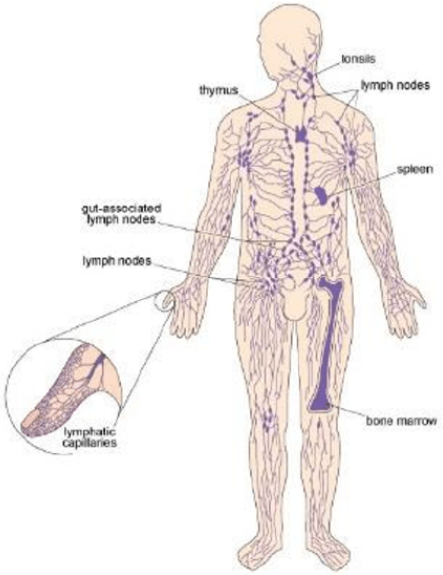


Figure 16.2.11.3. The human lymphatic system

The lymphatic system includes specialized organs and tissues where leukocytes develop. During an immune response to pathogens, we may become aware of swollen lymph nodes (popularly called 'glands') in the neck, armpits or groin, which enlarge

when the leukocytes they contain are multiplying near a site of infection.

Leukocytes can distinguish between 'self', the cells and proteins generated by the organism whose body they patrol, and 'non-self' (or 'foreign') material such as pathogens that originated outside the host's body. Leukocytes are *self-tolerant*, i.e. they do not normally attack the host's own cells or body proteins, but direct their actions only against non-self material that may pose a threat.

Although we have referred to 'the' immune response, as if it was just one thing, in fact, there are two types of immune response, distinguished as *innate* and *adaptive* immunity.

Innate immunity

All animals, even those with much simpler bodies than our own (e.g. parasitic worms) respond to tissue damage in ways that resemble inflammation in humans. They have cells similar to leukocytes and defensive proteins that flood into areas of tissue damage or infection. These leukocytes and proteins can defend the organism from pathogens because they recognize common patterns of molecules that occur in the structures of many different types of pathogens. These pathogen 'signature' molecules are known as PAMPs, or *pathogen-associated molecular patterns*.

The fact that PAMPs are commonly found in unrelated pathogens means that the leukocytes that recognize them cannot tell one type of pathogen from another. This *non-specific* immune response against pathogens is so widespread among animals that it is described as innate immunity ('innate' means 'inborn'). Some texts use the alternative term 'natural' immunity.

The leukocytes involved in innate immunity are of two general types, each with a different action against pathogens:

- Cytotoxic [sigh-toh-tox-ik] leukocytes, which simply means 'cell poisoning' (the prefix 'cyto' denotes a cell). These leukocytes have various methods of attaching to the outside of a pathogen and releasing destructive chemicals onto its surface. Worm larvae, bacteria and protists can all be killed this way.
- Phagocytic [fag-oh-sit-ik] leukocytes (the prefix 'phago' comes from a Greek word meaning 'to eat'), often abbreviated to phagocytes [fag-oh-sigh-tz]. These leukocytes engulf small pathogens such as bacteria, drawing them into the cytosol where destructive chemicals break them down. This action is termed phagocytosis [fag-ohsigh-toh-siss].

The anti-pathogen activities of certain specialized proteins are important contributors to the innate immune response. They include proteins that accelerate inflammation, target leukocytes onto pathogens or make host cells resistant to invasion by viruses. Their concentration increases rapidly in the bloodstream during an infection and this rise can be detected in blood tests as a diagnostic sign of infection.

In summary, all animals have innate immunity based on cells similar to human leukocytes and defensive proteins that defend the organism against pathogens 'in general' in a nonspecific way, i.e. these defenses cannot distinguish between one type of pathogen and another. Humans and other warm-blooded animals have an additional defensive capability called adaptive immunity, which differentiates specifically between pathogens, as the next section describes.

Adaptive Immunity

Adaptive immunity is due to the actions of two types of specialized leukocytes, known as T cells and B cells. (If you are interested, the letters denote 'thymus' and 'bone marrow', the tissues where each of these leukocytes mature.) We will describe their individual contributions to the adaptive immune response shortly, but first we focus on the most striking difference between innate and adaptive immunity. The clue lies in the word 'adaptive'.

T cells and B cells have recognition methods that distinguish between different pathogens (e.g. different species of bacteria), and they *adapt* during their first encounter with a particular pathogen. The second time they meet it in the body, the adaptive response begins earlier, lasts longer and is more effective than it was on the first occasion.

So, there is a much faster and increased response to a subsequent encounter with a pathogen and this demonstrates the adaptability of the immune system. This response is due to the production of long-lived memory cells that circulate in the body after the primary adaptive immune response subsides. These memory cells are specifically programmed to recognize the *same* pathogens that triggered the primary response if they ever get into the body again.

Antigens and the specific recognition of pathogens

Every type of pathogen has at least one (often many more) unique molecules known as antigens in their structure. In addition to

the PAMPs (pathogen-associated molecular patterns) shared by many different pathogens, each type of pathogen also has its own unique distinctive antigens. Each individual T cell and B cell (the leukocytes responsible for adaptive immunity) is programmed to recognize just one specific antigen, so it follows that each T or B cell can usually recognize only one type of pathogen, or at most two or three closely related pathogens that have very similar antigens. Recognition of an antigen by these adaptive leukocytes triggers an immune response against only those pathogens with that antigen in their structure. The political slogan 'One person, one vote' springs to mind as an analogy for 'One adaptive leukocyte, one target'!

Antibodies and B cells

Antibodies are very large proteins that contribute to adaptive immunity. A distinguishing feature of antibodies is that their structure includes at least two binding sites for antigens. B cells produce antibodies and also use them as their antigen receptors. The B cells carry antibodies embedded by the 'tail' in their outer cell membrane, with the binding sites facing outwards. This enables the B cell to bind to antigens that fit the binding sites in the antibodies it carries on its surface. This binding event is essential (but not sufficient on its own) to activate B cells into making a lot more antibody molecules that recognize the same antigen. These antibodies are released by the B cells and circulate in the bloodstream, tissue fluids and the lymphatic system. Antibodies are also abundant in the mucus membranes lining the respiratory system, the gut and the reproductive system, i.e. the sites in the body in contact with substances such as air, food, drinking water and sexual fluids that could contain pathogens.

Antibodies are often portrayed in the media as if they were 'magic bullets' that attack pathogens, but in fact they are more like 'waving flags' with a message that reads 'here is a pathogen – come and destroy it'. When antibodies bind to a pathogen, they simply label it for destruction by leukocytes with the innate ability to phagocytose (engulf) it, or cytotoxic (cell-killing) leukocytes and defensive proteins. You can think of them as recruiting the cells and defensive proteins of the innate immune system to join the attack. We conclude this tour of adaptive immunity by describing the T cells.

T cells in adaptive immunity

There are two types of T cells with different roles in adaptive immunity. The cytotoxic T cells release destructive chemicals onto their target's outer surface in much the same way as the cytotoxic leukocytes do in an innate immune response. But there is one crucial difference. Cytotoxic T cells are programmed to kill the body's *own* cells that have become infected by viruses or by the few types of bacteria and single-celled pathogens that can 'hide' inside the cells of their host (*Mycobacterium tuberculosis*, the bacteria that cause TB, can do this). Without the cytotoxic T cells, we woud be particularly susceptible to infectious diseases caused by these pathogens.

The other T cell type is called the **helper T cells**. They send activation signals to all the other leukocytes involved in inflammation, phagocytosis, cytotoxicity or production of antibodies by B cells. Recognition of a pathogen by binding to it is only the first step. The other leukocytes cannot take action against the pathogens they encounter without activation signals from the helper T cells.

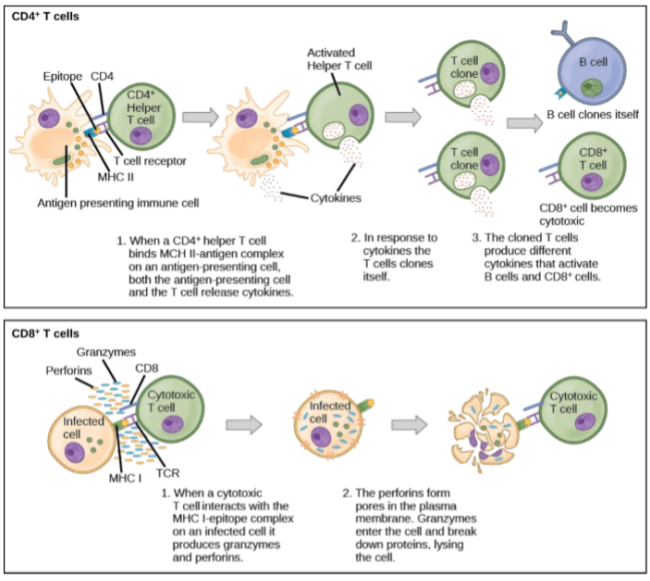


Figure 16.2.11.4. The Cell-Mediated Immune Response

Vaccination

Vaccination relies on the development of immunological memory for its protective effect. Vaccines contain killed pathogens, or extracts from pathogens, or modified strains of pathogens that are no longer harmful. For example, the MMR vaccine contains weakened (the technical term is 'attenuated') variants of the three viruses that cause measles, mumps and rubella (Figure 16.2.11.5).



Figure 16.2.11.5. The MMR vaccine contains live attenuated strains of measles, mumps and rubella viruses.

Note that each of the memory cells and the T cells and B cells generated in an adaptive immune response are specifically directed against just one type of pathogen or a very closely related strain. Vaccination with MMR vaccine is only protective against measles, mumps and rubella infection.

Despite decades of effort, medical science has so far been unable to produce effective vaccines against a number of important infectious diseases, including HIV/AIDS and other sexually transmitted infections (although trials of several candidate vaccines are underway). Vaccines against malaria have shown some potential, but they only protected about half the vaccinated children in large-scale African trials. There are no effective vaccines against infections caused by any other single-celled or multicellular parasites.

Some vaccines are effective only for a relatively short time, e.g. cholera vaccines give protection for only around six months. Others, such as the tetanus vaccine, need repeated booster doses. Annual influenza vaccinations are offered to vulnerable groups in the population because influenza viruses alter their antigens over time.

Opposition to vaccination

Another major challenge is parental opposition to vaccination because of concerns about vaccine safety. Some parents are understandably anxious about taking a healthy child to be given a vaccine derived from infectious agents. Most vaccines are injected, which can be a frightening and painful experience for a child. Of even greater concern is that some children experience a negative reaction to a vaccine, most often inflammation around the injection site and/or a mild fever lasting a day or two, but rare instances of more severe reactions such as convulsions sometimes occur.

Hesitancy about vaccinating a child is increased if parents have no experience of the disease the vaccine prevents, because it has become rare in communities with high vaccine coverage. Some parents conclude that vaccination is unnecessary and might expose their children to an avoidable risk.

Negative rumors about a vaccine are another deterrent. For example, the myth that vaccination is a Western plot to sterilize Muslim children has deterred parents in northern Nigeria, Pakistan and Afghanistan from allowing their children to be vaccinated against polio (Figure 16.2.11.6). Terrorist attacks have occurred against polio vaccination teams in all three countries – the only remaining locations where polio had not been eradicated by the WHO target of 2015.



Figure 16.2.11.6. Negative rumors about the oral polio vaccine did not deter this Nigerian child's parents from bringing her for vaccination.

An inevitable consequence of falling vaccination rates in a community is an increase in infections, sometimes with fatal outcomes. In 2014, the WHO warned that progress on eliminating measles had stalled and the number of deaths had begun to rise – from 122 000 in 2012 to 145 700 in 2013.

Countries urgently need to prioritize maintaining and improving immunization coverage. Failure to reverse this alarming trend could jeopardize the momentum generated by a decade of achievements in reducing measles mortality.

Even in countries where over 90% of children are fully vaccinated, uptake rates can plummet under pressure from negative rumors. For example, false claims in 1998 that the MMR vaccine caused autism led to a sustained fall in vaccinations in the United States and United Kingdom, followed by a significant rise in measles cases and, to a lesser extent, mumps. The largest outbreak of measles around Wales in 2012–13 caused more than 1200 cases and one death (Public Health Wales, 2013). Once parents saw the reality of measles infection and the misery and discomfort it causes, a rapid increase in uptake of the MMR vaccine followed the outbreak. The memory of infection fades in well-protected communities, until an outbreak reminds everyone of how devastating infectious diseases can be.

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16.2.12: Risk Factors and Levels of Disease Prevention

What is a Risk Factor?

Part of learning how to take charge of your health requires understanding your risk factors for different diseases. Risk factors are things in your life that increase your chances of getting a certain disease. Some risk factors are beyond your control. You may be born with them or exposed to them through no fault of your own.

Some risk factors that you have little or no control over include your:

- Family history of a disease
- Sex/gender — male or female
- Ancestry

Some risk factors you can control include:

- What you eat
- How much physical activity you get
- Whether you use tobacco
- How much alcohol you drink
- Whether you misuse drugs

In fact, it has been estimated that almost 35 percent of all U.S. premature deaths in 2000 could have been avoided by changing just three behaviors:

- Stopping smoking
- Eating a healthy diet (eating more fruits and vegetables and less red meat)
- Getting more physical activity

You can have one risk factor for a disease or you can have many. The more risk factors you have, the more likely you are to get the disease. For example, if you eat healthy, exercise on a regular basis, and control your blood pressure, your chances of getting heart disease are less than if you are diabetic, a smoker, and inactive. To lower your risks, take small steps toward engaging in a healthy lifestyle, and you'll see big rewards.

People with a family health history of chronic disease may have the most to gain from making lifestyle changes. You can't change your genes, but you can change behaviors that affect your health, such as smoking, inactivity, and poor eating habits. In many cases, making these changes can reduce your risk of disease even if the disease runs in your family. Another change you can make is to have screening tests, such as mammograms and colorectal cancer screening. These screening tests help detect disease early. People who have a family health history of a chronic disease may benefit the most from screening tests that look for risk factors or early signs of disease. Finding disease early, before symptoms appear, can mean better health in the long run.

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16.2.13: Immunity and Immunizations

In 2010, a pertussis (whooping cough) outbreak in California sickened 9,143 people and resulted in 10 infant deaths: the worst outbreak in 63 years (Centers for Disease Control 2011b). Researchers, suspecting that the primary cause of the outbreak was the waning strength of pertussis vaccines in older children, recommended a booster vaccination for 11–12-year-olds and also for pregnant women (Zacharyczuk 2011). Pertussis is most serious for babies; one in five needs to be hospitalized, and since they are too young for the vaccine themselves, it is crucial that people around them be immunized (Centers for Disease Control 2011b). Several states, including California, have been requiring the pertussis booster for older children in recent years with the hope of staving off another outbreak.

But what of people who do not want their children to have this vaccine, or any other? That question is at the heart of a debate that has been simmering for years. Vaccines are biological preparations that improve immunity against a certain disease. Vaccines have contributed to the eradication and weakening of numerous infectious diseases, including smallpox, polio, mumps, chicken pox, and meningitis.

However, many people express concern about potential negative side effects from vaccines. These concerns range from fears about overloading the child's immune system to controversial reports about devastating side effects of the vaccines. One misapprehension is that the vaccine itself might cause the disease it is supposed to be immunizing against.

Another commonly circulated concern is that vaccinations, specifically the MMR vaccine (MMR stands for measles, mumps, and rubella), are linked to autism. The autism connection has been particularly controversial. In 1998, a British physician named Andrew Wakefield published a study in Great Britain's Lancet magazine that linked the MMR vaccine to autism. The report received a lot of media attention, resulting in British immunization rates decreasing from 91 percent in 1997 to almost 80 percent by 2003, accompanied by a subsequent rise in measles cases (Devlin 2008). A prolonged investigation by the British Medical Journal proved that not only was the link in the study nonexistent, but that Dr. Wakefield had falsified data in order to support his claims (CNN 2011). Dr. Wakefield was discredited and stripped of his license, but the doubt still lingers in many parents' minds.

In the United States, many parents still believe in the now discredited MMR-autism link and refuse to vaccinate their children. Other parents choose not to vaccinate for various reasons like religious or health beliefs. In one instance, a boy whose parents opted not to vaccinate returned home to the U.S. after a trip abroad; no one yet knew he was infected with measles. The boy exposed 839 people to the disease and caused 11 additional cases of measles, all in other unvaccinated children, including one infant who had to be hospitalized. According to a study published in Pediatrics (2010), the outbreak cost the public sector $10,376 per diagnosed case. The study further showed that the intentional non-vaccination of those infected occurred in students from private schools, public charter schools, and public schools in upper-socioeconomic areas (Sugerman et al. 2010).

Consider these questions about immunization:

- Should parents be forced to immunize their children?
- How does this story of vaccines in a high-income region compare to that in a low-income region, like sub-Saharan Africa, where populations are often eagerly seeking vaccines rather than refusing them?
- Do you believe all children should receive vaccinations?

Immunity and Immunizations

Shots may hurt a little... but the diseases they can prevent can hurt a lot more! Immunization shots, or vaccinations, are essential. They protect against things like measles, mumps, rubella, hepatitis B, polio, diphtheria, tetanus and pertussis (whooping cough). Immunizations are important for adults as well as for children. Here's why.

Your immune system helps your body fight germs by producing substances to combat them. Once it does, the immune system "remembers" the germ and can fight it again. Vaccines contain germs that have been killed or weakened. When given to a healthy person, the vaccine triggers the immune system to respond and thus build immunity.

Before vaccines, people became immune only by actually getting a disease and surviving it. Immunizations are an easier and less risky way to become immune.

Optional Learning Activity

Take action to raise awareness of immunizations (e.g., Assist a school nurse to host an immunization education event for parents at a local school)

- Create and distribute an immunization reminder flyers to all the members of your organization, club or place of worship.

Vaccines

Vaccines are the best defense we have against serious, preventable, and sometimes deadly contagious diseases. Vaccines are some of the safest medical products available, but like any other medical product, there may be risks. Accurate information about the value of vaccines as well as their possible side-effects helps people to make informed decisions about vaccination.

Federal law requires that Vaccine Information Statements explaining vaccine benefits and risks be handed out whenever (before each dose) certain vaccinations are given. Vaccine Information Statements are available in Spanish and many different languages. In addition, more detailed information describing the benefits and risks of a particular vaccine is available in the Prescribing Information from the Food and Drug Administration.

The following sections answer common questions asked about vaccines and how vaccines are tested and monitored to ensure they are safe and effective. These sections are currently available in English only.
Vaccines are held to the highest standard of safety. The United States currently has the safest, most effective vaccine supply in history. Vaccines undergo a rigorous and extensive evaluation program to determine a product's safety and effectiveness. If a vaccine does receive approval, it is continuously monitored for safety and effectiveness.

Many partners work together to make sure vaccines are safe. Government health scientists work with manufacturers, health care providers, academia, and global health groups such as the World Health Organization to build a comprehensive vaccine safety system. At the Department of Health and Human Services, primarily three agencies work on vaccine safety:

- Centers for Disease Control and Prevention (CDC)
- National Institutes of Health (NIH)
- Food and Drug Administration (FDA)

Vaccines undergo rigorous and extensive testing to determine their safety and effectiveness prior to approval. Following approval, FDA carefully monitors the quality of vaccines—all manufactured lots must pass tests before they can be used. Vaccine manufacturers also must follow strict manufacturing standards, and FDA conducts routine inspections of manufacturing sites.

Scientists from FDA and CDC work closely to monitor reports of vaccine side effects (adverse events) after they are approved and used widely. FDA and CDC take all reports seriously, and work together to evaluate and address any potential problems.

Learning Activity

Watch this video titled Get The Picture: Childhood Immunizations:

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

After talking with parents across the country, CDC put together this short video to help answer the tough questions that real moms had about childhood immunizations.

Understanding the importance of vaccines is crucial for you to protect your children's health. Read the script

- Did watching this video help you decide on whether or not to get your child immunized?
- Interview some parents to find out what they think about this issue.

Potential Side Effects

Vaccines, like all medical products, may cause side effects in some people. Most of these side effects are minor, such as redness or swelling at the injection site. Read further to learn about possible side effects from vaccines.

Any vaccine can cause side effects. For the most part these are minor (for example, a sore arm or low-grade fever) and go away within a few days.

Remember, vaccines are continually monitored for safety, and like any medication, vaccines can cause side effects. However, a decision not to immunize a child also involves risk and could put the child and others who come into contact with him or her at risk of contracting a potentially deadly disease.

How Well Do Vaccines Work?

Vaccines work really well. No medicine is perfect, of course, but most childhood vaccines produce immunity about 90–100% of the time.

What about the argument made by some people that vaccines don't work that well . . . that diseases would be going away on their own because of better hygiene or sanitation, even if there were no vaccines?

That simply isn't true. Certainly better hygiene and sanitation can help prevent the spread of disease, but the germs that cause disease will still be around, and as long as they are they will continue to make people sick.

All vaccines must be licensed (approved) by the Food and Drug Administration (FDA) before being used in the United States, and a vaccine must go through extensive testing to show that it works and that it is safe before the FDA will approve it. Among these tests are clinical trials, which compare groups of people who get a vaccine with groups of people who get a control. A vaccine is approved only if FDA makes the determination that it is safe and effective for its intended use.

If you look at the history of any vaccine-preventable disease, you will virtually always see that the number of cases of disease starts to drop when a vaccine is licensed. Vaccines are the most effective tool we have to prevent infectious diseases.

Prevention

Vaccines help the body's immune system prepare for future attacks. Vaccines consist of killed or modified microbes, parts of microbes, or microbial DNA that trick the body into thinking an infection has occurred. A vaccinated person's immune system attacks the harmless vaccine and prepares for invasions against the kind of microbe the vaccine contained. In this way, the person becomes immunized against the microbe: if re-exposure to the infectious microbe occurs, the immune system will quickly recognize how to stop the infection.

This section explains more in detail about how your immune system works to prevent you from getting sick. Knowing how your immune system works may help you understand how vaccines work with your immune system to protect you.

What is the Immune System?

The immune system is a network of cells, tissues, and organs that work together to defend the body against attacks by "foreign" invaders. These are primarily microbes—tiny organisms such as bacteria, parasites, and fungi that can cause infections. Viruses also cause infections, but are too primitive to be classified as living organisms. The human body provides an ideal environment for many microbes. It is the immune system's job to keep them out or, failing that, to seek out and destroy them.

When the immune system hits the wrong target, however, it can unleash a torrent of disorders, including allergic diseases, arthritis, and a form of diabetes. If the immune system is crippled, other kinds of diseases result.

The immune system is amazingly complex. It can recognize and remember millions of different enemies, and it can produce secretions (release of fluids) and cells to match up with and wipe out nearly all of them.

The secret to its success is an elaborate and dynamic communications network. Millions and millions of cells, organized into sets and subsets, gather like clouds of bees swarming around a hive and pass information back and forth in response to an infection. Once immune cells receive the alarm, they become activated and begin to produce powerful chemicals. These substances allow the cells to regulate their own growth and behavior, enlist other immune cells, and direct the new recruits to trouble spots.

In addition, scientists are rapidly unraveling the genetic blueprints that direct the human immune response, as well as those that dictate the biology of bacteria, viruses, and parasites. The combination of new technology and expanded genetic information will no doubt reveal even more about how the body protects itself from disease.

Mounting an Immune Response

Infections are the most common cause of human disease. They range from the common cold to debilitating conditions like chronic hepatitis to life-threatening diseases such as AIDS. Disease-causing microbes (pathogens) attempting to get into the body must first move past the body's external armor, usually the skin or cells lining the body's internal passageways.

The skin provides an imposing barrier to invading microbes. It is generally penetrable only through cuts or tiny abrasions. The digestive and respiratory tracts—both portals of entry for a number of microbes—also have their own levels of protection. Microbes entering the nose often cause the nasal surfaces to secrete more protective mucus, and attempts to enter the nose or lungs can trigger a sneeze or cough reflex to force microbial invaders out of the respiratory passageways. The stomach contains a strong acid that destroys many pathogens that are swallowed with food.

If microbes survive the body's front-line defenses, they still have to find a way through the walls of the digestive, respiratory, or urogenital passageways to the underlying cells. These passageways are lined with tightly packed epithelial cells covered in a layer of mucus, effectively blocking the transport of many pathogens into deeper cell layers.

Mucosal surfaces also secrete a special class of antibody called IgA, which in many cases is the first type of antibody to encounter an invading microbe. Underneath the epithelial layer a variety of immune cells, including macrophages, B cells, and T cells, lie in wait for any microbe that might bypass the barriers at the surface.

Next, invaders must escape a series of general defenses of the innate immune system, which are ready to attack without regard for specific antigen markers. These include patrolling phagocytes, natural killer T cells, and complement.

Microbes cross the general barriers then confront specific weapons of the adaptive immune system tailored just for them. These specific weapons, which include both antibodies and T cells, are equipped with singular receptor structures that allow them to recognize and interact with their designated targets.

Immunity

Long ago, physicians realized that people who had recovered from the plague would never get it again—they had acquired immunity. This is because some of the activated T and B cells had become memory cells. Memory cells ensure that the next time a person meets up with the same antigen, the immune system is already set to demolish it.

Immunity can be strong or weak, short-lived or long-lasting, depending on the type of antigen it encounters, the amount of antigen, and the route by which the antigen enters the body. Immunity can also be influenced by inherited genes. When faced with the same antigen, some individuals will respond forcefully, others feebly, and some not at all.

An immune response can be sparked not only by infection but also by immunization with vaccines. Some vaccines contain microorganisms—or parts of microorganisms— that have been treated so they can provoke an immune response but not full-blown disease.

Immunity can also be transferred from one individual to another by injections of serum rich in antibodies against a particular microbe (antiserum). For example, antiserum is sometimes given to protect travelers to countries where hepatitis A is widespread. The antiserum induces passive immunity against the hepatitis A virus. Passive immunity typically lasts only a few weeks or months.

Vaccines

For many years, healthcare providers have used vaccination to help the body's immune system prepare for future attacks. Vaccines consist of killed or modified microbes, parts of microbes, or microbial DNA that trick the body into thinking an infection has occurred.

A vaccinated person's immune system attacks the harmless vaccine and prepares for invasions against the kind of microbe the vaccine contained. In this way, the person becomes immunized against the microbe. Vaccination remains one of the best ways to prevent infectious diseases, and vaccines have an excellent safety record. Previously devastating diseases such as smallpox, polio, and whooping cough (pertussis) have been greatly controlled or eliminated through worldwide vaccination programs.

Recommended Vaccines for Young Adults

The transition to adulthood is an exciting time in a young person's life. Starting a career, getting an apartment, entering college, or joining the armed forces all offer unique rewards and challenges.

Yet young adults may not know that some vaccines can make this transitional time a healthier one.

Vaccines recommended for young adults ages 19–24 include:

- Meningococcal conjugate vaccine, which helps prevent meningococcal disease
- Tdap vaccine, which protects against tetanus, diphtheria, and pertussis (also known as whooping cough)
- HPV vaccine, which protects against the viruses that cause most cervical cancers, anal cancer, and genital warts
- Seasonal flu vaccine

There may be other vaccines recommended for young adults because their health, job, or lifestyle may put them at higher risk for certain diseases. Young adults should talk to a doctor or nurse to find out if there are other vaccines that they may need.

Learning Activity

Take this quiz to find out to find out which vaccines **YOU** may need.

Antibiotic / Antimicrobial Resistance

Antibiotics and similar drugs, together called antimicrobial agents, have been used for the last 70 years to treat patients who have infectious diseases. Since the 1940s, these drugs have greatly reduced illness and death from infectious diseases. Antibiotic use has been beneficial and, when prescribed and taken correctly, their value in patient care is enormous.

However, these drugs have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted to them, making the drugs less effective. People infected with antimicrobial-resistant organisms are more likely to have longer, more expensive hospital stays, and may be more likely to die as a result of the infection.

Sexually Transmitted Diseases and HIV

Sexually transmitted diseases (STDs) are infections that you can get from having sex with someone who has the infection. The causes of STDs are bacteria, viruses, and parasites. There are more than 20 types of STDs, including:

- Bacterial
  - Gonorrhea
- Viral
  - Genital herpes
  - HIV/AIDS
  - HPV
  - Syphilis
- Parasitic

- Trichomoniasis

Most STDs affect both men and women, but in many cases the health problems they cause can be more severe for women. If a pregnant woman has an STD, it can cause serious health problems for the baby.

If you have an STD caused by bacteria or parasites, your health care provider can treat it with antibiotics or other medicines. If you have an STD caused by a virus, there is no cure. Sometimes medicines can keep the disease under control. Correct usage of latex condoms greatly reduces, but does not completely eliminate, the risk of catching or spreading STDs.

Gonorrhea

Gonorrhea is a curable sexually transmitted disease. It is most common in young adults. The bacteria that cause gonorrhea can infect the genital tract, mouth or anus.

Gonorrhea does not always cause symptoms, especially in women. In men, gonorrhea can cause pain when urinating and discharge from the penis. If untreated, it can cause epididymitis, which affects the testicles and can lead to infertility. In women, gonorrhea can cause bleeding between periods, pain when urinating and increased discharge from the vagina. If untreated, it can lead to pelvic inflammatory disease, which causes problems with pregnancy and infertility. Gonorrhea can pass from mother to baby during pregnancy.

You can cure gonorrhea with antibiotics prescribed by your health care provider. Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading gonorrhea.

Genital Herpes

Genital herpes is a sexually transmitted disease (STD) caused by a herpes simplex virus (HSV). It can cause sores on your genital or rectal area, buttocks, and thighs. You can get it from having sex, even oral sex. The virus can spread even when sores are not present. Mothers can also infect their babies during childbirth.

Symptoms of herpes are called outbreaks. You usually get sores near the area where the virus has entered the body. They turn into blisters, become itchy and painful, and then heal. Sometimes people do not know they have herpes because they have no symptoms or very mild symptoms. The virus can be more serious in newborn babies or in people with weak immune systems.

Most people have outbreaks several times a year. Over time, you get them less often and the symptoms become milder. The virus stays in your body for life.

Medicines do not cure genital herpes, but they can to help your body fight the virus. This can help lessen symptoms, decrease outbreaks, and lower the risk of passing the virus to others. Correct usage of latex condoms can reduce, but not eliminate, the risk of catching or spreading herpes.

Learning Activity

Watch this video about Molly's story and herpes.

HPV (or genital warts)

Human papillomaviruses (HPV) are common viruses that can cause warts. There are more than 100 types of HPV. Most are harmless, but about 30 types put you at risk for cancer. These types affect the genitals and you get them through sexual contact with an infected partner. They are classified as either low-risk or high-risk. Low-risk HPV can cause genital warts. High-risk HPV can lead to cancers of the cervix, vulva, vagina, and anus in women. In men, it can lead to cancers of the anus and penis.

Although some people develop genital warts from HPV infection, others have no symptoms. Your health care provider can treat or remove the warts. In women, Pap smears can detect changes in the cervix that might lead to cancer.

Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading HPV. A vaccine can

protect against several types of HPV, including some that can cause cancer.

Trichomoniasis

Trichomoniasis is a sexually transmitted disease caused by a parasite. It affects both women and men, but symptoms are more common in women. Symptoms in women include a green or yellow discharge from the vagina, itching in or near the vagina and discomfort with urination. Most men with trichomoniasis don't have any symptoms, but it can cause irritation inside the penis.

You can cure trichomoniasis with antibiotics. In men, the infection usually goes away on its own without causing symptoms. But an infected man can continue to infect or reinfect a woman until he gets treated. So it's important that both partners get treated at the same time. Correct usage of latex condoms greatly reduces, but does not eliminate, the risk of catching or spreading trichomoniasis.

AIDS and HIV

AIDS was first reported in the United States in 1981 and has since become a major worldwide epidemic. AIDS is caused by the human immunodeficiency virus, or HIV. By killing or damaging cells of the body's immune system, HIV progressively destroys the body's ability to fight infections and certain cancers. People diagnosed with AIDS may get life-threatening diseases called opportunistic infections. These infections are caused by microbes such as viruses or bacteria that usually do not make healthy people sick.

Since 1981, more than 980,000 cases of AIDS have been reported in the United States to the Centers for Disease Control and Prevention (CDC). According to CDC, more than 1,000,000 Americans may be infected with HIV, one-quarter of whom are unaware of their infection. The epidemic is growing most rapidly among minority populations and is a leading killer of African-American males ages 25 to 44. According to CDC, AIDS affects nearly seven times more African Americans and three times more Hispanics than whites. In recent years, an increasing number of African-American women and children are being affected by HIV/AIDS.

- The U.S. HIV/AIDS epidemic began in 1981 and continues to disproportionately affect minorities, men who have sex with men of all races, women, and youth.
- More than 1 million people in the United States currently are living with HIV/AIDS.
- About 21 percent of those infected with HIV are unaware of their infection.
- Since the U.S. epidemic began, 617,025 people have died of AIDS.
- In 2008, there were approximately 42,439 new HIV infections, with the highest proportion among African Americans despite the fact that they make up only 12 percent of the U.S. population.

HIV

HIV stands for human immunodeficiency virus. It kills or damages the body's immune system cells. AIDS stands for acquired immunodeficiency syndrome. It is the most advanced stage of infection with HIV.
HIV most often spreads through unprotected sex with an infected person. It may also spread by sharing drug needles or through contact with the blood of an infected person. Women can give it to their babies during pregnancy or childbirth.

The first signs of HIV infection may be swollen glands and flu-like symptoms. These may come and go a month or two after infection. Severe symptoms may not appear until months or years later.

A blood test can tell if you have HIV infection. Your health care provider can perform the test.

There is no cure, but there are many medicines to fight both HIV infection and the infections and cancers that come with it. People can live with the disease for many years.

AIDS Prevention

Currently, there is no vaccine to prevent HIV infection nor is there a cure for HIV/AIDS. To reduce your risk of becoming infected with HIV or transmitting the virus to others

- Get tested regularly for HIV
- Practice abstinence
- Remain faithful to your spouse or partner
- Consistently use male latex or female polyurethane condoms
- Do not share needles

Detection and Treatment in HIV Prevention

Testing and treatment of sexually transmitted diseases (STDs) can be an effective tool in preventing the spread of HIV, the virus that causes AIDS. An understanding of the relationship between STDs and HIV infection can help in the development of effective HIV prevention programs for persons with high-risk sexual behaviors.

What is the link between STDs and HIV infection?

Individuals who are infected with STDs are at least two to five times more likely than uninfected individuals to acquire HIV infection if they are exposed to the virus through sexual contact. In addition, if an HIV-infected individual is also infected with another STD, that person is more likely to transmit HIV through sexual contact than other HIV-infected persons (Wasserheit, 1992).

There is substantial biological evidence demonstrating that the presence of other STDs increases the likelihood of both transmitting and acquiring HIV.

- **Increased susceptibility.** STDs appear to increase susceptibility to HIV infection by two mechanisms. Genital ulcers (e.g., syphilis, herpes, or chancroid) result in breaks in the genital tract lining or skin. These breaks create a portal of entry for HIV. Additionally, inflammation resulting from genital ulcers or non-ulcerative STDs (e.g., chlamydia, gonorrhea, and trichomoniasis) increase the concentration of cells in genital secretions that can serve as targets for HIV (e.g., CD4+ cells).
- **Increased infectiousness.** STDs also appear to increase the risk of an HIV-infected person transmitting the virus to his or her sex partners. Studies have shown that HIV-infected individuals who are also infected with other STDs are particularly likely to shed HIV in their genital secretions. For example, men who are infected with both gonorrhea and HIV are more than twice as likely to have HIV in their genital secretions than are those who are infected only with HIV. Moreover, the median concentration of HIV in semen is as much as 10 times higher in men who are infected with both gonorrhea and HIV than in men infected only with HIV. The higher the concentration of HIV in semen or genital fluids, the more likely it is that HIV will be transmitted to a sex partner.

How can STD treatment slow the spread of HIV infection?

Evidence from intervention studies indicates that detecting and treating STDs may reduce HIV transmission.

- **STD treatment reduces an individual's ability to transmit HIV**. Studies have shown that treating STDs in HIV-infected individuals decreases both the amount of HIV in genital secretions and how frequently HIV is found in those secretions (Fleming, Wasserheit, 1999).
- Herpes can make people more susceptible to HIV infection, and it can make HIV-infected individuals more infectious. It is critical that all individuals, **especially those with herpes**, know whether they are infected with HIV and, if uninfected with HIV, take measures to protect themselves from infection with HIV.
- Among individuals with both herpes and HIV, trials are underway studying if treatment of the genital herpes helps prevent HIV transmission to partners.

Learning Activity

Watch this video about AIDS from PBS.

Illness, Sickness, and Disease

Discussing the complexities of what constitutes a disease requires careful distinction among related, but distinct concepts.

In 1973, Susser, an epidemiologist, proposed some definitions that remain useful. He used “illness” to refer to the subjective sense of feeling unwell; illness does not define a specific pathology, but refers to a person’s subjective experience of it, such as discomfort, tiredness, or general malaise. The way a patient reports symptoms is influenced by his or her cultural background, and Susser applied the term “sickness” to refer to socially and culturally held conceptions of health conditions (e.g., the dread of cancer or the stigma of mental illness), which in turn influence how the patient reacts). The social perceptions of disease that Illich described modify the ways a patient perceives and presents his symptoms.

Cultural conventions likewise affect where the boundary between disease and non-disease is placed: menopause may be considered a health issue in North America, but symptoms are far less commonly reported in Japan. Disease implies a focus on pathological processes that may or may not produce symptoms and that result in a patient’s illness. For example, a patient complains of tiredness and malaise–his illness as he experiences it. He consults a doctor about it–because he believes that he might have a sickness. The doctor might attribute the patient’s symptoms to a thyroid condition–a disease.

This model focuses on pathological processes, and on understanding, diagnosing, and treating the physical and biological aspects of disease. The goal of treatment is to restore the patient’s physiological integrity and function. Diagnosis involves recognizing and applying a label to a pattern of signs and symptoms that is at least partly understood in terms of abnormal structure or function of cells, organs, and systems. This offers a rational basis for the investigation of effective treatments. For instance, a certain pattern of chest pain known as angina pectoris is understood biologically as a disorder of the coronary arteries that causes cardiac ischemia, and the treatments it are geared to the specific causes of restoring cardiac blood flow and reducing cardiac effort.

Early biomedical conceptions supposed that a disease is either present or absent: a bacterium has invaded the body or it has not. However, as medicine increasingly tackled conditions, such as hypertension, which represent deviations from normal values, which themselves have a range and can be debated, it became apparent that there may be no set threshold for defining disease. Thus, instead of being seen as a state that is qualitatively distinct from health, many diseases have to be approached as a quantitative threshold on a continuum of biological variability. Organizations such as the World Health Organization (WHO) and the National Institutes of Health have proposed different classifications of hypertension and have changed how they constitute hypertension over time. Hypertension can be mild, moderate or severe, or defined as pre-hypertension or hypertension stage 1 or stage 2.

Optional: Video Lectures about Epidemics

Epidemics in Western Society is a course taught Frank Snowden at Yale.

This course consists of video lectures with an international analysis of the impact of epidemic diseases on western society and culture from the bubonic plague to HIV/AIDS and the recent experience of SARS and swine flu.

Leading themes include:

- infectious disease and its impact on society
- the development of public health measures
- the role of medical ethics
- the genre of plague literature
- the social reactions of mass hysteria and violence
- the rise of the germ theory of disease
- the development of tropical medicine
- a comparison of the social, cultural, and historical impact of major infectious diseases
- the issue of emerging and re-emerging diseases

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17.1: BONUS- ENVIRONMENTAL WELLNESS - A HEALTHY PLANET

Learning Outcomes

By the end of this chapter you will be able to:

- Explain the relationship of CO2 to climate change.
- Provide evidence of climate change.
- Explain the impact of climate change on public health.
- List strategies for increasing health of the planet.

How are you impacting the environment?

How is the environment impacting you?

Mahatma Gandhi is quoted as saying, “Earth provides enough to satisfy every man’s needs, but not every man’s greed.” What was Gandhi trying to convey with that statement? Maybe, that the Earth does not have limitless resources for human consumption and that we as humans impact the health of the planet by the choices we make. All humans live on one planet, planet Earth. Some call Earth “Mother Earth” because Earth nurtures life just like a mother. Human societies throughout history have symbols and depictions of Earth as a nurturer since every species on Earth depends on the resources of the planet for existence. The relationship between humans and the environment is studied through a branch of public health known as **Environmental Health**. Environmental health seeks to understand how the environment impacts human health and how humans impact the health of the planet.

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- World Health Organization: *Climate Change*
- *National Institute for Environmental Health Sciences*

Note: This is bonus material, for the curious. It is not part of our course.

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17.1.1: Climate Literacy

Climate Science Literacy is an understanding of your influence on climate and climate's influence on you and society. It is important for each human living on earth to understand climate. Society needs citizens who understand the climate system and know how to apply that knowledge in their careers and in their engagement as active members of their communities.

A climate-literate person:

- Understands the essential principles of Earth's climate system.
  - Essential Principle 1: The Sun is the Primary Source of Energy for Earth's Climate System
  - Essential Principle 2: Climate is regulated by complex interactions among components of the Earth system.
  - Essential Principle 3: Life on Earth depends on, is shaped by, and affects climate.
  - Essential Principle 4: Climate varies over space and time through both natural and man-made processes.
  - Essential Principle 5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
  - Essential Principle 6: Human activities are impacting the climate system.
  - Essential Principle 7: Climate change will have consequences for the Earth system and human lives
- Knows how to assess scientifically credible information about climate.
- Communicates about climate and climate change in a meaningful way.
- Is able to make informed and responsible decisions with regard to actions that may affect climate.

This chapter is intended to help build your climate literacy.

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17.1.2: Climate Change and Global Warming

“Climate change” and “global warming” are often used interchangeably but have distinct meanings. Global warming is the long-term heating of Earth’s climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere. Climate change is long-term changes in the average weather patterns that have come to define Earth’s local, regional and global climates.

Global Warming: The Greenhouse Effect

Imagine stepping into a greenhouse. The temperature inside and outside of a greenhouse can be very different. Outside of a greenhouse you can feel the heat from the sun’s rays, but the heat can escape to the atmosphere, however, inside the greenhouse, the sun’s rays are turned to heat and the heat is trapped by the greenhouse. The way a greenhouse traps heat making it warmer inside than outside, is similar to how the greenhouse gases in the Earths atmosphere, such as CO2, trap heat and increase the temperature of the planet.

Earth is surrounded by the earth’s atmosphere, which is an envelope of gases surrounding the earth. The sun provides solar radiation to our planet that passes through the earths atmosphere. When the Sun’s solar rays hit our planet the solar radiation turns to heat. Gases in the atmosphere, such as carbon dioxide, nitrous oxide, methane, and water vapor, block heat from escaping, thus trapping in heat inside our atmosphere.

The trapping of heat is called the Greenhouse effect. Global warming refers to the recent and ongoing global average increase in temperature near the Earth’s surface. Scientists attribute the global warming trend observed since the mid-20th century to the “greenhouse effect.”

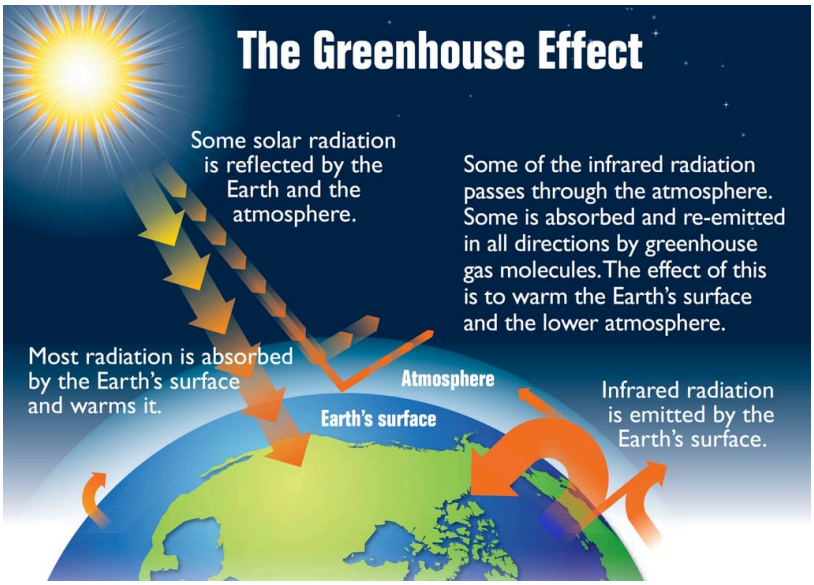


Figure 17.1.2.1**: The Greenhouse effect**

Evidence/Indicators of Climate Change

A picture is worth 1,000 words

Nasa has provided a library of "Images of Change" that show show a before and after comparison of land masses, glaciers, oceans, etc to depict how climate change is impacting the world around you. Some of the pictures show more recent changes, for example how the drought has changed Lake Powell, others show changes over time, such as the Muir Glacier Melt in Alaska.



Figure 17.1.2.2: Muir Glacier Melt, Alaska. 1941 compared to 2004

The Earth's climate is changing. Observations from around the world show the **widespread effects** of increasing greenhouse gas concentrations on Earth's climate. For example:

- High temperature extremes, droughts, and heavy precipitation events are becoming more frequent and intense.
- Glaciers and snow cover are shrinking, and sea ice is retreating.
- Seas are warming, rising, and becoming more acidic, and marine species are moving to new locations in colder waters.
- Flooding is becoming more frequent along the U.S. coastline.
- Growing seasons are lengthening, and areas burned by wildfire are growing.

The Environmental Protection Agency has compiled a key set of indicators[1] related to the causes and effects of climate change. The climate change indicators provide important information on how and why the climate is changing. These indicators include: greenhouse gases, weather and climate, oceans, snow and ice, health and society, and ecosystem

Greenhouse gases

Ice cores[2] are like frozen time capsules that allow scientists to reconstruct climate far into the past. Using ice cores, scientists have been able to measure greenhouse gas emissions from over 800,000 years ago. Ice cores provide a direct measurement of greenhouse gases thus are considered a gold standard. As greenhouse gas emissions from human activities increase, they build up in the atmosphere and warm the climate, leading to many other worldwide changes in the atmosphere, on land, and in the oceans. Greenhouse gases from human activities are the most significant driver of observed climate change since the mid-20th century.

Summary of key points:

- In the United States, greenhouse gas emissions caused by human activities increased by 2 percent from 1990 to 2019. Since 2005, however, total U.S. greenhouse gas emissions have decreased by 12 percent. Carbon dioxide accounts for most of the nation's emissions and most of the increase since 1990. Transportation is the largest source of greenhouse gas emissions in the United States, followed by electricity generation. Emissions per person have decreased slightly in the last few years.
- Worldwide, net emissions of greenhouse gases from human activities increased by 43 percent from 1990 to 2015. Emissions of carbon dioxide, which account for about three-fourths of total emissions, increased by 51 percent over this period. As with the United States, the majority of the world's emissions result from transportation, electricity generation, and other forms of energy production and use.
- Concentrations of carbon dioxide and other greenhouse gases in the atmosphere have increased since the beginning of the industrial era. Almost all of this increase is attributable to human activities. Historical measurements show that the current global atmospheric concentrations of carbon dioxide are unprecedented compared with the past 800,000 years, even after accounting for natural fluctuations.
- From 1990 to 2019, the total warming effect from greenhouse gases added by humans to the Earth's atmosphere increased by 45 percent. The warming effect associated with carbon dioxide alone increased by 36 percent.

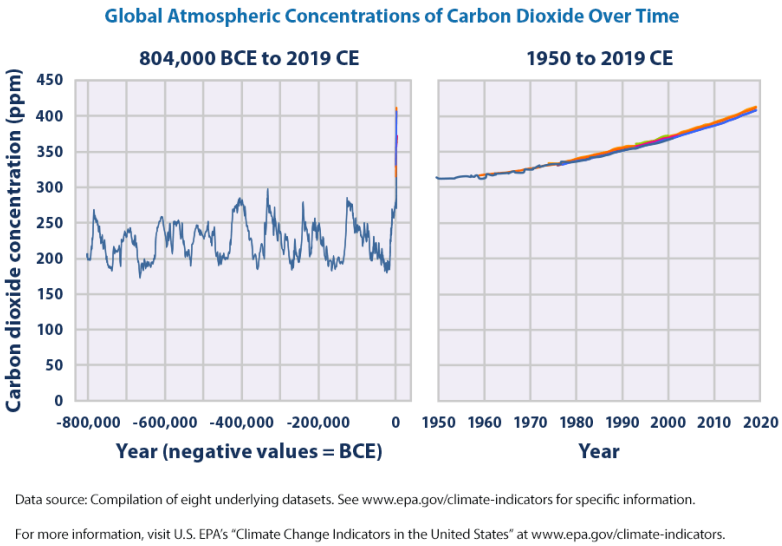


Figure 17.1.2.3: Global Atmospheric Concentrations of Greenhouse Gases

Weather and climate

Rising global average temperature is associated with widespread changes in weather patterns. Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere "behaves" over relatively long periods of time.

Summary of Key Points

- Average temperatures have risen across the contiguous 48 states since 1901, with an increased rate of warming over the past 30 years.
- Eight of the top 10 warmest years on record have occurred since 1998. All of the top 10 warmest years on record worldwide have occurred since 2005.
- Since 1896, average winter temperatures across the contiguous 48 states have increased by nearly 3°F. Spring temperatures have increased by about 2°F, while summer and fall temperatures have increased by 1.4°F.
- Record-setting daily high temperatures have become more common than record lows. Since the 1970s, unusually hot summer days (highs) and unusually hot summer nights (lows) have become more common over the last few decades. Unusually cold winter temperatures have become less common—particularly very cold nights (lows).
- Heat waves are occurring three times more often than they did in the 1960s—about six per year compared with two per year. The average heat wave season is 47 days longer, and individual heat waves are lasting longer and becoming more intense.
- Since 1901, precipitation has increased at an average rate of 0.1 inches per decade over land areas worldwide. However, shifting weather patterns have caused certain areas, such as the Southwest, to experience less precipitation than usual.
- The prevalence of extreme single-day precipitation events remained fairly steady between 1910 and the 1980s but has risen substantially since then. Nationwide, nine of the top 10 years for extreme one-day precipitation events have occurred since 1996.
- Floods have generally become larger across parts of the Northeast and Midwest and smaller in the West, southern Appalachia, and northern Michigan. Large floods have become more frequent across the Northeast, Pacific Northwest, and parts of the northern Great Plains, and less frequent in the Southwest and the Rockies.
- Drought trends vary by region, as the West has generally experienced more drought while the Midwest and Northeast have become wetter.
- The southwestern United States is particularly sensitive to changes in temperature and thus vulnerable to drought, as even a small decrease in water availability in this already arid region can stress natural systems and further threaten water supplies. Several measures indicate persistent and more severe drought conditions in recent years.

Oceans

Covering about 70 percent of the Earth's surface, the world's oceans have a two-way relationship with weather and climate. The oceans influence the weather on local to global scales, while changes in climate can fundamentally alter many properties of the oceans.

Summary of Key Points

- The amount of heat stored in the ocean has increased substantially since the 1950s. Ocean heat content not only determines sea surface temperature, but also affects sea level and currents.
- Sea surface temperatures have been consistently higher during the past three decades than at any other time since reliable observations began in the late 1800s.
- When averaged over all of the world's oceans, sea level has risen at a rate of roughly six-tenths of an inch per decade since 1880. Changes in sea level relative to the land vary by region. Along the U.S. coastline, sea level has risen the most along the Mid-Atlantic coast and parts of the Gulf coast, where several stations registered increases of more than 8 inches between 1960 and 2020. Sea level has decreased relative to the land in parts of Alaska and the Pacific Northwest.
- As sea level rises, dry land and wetlands can turn into open water. Along many parts of the Atlantic coast, this problem is made worse by low elevations and land that is already sinking. Between 1996 and 2011, the coastline from Florida to New York lost more land than it gained.
- Flooding is becoming more frequent along the U.S. coastline as sea level rises. Every site measured has experienced an increase in coastal flooding since the 1950s. The rate is accelerating at most locations along the East and Gulf coasts. The East Coast suffers the most frequent coastal flooding and has generally experienced the largest increases in the number of flood days.
- The ocean has become more acidic over the past few decades because of increased levels of atmospheric carbon dioxide, which dissolves in the water. Higher acidity affects the balance of minerals in the water, which can make it more difficult for certain marine animals to build their protective skeletons or shells.

Snow and Ice

The Earth's surface contains many forms of snow and ice, including sea, lake, and river ice; snow cover; glaciers, ice caps, and ice sheets; and frozen ground. Climate change can dramatically alter the Earth's snow- and ice-covered areas because snow and ice can easily change between solid and liquid states in response to relatively minor changes in temperature.

Summary of Key Points

- The part of the Arctic Ocean covered by ice is typically smallest in September, after the summer melting season. Arctic sea ice has decreased over time, and in September 2020 it was the second smallest ever recorded. The length of the melt season for Arctic ice has grown, and the ice has also become thinner, which makes it more vulnerable to further melting.
- Antarctic sea ice has increased slightly overall since 1979, though it has decreased in the last few years. Slight increases in Antarctic sea ice are outweighed by the loss of sea ice in the Arctic during the same time period.
- Since 1992, the giant ice sheets that cover Greenland and Antarctica have each lost more than 100 billion metric tons of ice per year on average. The total amount of ice lost from 1992 to 2018 was enough to raise sea level worldwide by an average of roughly seven-tenths of an inch.
- Glaciers in the United States and around the world have generally shrunk since the 1960s, and the rate at which glaciers are melting has accelerated over the last decade.
- Lakes in the northern United States are freezing later and thawing earlier compared with the 1800s and early 1900s.
- Since the early 1970s, all five of the Great Lakes have experienced a long-term decrease in the maximum area that freezes each year, but the decrease is only statistically meaningful in one lake (Superior). The number of frozen days per year has also decreased for all five lakes since the early 1970s.
- Total snowfall has decreased in most parts of the country since widespread records began in 1930. One reason for this decline is that nearly 80 percent of the locations studied have seen more winter precipitation fall in the form of rain instead of snow.
- Between 1972 and 2020, the average portion of North America covered by snow decreased at a rate of about 1,870 square miles per year, based on weekly measurements taken throughout the year. The length of time when snow covers the ground has become shorter by nearly two weeks since 1972, on average.
- The amount of snow on the ground (snowpack) in early spring decreased at 86 percent of measurement sites in the western United States between 1955 and 2020 and snowpack at all sites declined by an average of 19 percent during this time period.
- About 80 percent of Alaska's land is underlain by permafrost, which refers to rock or soil with ice that stays frozen for two or more years. Between 1978 and 2020, permafrost temperatures increased at 14 out of 15 long-term monitoring sites in Alaska.
- The number of days per year with unfrozen ground has increased at an average rate of about four days per decade in both the contiguous 48 states and Alaska. Unfrozen days have generally increased across North America, with some variability by region.

Health and Society

Changes in the Earth's climate can affect public health, agriculture, water supplies, energy production and use, land use and development, and recreation.

Summary of Key Points

- Since 1979, more than 11,000 Americans were reported to have died as a direct result of heat-related illnesses such as heat stroke, and even more died where heat was a contributing factor.
- From 2001 to 2010, a total of about 28,000 heat-related hospitalizations were recorded across 20 states.
- Since 1979, more than 19,000 Americans were reported to have died from exposure to cold temperatures, and even more died where exposure to cold was a contributing factor.
- As the U.S. climate has warmed in recent years Americans in the North and West are using less energy for heating and more energy for air conditioning, while much of the Southeast has experienced the opposite results.

- Since 1973, the average amount of electricity used by Americans at home during the summer has nearly doubled, but it appears to have leveled somewhat in recent years. Conversely, the average American's winter use of natural gas (the most common home heating fuel) has decreased since 1974.
- Nationwide, the rate of reported cases of Lyme disease has nearly doubled since 1991. The number and distribution of reported cases of Lyme disease have increased in the Northeast and upper Midwest over time, where some states now report 50 to 110 more cases of Lyme disease per 100,000 people than they did in 1991.
- The length of the growing season for crops and other plants has increased in almost every state. States in the Southwest (e.g., Arizona and California) have seen the most dramatic increase. In contrast, the growing season has become slightly shorter in two states (Alabama and Georgia). The observed changes reflect earlier spring warming as well as later arrival of fall frosts. The length of the growing season has increased more rapidly in the West than in the East.
- Since the late 1940s, the annual number of growing degree days increased at 75 percent of the locations measured across the contiguous 48 states. The average change was a 9 percent increase. The largest increases occurred in the West and the Northeast.
- The length of ragweed pollen season has increased at 10 out of 11 locations studied in the central United States and Canada since 1995 allowing ragweed plants to produce pollen later into the year, potentially prolonging the allergy season for millions of people.

Ecosystems

Ecosystems provide humans with food, clean water, and a variety of other services that can be affected by climate change.

Summary of Key Points

- Since 1983, the United States has had on average 70,000 recorded wildfires per year. The top 10 years with the largest acreage burned since 1983, have all occurred since 2004 with many of the largest increases occurring in western states.
- Over the past 79 years, minimum, maximum, and average streamflows have changed in many parts of the country—some higher, some lower. Among rivers and streams strongly influenced by snowmelt, peak flow from winter-spring runoff is happening at least five days earlier than it did in the mid-20th century.
- From 1960 through 2014, water temperature increased at 79 percent of the stream sites measured in the Chesapeake Bay region.
- Between 1960 and 2020, water temperatures increased by 1.9°F in the Snake River at a site on tribal lands in eastern Washington. Several species of salmon use the Snake River to migrate and spawn, and these salmon play an important role in the diet, culture, religion, and economy of the region's Native Americans.
- Since 1985, summer surface water temperatures have increased in 32 of the 34 lakes with long-term records that this indicator tracks across North America.
- Water levels in most of the Great Lakes appear to have declined slightly over the last few decades.
- Long-term studies have found that bird species in North America have shifted their wintering grounds northward by an average of more than 40 miles since 1966, with several species shifting by hundreds of miles. Some birds shift their range or alter their migration habits to adapt to changes in temperature or other environmental conditions.
- Shifts in location have occurred among several economically important fish and shellfish species that have moved about 20 miles, and 21 feet deeper in the water, between 1982 and 2018. For example, American lobster, black sea bass, and red hake in the Northeast have moved northward by an average of 113 miles.
- Leaf growth and flower blooms are examples of natural events whose timing can be influenced by climate change. In general, leaf and bloom events are happening earlier throughout the North and West but later in much of the South. for example, Cherry Blossom Bloom Dates in Washington, D.C. Peak bloom dates of the iconic cherry trees in Washington, D.C., recorded since the 1920s, indicate that cherry trees are blooming slightly earlier than in the past. Bloom dates are key to planning the Cherry Blossom Festival, one of the region's most popular spring attractions.

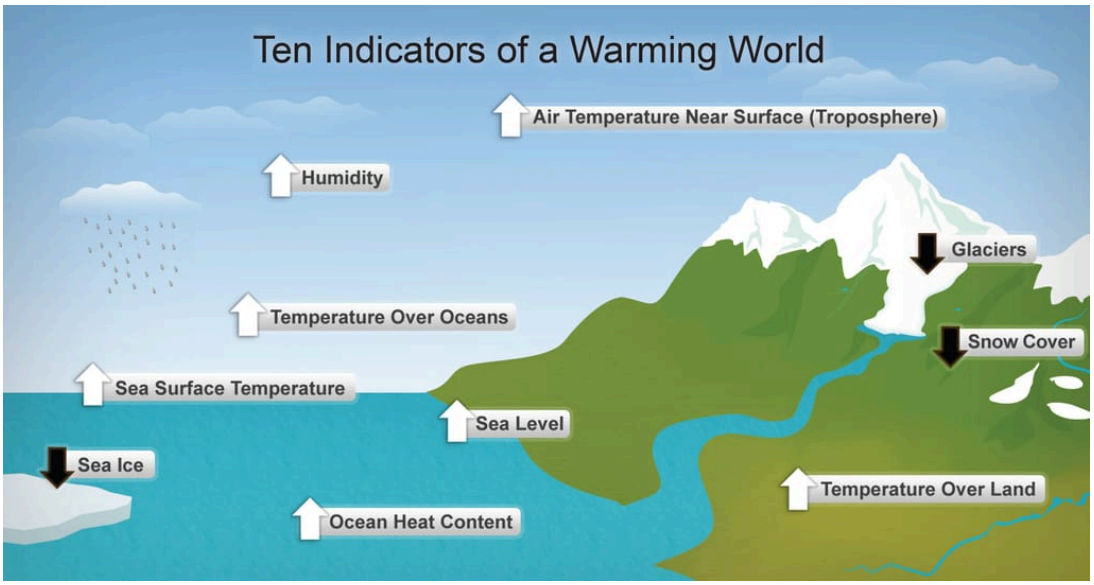


Figure 17.1.2.3: Ten Indicators of a Warming World

Exercises: Data, data, and more data

Are you curious how the U.S. compares to other countries in the various elements of climate change? Do you like looking at data and graphs? If so, check out "Our World in Data" to view extensive data and graphs on climate change for the U.S. and around the world.

Impacts of Climate Change on Human Health

Climate change is a significant threat to the health of the American people and every American is vulnerable to the health impacts associated with climate change. The U.S. Global Change Research Program's (USGCRP's) National Climate Assessment (NCA) process has published a scientific assessment on the impact of climate change on human health[3].

With climate change, the frequency, severity, duration, and location of weather and climate phenomena, like rising temperatures, heavy rains and droughts, and some other kinds of severe weather, are changing. This means that areas already experiencing health-threatening weather and climate phenomena are likely to experience worsening impacts, it also means that some locations will experience new climate-related health threats. Climate changes that impact human health include: wildfires, heat waves, drought, cold waves and winter storms, sea level changes, hurricanes, floods, extreme precipitation, and rising temperatures.

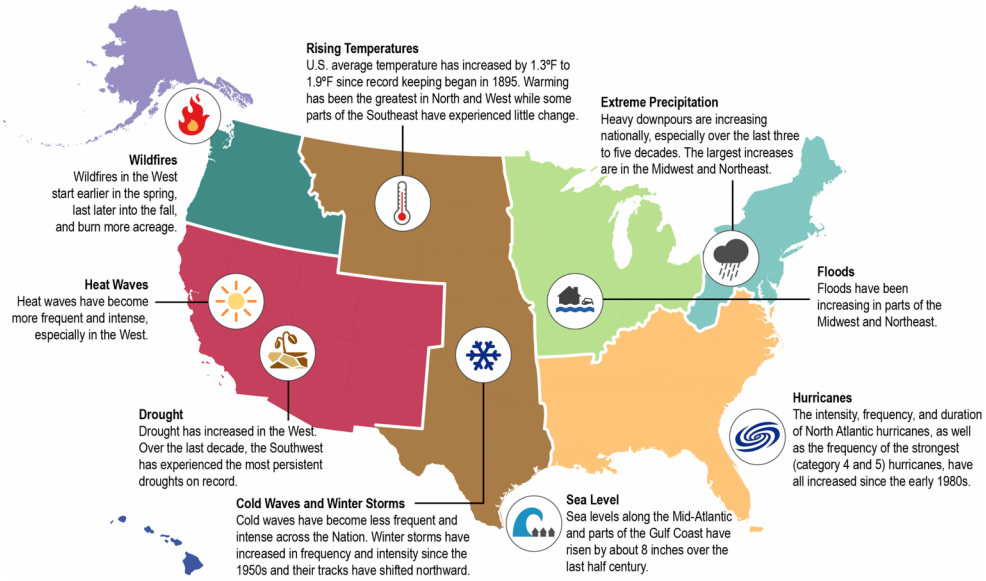


Figure 17.1.2.4: Major U.S. national and regional climate trends

Changes in the environment may have numerous impacts to existing health conditions and the development of new diseases.

Table 17.1.2.1: Health Risks Associated with Climate Change
Source: Adapted from Impacts of Global Climate Change on Health: Climate Change and Health

Health Conditions	Possible Influences of Climate Change
ALZHEIMER'S DISEASE	Persons with cognitive impairments are vulnerable to extreme weather events that require evacuation or other emergency responses.
ASTHMA	Asthma is exacerbated by changes in pollen season and allergenicity and in exposures to air pollutants affected by changes in temperature, humidity, and wind.
CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)	COPD patients are more sensitive than the general population to changes in ambient air quality associated with climate change.
DIABETES	Diabetes increases sensitivity to heat stress; medication and dietary needs may increase vulnerability during and after extreme weather events.
CARDIOVASCULAR DISEASE	Cardiovascular disease increases sensitivity to heat stress.
MENTAL ILLNESS	Mental illness may impair responses to extreme events ; certain medications increase sensitivity to heat stress.
OBESITY	Obesity increases sensitivity to high ambient temperatures.
DISABILITY	Persons with disabilities may find it hard to respond when evacuation is required and when there is no available means of transportation or easy exit from residences.

The following sections provide key findings from the "The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment." In the official report, each key finding is notated with a level of confidence, from medium to high levels of confidence based on scientific analyses.

Temperature-Related Death and Illness

Key findings:

- By the end of the century, an increase of thousands to tens of thousands of premature heat-related deaths in the summer and a decrease of premature cold-related deaths in the winter are projected each year as a result of climate change.
- Days that are hotter than usual in the summer or colder than usual in the winter are both associated with increased illness and death.

- Some populations are more vulnerable to death or illness due to high temperatures such as children, older adults, people working outdoors, the socially isolated and economically disadvantaged, those with chronic illnesses, as well as some communities of color.

Air Quality Impacts

Key Findings

- Changes in the climate affect the air we breathe, both indoors and outdoors.
- Climate-driven increases in ozone will cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms
- Changes in climate, specifically rising temperatures, altered precipitation patterns, and increasing concentrations of atmospheric carbon dioxide, are expected to contribute to increases in the levels of some airborne allergens and associated increases in asthma episodes and other allergic illnesses .
- Climate change is projected to increase the number and severity of naturally occurring wildfires in parts of the United States, increasing emissions of particulate matter and ozone precursors and resulting in additional adverse health outcomes.

Extreme Events

Key Findings

- Extreme weather events can cause death or injury during an event (for example, drowning during floods), however health impacts can also occur before or after an extreme event, as individuals may be involved in activities that put their health at risk, such as disaster preparation and post-event cleanup.
- Climate change will increase exposure risk in some regions of the United States due to projected increases in the frequency and/or intensity of drought, wildfires, and flooding related to extreme precipitation and hurricanes.
- Many types of extreme events related to climate change cause disruption of infrastructure, including power, water, transportation, and communication systems, that are essential to maintaining access to health care and emergency response services and safeguarding human health.
- Climate change will increase exposure risk to coastal flooding due to increases in extreme precipitation and in hurricane intensity and rainfall rates, as well as sea level rise and the resulting increases in storm surge

Vector-Borne Diseases

Key Findings

- Vector-borne diseases are illnesses that are transmitted by vectors, which include mosquitoes, ticks, and fleas.
- Climate change is expected to alter the geographic and seasonal distributions of existing vectors and vector-borne diseases.
- Ticks capable of carrying the bacteria that cause Lyme disease and other pathogens will show earlier seasonal activity and a generally northward expansion in response to increasing temperatures associated with climate change. Longer seasonal activity and expanding geographic range of these ticks will increase the risk of human exposure to ticks.
- Alterations in the distribution, abundance, and infection rate of mosquitoes will influence human exposure to bites from infected mosquitoes, which is expected to alter risk for human disease.
- Vector-borne pathogens are expected to emerge or reemerge due to the interactions of climate factors with many other drivers, such as changing land-use patterns.

Water-Related Illness

Key Findings

- Increases in water temperatures associated with climate change will alter the seasonal windows of growth and the geographic range of suitable habitat for freshwater toxin-producing harmful algae, certain naturally occurring Vibrio bacteria, and marine toxin-producing harmful algae. These changes will increase the risk of exposure to waterborne pathogens and algal toxins that can cause a variety of illnesses.
- Runoff from more frequent and intense extreme precipitation events will increasingly compromise recreational waters, shellfish harvesting waters, and sources of drinking water through increased introduction of pathogens and prevalence of toxic algal blooms. As a result, the risk of human exposure to agents of water-related illness will increase.
- Increases in some extreme weather events and storm surges will increase the risk that infrastructure for drinking water, wastewater, and stormwater, will fail due to either damage or exceedance of system capacity, especially in areas with aging infrastructure. As a result, the risk of exposure to water-related pathogens, chemicals, and algal toxins will increase in recreational and shellfish harvesting waters, and in drinking water where treatment barriers break down.

Food Safety, Nutrition, and Distribution

Key Findings

- Climate change, including rising temperatures and changes in weather extremes, is expected to increase the exposure of food to certain pathogens and toxins. This will increase the risk of negative health impacts
- Elevated sea surface temperatures will lead to greater accumulation of mercury in seafood, while increases in extreme weather events will introduce contaminants into the food chain. Rising carbon dioxide concentrations and climate change will alter incidence and distribution of pests, parasites, and microbes, leading to increases in the use of pesticides and veterinary drugs
- The nutritional value of agriculturally important food crops, such as wheat and rice, will decrease as rising levels of atmospheric carbon dioxide continue to reduce the concentrations of protein and essential minerals in most plant species.
- Increases in the frequency or intensity of some extreme weather events associated with climate change will increase disruptions of food distribution by damaging existing infrastructure or slowing food shipments. These impediments lead to increased risk for food damage, spoilage, or contamination, which will limit availability of and access to safe and nutritious food depending on the extent of disruption and the resilience of food distribution infrastructure.

Mental Health and Well-Being

Key Findings

- Many people exposed to climate-related or weather-related disasters experience stress and serious mental health consequences.
- Specific groups of people are at higher risk for distress and other adverse mental health consequences from exposure to climate-related or weather-related disasters. These groups include children, the elderly, women (especially pregnant and post-partum women), people with preexisting mental illness, the economically disadvantaged, the homeless, and first responders
- Many people will experience adverse mental health outcomes and social impacts from the threat of climate change, the perceived direct experience of climate change, and changes to one's local environment.
- Increases in extreme heat will increase the risk of disease and death for people with mental illness, including elderly populations and those taking prescription medications that impair the body's ability to regulate temperature.

Populations of Concern

Key Findings

- Across the United States, people and communities differ in their exposure, their inherent sensitivity, and their adaptive capacity to respond to and cope with climate change related health threats [Very High Confidence]. Vulnerability to climate change varies across time and location, across communities, and among individuals within communities.
- People experience different inherent sensitivities to the impacts of climate change at different ages and life stages. For example, the very young and the very old are particularly sensitive to climate-related health impacts.
- Climate change threatens the health of people and communities by affecting exposure, sensitivity, and adaptive capacity. Social determinants of health, such as those related to socioeconomic factors and health disparities, may amplify, moderate, or otherwise influence climate-related health effects, particularly when these factors occur simultaneously or close in time or space.
- The use of geographic data and tools allows for more sophisticated mapping of risk factors and social vulnerabilities to identify and protect specific locations and groups of people

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17.1.3: Healthier Home, Community, Country, and World

Although climate change has enormous impacts on health, there are additional concerns and actions that you can take to increase your environmental health.

Overpopulation

Average life expectancy in 1900 was 48 years, and today that has increased to about 78 years. We have made incredible advances that have contributed to an increase our life expectancy. For example, infant mortality rates have decreased dramatically during the 20th century, from 165 deaths per 1,000 births in 1900 to 7 deaths per 1,000 births today, advances in fertility treatments have provided new opportunities for conceiving children, and people have lived safer healthier lives with advances like clean drinking water, car safety belts, and work hard hats. These advances have helped to increase our worldwide population. The world population reached 1 billion people in 1803 and in just over 100 years, that population doubled to 2 billion people in 1928. It then took only about 50 years to double the population again to 4 billion people by 1975. By 2023 the population is expected to double again to 8 billion people. With these trends in growth the population is likely to reach 8.5 billion in 2030 and 9.7 billion in 2050.

Many believe overpopulation is the root cause of environmental health issues we are facing today. It is unknown how many people the Earth can support, however scientist do believe there is a limit and that humans are negatively impact the health of the planet which in turn is causing health issues for people. Overpopulation may cause food shortages, increase rate of disease transmission due to living closer together, lack of clean water, fear of limited employment opportunities for the demand, and disappearance of nonrenewable energy, such as the estimation that natural gas will run out in the next 35 years. With current population growth trends it becomes even more important for humans to take care of the planet.

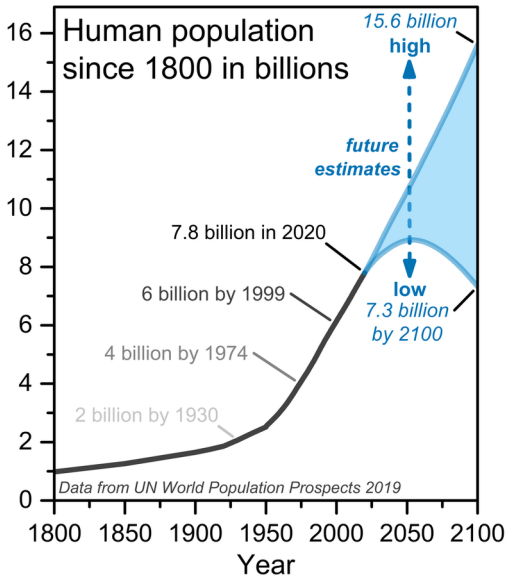


Figure 17.1.3.6: Human Population Growth since 1800

Energy Use: Fossil Fuels to Renewable Energy

All forms of electricity generation have an environmental impact on our air, water and land, but it varies. Of the total energy consumed in the United States, about 40% is used to generate electricity, making electricity use an important part of each person's environmental footprint. The total amount of greenhouse gases that are emitted into the atmosphere each year by a person, family, building, organization, or company are called the carbon footprint.

Producing and using electricity more efficiently reduces both the amount of fuel needed to generate electricity and the amount of greenhouse gases and other air pollution emitted as a result. Electricity from renewable resources such as solar, geothermal, hydropower, and wind generally do not contribute to climate change or local air pollution since no fuels are combusted.

Clean energy includes renewable energy, energy efficiency and efficient combined heat and power.

Measure and reduce your energy impact

How much energy are you using? What is your carbon footprint? How can you reduce your impact?

- Use EPA's household carbon footprint calculator to estimate your household's annual emissions and find ways you can cut emissions.
- Learn about the many ways to save in your home and track your progress with "My ENERGY STAR"
- Use Power Profiler to learn about the air emissions associated with your home or business's electricity use.
- Use AirNow to learn about local air quality.
- Use MyEnvironment to access local environmental quality information.

Waste

We all play a role in helping to prevent and remove trash in the environment. You can take action at home, school, and work to ensure a cleaner community and healthier waters.

Most of the trash that pollutes our rivers, lakes, estuaries, and oceans comes from sources on land. Plastic trash, in particular, threatens human health, aquatic ecosystems, and the economy. The most effective way to prevent trash from polluting our waterways is to reduce the amount of waste you create.

How much trash ends up in the ocean?

One of the most extreme and dramatic examples of the amount of trash that ends up in the ocean is known as the Great Pacific Garbage Patch, or "garbage island." It is is a collection of marine debris in the North Pacific Ocean between California and Hawaii[4]. The collection is estimated to be about double the size of the state of Texas.

The garbage patch was discovered in 1997 by Charles Moore. Moore had just finished a Los Angeles-to-Hawaii sail race known as the Transpac and he decided to take a short cut back to LA. He said, "on the way back to our home port in Long Beach, California, we decided to take a shortcut through the [North Pacific subtropical] gyre, which few seafarers ever cross. Fishermen shun it because its waters lack the nutrients to support an abundant catch. Sailors dodge it because it lacks the wind to propel their sailboats... as I gazed from the deck at the surface of what ought to have been a pristine ocean, I was confronted, as far as the eye could see, with the sight of plastic"[5].

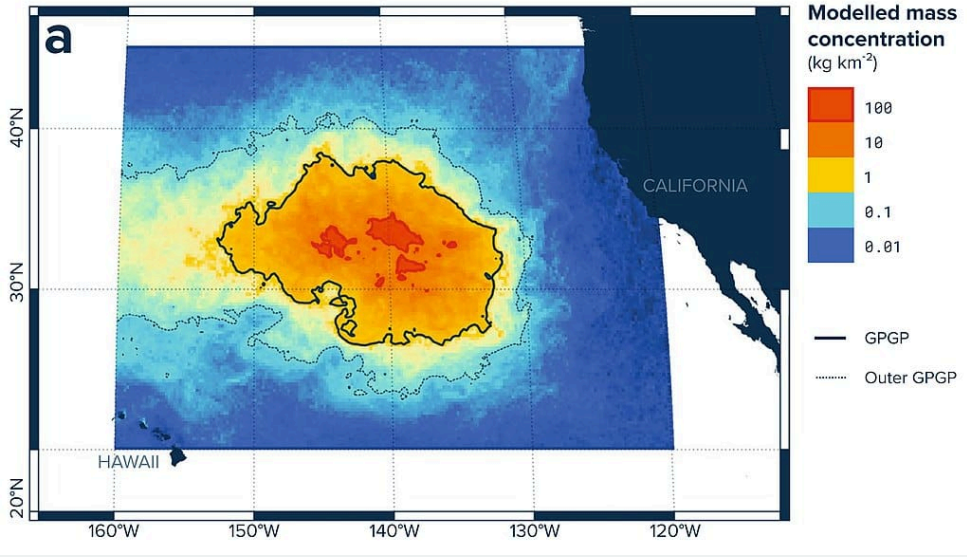


Figure 17.1.3.7: Map of the Great Pacific Garbage Patch

The 3 R's: Reduce, Reuse, and Recycle

The first goal should be to reduce your impact by reducing the energy you use, reducing the amount of waste you produce, reducing the amount of water you consume, etc.

The second goal should be to reuse as much as possible. Buy used items, repurpose items, share items with others, etc.

The last goal should be to recycle. Recycle plastics, aluminum, paper, etc to allow for them to be reused.

The following are tips to achieve the 3 R's.

- Think Green Before You Shop.
  - Do you really need it? Will you really use it?
  - How "green" is it? Is it built to last? Is it "energy star" rated? Is it made of recyclable material?
  - Can you borrow it or buy it used instead?
- Reduce your food waste by shopping smart.
  - Buy only what you need, compost food scraps, and donate unused food to food banks or shelters.
  - One-third of all food in the United States goes uneaten. The EPA estimates that in 2018, about 81 percent (about 20.3 tons) of households' wasted food ended up in landfills or combustion facilities.
  - Preventing food from going to waste is one of the easiest and most powerful actions you can take to save money and lower your climate change footprint by reducing greenhouse gas (GHG) emissions and conserving natural resources.
- Reuse or repurpose items such as old clothing, cloth grocery bags, and containers to prevent waste.
- Buy used items to reduce waste as well as the emissions created by producing new materials or disposing of them in landfills.
- Donate unused clothing, electronics and building materials to make sure others can reuse them too! One person's trash is another person's treasure. Instead of discarding unwanted appliances, tools or clothes, try selling or donating them
- Buy products made with recycled content. Check labels to see if a product or its packaging is made from recycled materials. You help close the recycling loop by buying new products made from recycled materials
- Know before you throw.
  - Know what items your local recycling program collects and encourage your household to recycle right and recycle more.
  - Unsure how to recycle? Visit Earth911-More ideas,Less waste for help
- Maintain and repair products, like clothing, tires and appliances, so that they won't have to be thrown out and replaced as frequently.
- Borrow, rent or share items that are used infrequently, like party decorations, tools or furniture.
- Learn about what you can do at home, at school, at work and in your community!

Sustainability

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment.

The National Environmental Policy Act of 1969 committed the United States to sustainability, declaring it a national policy “to create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.”

Production, processing, packaging, and transportation of food is highly dependent on the use of fossil fuels and chemical fertilizers. These can greatly harm our health and the health of the environment. As a consumer, you have power to make a difference by considering the impact of your choices. Opting for local, healthy, environmentally responsible food helps promote both personal health and overall health of the community.

Choose foods that:

- Do not harm the environment.
- Support and preserve rural communities.
- Are healthy and nutritious.
- Respect farm animals.
- Provide farmers with fair wages.
- Are free of added toxins.
- Are grown locally.
- Do not harm the health of farm workers.

What can you do?

Find out what you can do to help make a difference in our environment every day. Whether you’re at home, on the go, in the office, or at school, there are many opportunities to go green by Reducing, Reusing, and Recycling.

Review the tips for home, school, work, communities, travel, and holiday/events. Identify strategies that you could implement to support a healthy planet:

- Tips for Home
- Tips for Students and Schools
- Tips for Work
- Tips for Communities
- Tips for Travel
- Tips for Holidays and Events

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Healthy Community Design

The way we design and build our communities affects our physical and mental health. How can communities come together to design healthier places to work, play, and live? The American Institute of Architects, American Planning Association, American Public Health Association, American Society of Civil Engineers, American Society of Landscape Architects, National Recreation and Park Association, U.S. Green Building Council, and Urban Land Institute have come together for a joint call to action to implement healthier places.

Examples of work to create healthier places include:

- Northwest Arkansas: Turning the wheels to build biking infrastructure and access
- Phoenix: Design strategies for burning health issues
- Los Angeles: Convening new partnerships, breaking out of silos
- Salinas, California: A neighborhood's plans for a vibrant transformation
- Denver: A stormwater problem becomes a health equity opportunity
- Colorado: Broadening the discussion about health and the built environment
- Washington, D.C.: A lesson plan for health and health equity
- South Bend, Indiana: Driving results for community safety and health
- Winchester, Kentucky: Reimagining parks, health and an entire small town
- Baltimore: An alley becomes a gateway to a healthier community

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17.1.4: End-of-Chapter Material

Key takeaways for this Chapter

- Every citizen needs to be climate literate.
- The planet is warming due to the greenhouse effect, also known as global warming.
- The Earths climate is changing causing numerous problems with our weather, oceans, snow/ice, and ecosystems.
- Human health is being negatively impacted by climate change.
- Humans can take actions to increase the health of the planet

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17.1.5: ENVIRONMENTAL HEALTH

502 Bad Gateway

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17.1.5.4: Environmental Health and the Emergence of the Modern Environmental Movement

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- 17.1.5.8.1: Flint Water Crisis
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17.1.5.15: Co-Benefits of Taking Steps to Address Climate Change

17.1.5.16: Climate Change Policy

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- 17.1.5.16.3: Emergency preparedness (whether emergency is climate related or not)

17.1.5.17: Additional Resources

17.1.5.18: References - if not already on each page

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17.1.5.1: Introduction

Environmental health includes both the human impact on the earth, as well as the health effects of different environmental exposures (chemicals, gasses, radiation, etc.) on humans. According to the World Health Organization (WHO):

> Healthier environments could prevent almost one quarter of the global burden of disease....Clean air, stable climate, adequate water, sanitation and hygiene, safe use of chemicals, protection from radiation, healthy and safe workplaces, sound agricultural practices, health-supportive cities and built environments, and a preserved nature are all prerequisites for good health (WHO, 2020).

Why is environmental health such a large and active area of public health?

Environmental factors contribute to leading causes of morbidity and mortality around the world, causing nearly 1 in 4 human deaths globally in 2016 (WHO, n.d.). Recognizing that human health is interconnected to the health of animals as well as the entire ecosystem in which we live, the One Health framework has been developed to promote an interdisciplinary approach to environmental health. Taking this holistic approach can help to reduce zoonotic disease transmission, improve access to food and clean water, and mitigate and adapt to the effects of climate change (WHO, 2022). Environmental health draws on the sciences of biology, ecology, chemistry, engineering, and more to address hazards that threaten human (and animal) health.

In this chapter, we'll start with an overview of environmental health and how public health approaches environmental hazards. Then we will look at several specific environmental health concerns:

- Clean air
- Clean water
- Waste management
- Food and drug safety
- Climate change
- Occupational health

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17.1.5.2: Learning Outcomes

At the completion of chapter, students will be able to

1. Discuss pollution as a major risk to human health at this time, in particular in the developing world.
2. Discuss risk assessment and the concept that "the dose makes the poison".
3. List sources and types of pollutants, including the six criteria pollutants, and explain the difference between primary and secondary pollutants.
4. Describe the role of the Environmental Protection Agency (EPA) in protecting the environment.
5. Outline the provisions of the Clean Air Act, and explain the purpose of air quality standards.
6. List the major types of indoor air pollutants and describe ways to reduce exposure to them.
7. Explain the difference between point source and nonpoint source pollution (and what difference it makes when you are trying to reduce pollution)
8. Give examples of biological and nonbiological pollutants that threaten our drinking water.
9. Define the term "waterborne disease outbreak" and give examples of agents that can cause such an outbreak.
10. Describe the measures communities take to ensure the quality of drinking water and to manage wastewater.
11. Explain the general purpose of the Clean Water Act and the Safe Drinking Water Act.
12. Define pest, pesticide, target organism and nontarget organism.
13. Explain some of the health and safety concerns with pesticide use.
14. Describe the composition of municipal solid waste (MSW) and outline acceptable MSW management strategies.
15. Discuss the importance of "reduce, reuse, recycle" as an approach to reducing waste.
16. Define hazardous waste and give some examples.
17. Identify approaches used by the FDA, the USDA, and local health departments use to ensure food safety.
18. Describe in general terms how the FDA ensures drug safety.
19. Discuss occupational health risks and protections in relationship to environmental health.
20. Discuss climate change as a risk to human health, including how it may affect rates of infectious disease, access to food and clean water, natural disasters, forest fires, air quality and heat exhaustion.
21. Explain mitigation and adaptation as strategies to cope with climate change.
22. Discuss how measures to address climate change may also contribute to improvements in overall health (for example, prevention of chronic disease) – the "co-benefits" of action on climate change.

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17.1.5.3: What is environmental health

Here are a pair of definitions to get us started.

Environmental health – the study and management of environmental conditions that affect the health and well-being of humans

Environmental hazards – factors or conditions in the environment that increase the risk of human injury, disease, or death

Please watch this short video from the American Public Health Association for a quick overview of the environment's impact on health:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Environmental health is a very broad and essential component of protecting the public's health. Environmental health can work to prevent injuries (such as poisoning and burns), infectious diseases (such as those spread by parasites in water or food) and chronic conditions (such as cancer and asthma).

Environmental health also focuses on occupational health and working conditions. By examining the conditions at work sites and the physical risks to health, environmental health measures can keep us safer on the job.

Environmental health works to improve big systems that we interact with every day - such as how clean water will be delivered, how food will be processed, and how waste of all kinds will be disposed of.

Fundamentally, environmental health works to make sure that our communities, our workplaces, our water supply, and our nation as a whole are as free of hazards as possible.

How big of an influence is the environment on health?

The Lancet, a major medical journal from the UK, has released a number of studies about the effect of pollution on health. One landmark one came out in 2016. While in many past analyses, environmental causes of disease and injury have been generally seen as significant yet not huge -- maybe causing 5-15% of deaths -- the report from *The Lancet* offered a new view. They say that pollution kills up to 9 million people a year -- making it one of the leading causes of death. **Check out this brief video from *The Lancet* (required) -- captions available:**

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17.1.5.4: Environmental Health and the Emergence of the Modern Environmental Movement

If you think back to the story about John Snow breaking the handle off the Broad Street pump, to stop the spread of cholera in London in the 1850's, then you can see that public health has always been concerned about environmental health. Access to clean water and the question of how to dispose of sewage were among the first priorities of public health. Even today, in much of the world, these are the fundamental health problems that need to be addressed, to stop the spread of disease.

The modern environmental movement in the U.S. really kicked off in 1962 with the publication of *Silent Spring*, by Rachel Carson, a book that showed how pesticides were affecting the health of birds and were moving through our food supply and into our own bodies. Environmental health professionals joined with others - chemists, biologists, activists, farmers - to demand safety standards for pesticides and other chemicals in our environment.

Today, however, while there is regulation of SOME chemicals in our environment (usually through EPA, USDA or the FDA), thousands more chemicals are put into consumer products, agricultural products and industrial uses than could ever be tested for risks to human health. Often, a dangerous chemical does not start to be regulated until after it has caused some notable harm.

OPTIONAL: watch this five-minute clip about Rachel Carson's work and the growing awareness of pesticides in the 1960's.

NOTE to self: in Home > Older Versions > H54-W13-EnviroHealth-NoCC there are some "test your understanding" questions and an image from NYT probably not fair use.

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17.1.5.5: Measuring Risk

If I had to write on a post-it how environmental health workers assess risk, I'd jot down two phrases: the dose makes the poison and risk-benefit analysis.

The golden rule of toxicology: The dose makes the poison

Let's talk about "**the dose makes the poison**" first. This relates to hazard mapping. Just as something in the workplace that is hazardous in large quantities might not be hazardous in small quantities (for example, a match is less hazardous than a pizza oven), the dose of any kind of chemical or toxin makes all the difference between whether it is dangerous (poisonous, even) - or not.

One of the key tasks in toxicology (the study of toxins) is to determine how much of any given chemical can harm us. We are not able to live in a world without chemicals - even if we didn't produce gobs of them (for example, the chemicals in personal care products), we would still be exposed to naturally-occurring chemicals in the environment. The Environmental Protection Agency (EPA) tests about 1,500 new chemicals every year - yet upwards of 80,000 chemicals are used in commercial production in the US alone.

Many, many chemicals we come in contact with have not been tested, or not tested enough.

Even so, toxicologists do important work to determine *what dose is safe* - or in the case of medicines, even therapeutic. Anything can be a poison in too high a dose - even water. You may have heard of cases of people chugging gallons of water and having to be hospitalized as a result. The opposite is not true, however - it is not true that everything is safe in a small-enough dose (as there are some chemicals that are not safe in any dose).

The dose makes the poison. How much of something enters the body makes all the difference in how the body will respond.

Whose body? When measuring the safety of a chemical, researchers have to take into account that there are populations that are especially vulnerable - babies, children, elders, people with suppressed immune systems, etc. A calculation is made, for example, that if 10 mg is the safe dose for healthy adult, then a child should be exposed to no more than 10% of that.

Chemicals that were already in use before the 1970's wave of environmental regulations often have not been tested or assessed for safety. Industry was allowed to continue using what it had been using in the past, unless some new evidence emerged of its danger.

Tylenol (acetaminophen) is an important example to consider. Tylenol is very effective and very safe at the prescribed dose. It often causes less stomach pain than aspirin or ibuprofen, and it can be used in babies and children (aspirin, on the other hand, is not safe for children). It is frequently recommended by doctors and physicians, for these reasons. Yet Tylenol is responsible for a surprisingly high number of deaths every year in the US - something like 400 a year. This is because it is poisonous at higher-than-recommended doses. For someone who has a weakened liver already (due to illness or alcohol consumption), or for a child, taking as little as one or two extra pills of Tylenol beyond the recommended dose, can be poisonous. In general, we prefer to see medications where there is a bigger distance between an effective dose (say, 400 mg) and a dangerous dose (600 or 800 mg). But because Tylenol has been in use for a long time - and it does a good job, at the right dose - it continues to be widely prescribed and sold over the counter. (For more about the risks of Tylenol, you might want to listen to this optional episode of This American Life.)

Risk-Benefit Analysis

It is impossible to remove all hazards, all risks. The key question is, what risks are acceptable to us? And why?

Risk-benefit analysis is something we all do, informally. For example, if I go in late to work, there is a risk I will get in trouble. However there is a benefit to me too - maybe 15 extra minutes of sleep, or a chance to take the later train that isn't crowded. If the risk associated with arriving late is very great - say, I might get fired - then it is likely to outweigh the benefit. If the risk is small - I might get a nasty look from the boss - then the benefit starts to seem more attractive. If the benefit is very great - say, I go in late because I'm interviewing for a better job - then that could outweigh even a steep risk (like getting fired).

Environmental health professionals define and quantify the risks and benefits associated with different human activities and with different technological solutions. In addition to understanding science and public health and engineering, environmental health professionals may benefit from some studying math and economics, too.

Risk-benefit analysis also is reflected in discussions of environmental justice. We have to ask, whose risk? whose benefit? Communities are often presented with a choice about an environmental hazard that is phrased as jobs versus environment. That is, the benefit of industry is that it offers jobs, and the risk is that it pollutes. In many cases, this can be a false choice, when there is a third option available (even if it is more expensive), such as safe clean jobs in an industry that has minimized pollution to an acceptable level.

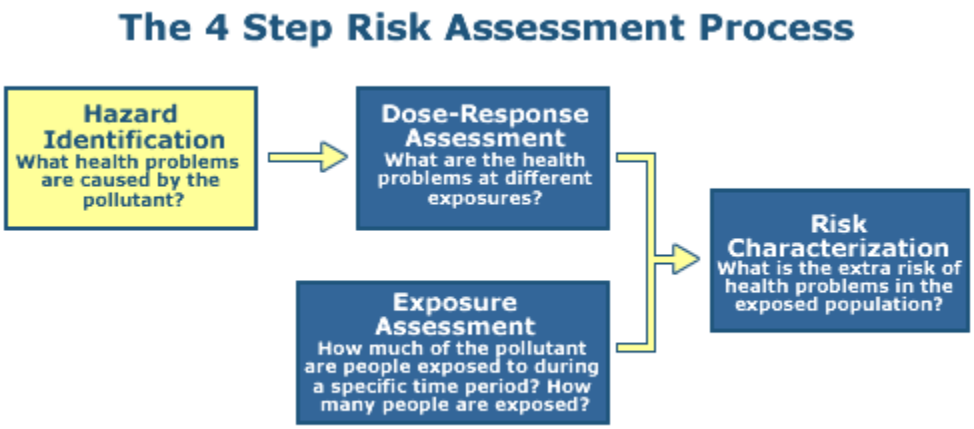


Figure 17.1.5.5.1: The 4 Step Risk Assessment Process. (Public Domain; EPA via https://www.epa.gov/risk/conducting-...isk-assessment)

Risk assessment typically involves four steps:

1. Hazard Identification: What health problems are caused by the pollutant in question?
2. Dose-Response Assessment: What are the health problems at different exposures? (at some doses, even a hazardous substance may be safe)
3. Exposure Assessment: How much of the pollutant are people exposed to during a specific time period? How many people are exposed?
4. Risk Characterization: What is the extra risk of health problems in the exposed population? (For example, while cancer may already be a risk, the exposure to asbestos increases the risk of cancer, so we want to quantify that "extra risk" associated with the asbestos exposure.)

Knowing how large the risk is, we can weigh it against the benefits that generating the pollution might bring. That decision is often a political decision, as there is no one scientific measure to determine if a certain benefit is worth the risk.

Test your understanding:

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17.1.5.6: Laws to Protect the Environment and Human Health

Environmental regulation was developed in response to the growing awareness of environmental risks, many of them man-made, many of them the result of industrialized agriculture and manufacturing. In the 1970's, laws were passed that still shape the health of our environment today.

Some of the most important environmental laws included:

- **The Clean Air Act amendments of 1970**- which required monitoring and regulation of six common air pollutants known to be health hazards (substances that negatively affect health). These six pollutants (called the "criteria air pollutants") include
  - particulate matter such as smoke, soot and ash (which is especially dangerous to human health when the particulates are very small and can stick in the lungs)
  - sulfur dioxide and nitrogen oxides (two common causes of "acid rain" that are mostly produced by industry)
  - carbon monoxide (highly poisonous, and largely created by motor exhaust - improvements in the engineering of cars and trucks has greatly reduced this toxin in the atmosphere)
  - ozone (a form of oxygen (O_3) that is very protective for us when it is in the upper atmosphere but quite toxic when it is appears at ground level
  - lead (highly toxic to the nervous system, blood and kidneys, especially for children who get exposed to lead when their brains are still developing - common in paint, some plastics and until the mid-1970's in gasoline)
- **The Clean Water Act of 1972** (amended in 1977 and more times since then) - the set goals for ensuring that lakes and rivers should be "fishable" and "swimmable" and that pollutants should not be discharged or spilled into lakes, rivers or other parts of the water supply. It also set in place standards for treatment of waste water from sewage as well as industrial waste, and instituted measures to minimize pollution from rain and storm runoff (which can wash agricultural chemicals from fields and gasoline from streets into rivers).

- **The Safe Drinking Water Act of 1974** (rewritten in 1996) - which required the Environmental Protection Agency (EPA) to set standards for local water systems, which are enforced at the state level. Drinking water is treated usually through a process that includes sedimentation, coagulation, filtration and disinfection - to remove contaminants that could affect health. While many people now prefer bottled water (due to excellent marketing from the corporations that benefit from the sale of bottled water), in the U.S. tap water is of very high quality - in fact, it is often safer than bottled water (which is less tightly regulated).

> Recent Supreme Court decisions have limited the reach of the Clean Water Act and the Clean Air Act, for example, limited the scope of environmental reviews, removing some wetlands from the Clean Water Act protections, and limiting the EPA's ability to regulate carbon pollution and some other pollutants (ADD CITATION). These changes along with changes in the EPA and a political environment that questions the role of regulations on business may lead to changes in how these laws are implemented, in reality.

NOTE: there are some "test your understanding" questions from SoftChalk I could put in here

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17.1.5.7: Clean Air

While air pollution is certainly a contributor to climate change via GHGs, it also harms human health in other ways. Air pollution is generated both by natural (biogenic) and human (anthropogenic) sources. Wildfires and volcanoes can spew particulate matter into the air, while vehicle emissions and industrial pollutants produce smog and other gasses. Some air pollutants also undergo chemical reactions when exposed to sunlight which create harmful ground level ozone. Wind currents and water vapor can carry pollutants miles away from their original source. The WHO asserts that both ambient (outdoor) and indoor air pollution contribute to over 7 million deaths around the world each year (WHO, 2019).

The Clean Air Act of 1970 regulates air pollution by empowering the Environmental Protection Agency (EPA) to set and enforce air quality standards. There are six pollutants for which the EPA sets National Ambient Air Quality Standards (NAAQS) for, which are called **criteria pollutants.** These include carbon monoxide, sulfur dioxide, nitrogen oxide, particulate matter, ozone, and lead. In 1990 the Clean Air Act was amended to include another category of **hazardous air pollutants**, such as volatile organic compounds (VOCs), pesticides, herbicides, and radionuclides (Frumkin, 2016). The Agency for Toxic Substances and Disease Registry (ATSDR), an agency of the U.S. Department of Health and Human Services, responds to potential toxic emergencies, assists local public health departments, conducts research, and maintains a registry with toxicological profiles of the health effects of natural and man-made hazardous substances that affect our soil, water, and air (ATSDR, 2024).

Primary air pollution is released straight from its source. For example, carbon monoxide is released from motor vehicle exhaust and the combustion of fossil fuels in power plants. It is also released in smoke from forest fires, and is present in environmental (or “second-hand”) tobacco smoke. When other compounds like nitrogen oxides and sulfur dioxide are exposed to sunlight, they can undergo chemical reactions that create ozone and particulate matter. These subsequent pollutants are called **secondary** air pollution. Thus, air quality is often worse on warm, sunny, summer days than on colder, winter days (Frumkin, 2016, Seabert et al., 2021).



Figure 11.4.2.1: Smoke cloud from the Mosquito Fire in California, September 2022. Cal Fire. (Public domain, via Wikimedia Commons)

Ozone is both beneficial and hazardous to human health depending on where it exists. In the stratosphere (upper layer of Earth’s atmosphere), ozone blocks harmful UV rays from the sun and protects humans, plants, and animals below - preventing things like skin cancer and cataracts. Compounds called chlorofluorocarbons (CFCs) were used extensively in the mid-20th century to make aerosol propellants, for refrigerators, and in building materials, but these and other pollutants were found to be depleting the ozone layer. Fortunately, in 1987, the Montreal Protocol was signed and countries began phasing out production of ozone depleting substances. Scientists predict that it will be completely repaired by the middle of the 21st century (EPA, 2023). Ground level ozone (in the troposphere) on the other hand, is quite harmful to humans, plants and animals. It can damage the heart and lungs and lead to a variety of chronic diseases (USGCRP, 2023a). Ozone can also be worse in the summer months as a layer of warm air called an inversion layer will trap pollution closer to ground level instead of letting it disperse upward into the stratosphere (Seabert et al., 2021).

Particulate matter is made up of very fine particles of dust, soot, and other solids or liquids of varying sizes. When breathing through the nose, larger particles are typically caught in the nose and upper respiratory system, trapped in mucus and expelled in coughs and sneezes. However, fine particulate matter, or PM2.5 (particulate matter smaller than 2.5 micrometers) can get inhaled much deeper into the lungs and cause damage to lung tissue, as well as increasing the risks of cardiovascular and neurological issues (USGCRP, 2023a). Particulate matter comes from dust, smoke, industrial pollution, vehicle emissions, pollen, and even sea-spray (Frumkin, 2016). We often see particulate matter in the air as smog or brownish haze, hovering over a city-scape on a sunny day.

Air pollution disparately affects minoritized communities including people of color and those of lower socioeconomic status, both in urban and rural areas. This can often be connected to policies and practices such as redlining, as well as industrial zoning. Exhaust from diesel trucks and industrial facilities can be much higher in urban areas, whereas rural areas may be more exposed to pollution from agricultural practices - such as dust and pesticides from crops, or emissions from concentrated animal feeding operations (aka “factory farms). Power plants also release air pollution as well as GHGs. Air quality is made worse by climate change, particularly during heat waves, which may create more secondary air pollution (USGCRP, 2023a).

While the EPA monitors and regulates ambient air pollution, it does not have the same oversight of indoor air pollution. Indoor air pollution can come from building materials, insulation, environmental tobacco smoke, and burning wood, coal, kerosene and even natural gas for cooking or warmth. Mold, mildew, pet dander and dust can also cause respiratory problems. Household cleaning products can release VOCs, which can be particularly harmful to the respiratory system if certain compounds are mixed and then inhaled. Improperly vented combustion for cooking or heating releases carbon monoxide, nitrogen oxides, and particulate matter into the household air. Radon is a radioactive gas that is released from uranium-rich rocks, and can seep into cracks in a home’s foundation and cause lung cancer. Switching to cleaner fuel sources for cooking (such as electricity), removing sources of pollution (such as environmental tobacco smoke), using appropriate ventilation when using cleaners or solvents, and using central ventilation and air conditioning (HVAC) filters or portable air filters are all ways to reduce indoor air pollutants. Additionally, any home improvement projects done on old houses should first be tested for asbestos and lead - as these were commonly used in building materials in the 20th century (EPA, 2014). According to the WHO, 2.3 billion people around the world still use solid fuel for cooking (such as wood, charcoal, and dung), exposing mostly women and children to high levels of air pollution and increasing the risk of respiratory and cardiovascular diseases, cancers, and some infectious diseases as well. In low and middle-income countries, efforts can be made to move toward cleaner fuel sources, such as natural gas and electricity, which would improve air quality, reduce GHGs, and improve health equity (WHO, 2023).



Figure 11.4.2.2: Woman feeding a cast iron wood stove. (Public Domain, CDC/ Dawn Arlotta, 2009.)

This home’s interior, though beautiful, houses a potential hazard on many levels, therefore, special care need be taken in order to safely operate this wood-burning stove, for not only does it generate a terrific amount of heat, it does so using flame, rather than electricity, which is much more difficult to control. This woman was about to place what appears to be a piece of treated lumber (which can also release harmful pollutants) into the stove as fuel.

NOTE: For more about ozone and how the world came together to start fixing the "ozone hole", please see the page on Additional Resources.

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17.1.5.8: CLEAN WATER

Humans cannot survive without water. Nearly all cities and towns have been built around sources of freshwater for drinking and agricultural uses. While our “blue planet” may be covered in water, the majority of it is too salty to be used for these purposes. In fact, only about 1% of the water on earth is both freshwater and accessible to humans via the water cycle (aka hydrological cycle). Water from melting snowpack and rain flows through rivers and streams to lakes and oceans and sinks into underground aquifers. From lakes and oceans it is evaporated into the atmosphere as water vapor. Eventually once this water vapor condenses into clouds and gets heavy enough, it is returned to the ground via precipitation (rain, snow, etc.) Freshwater is accessible to humans from two sources. **Surface water** includes any water source open to the air: lakes, rivers, streams, ponds, etc. The other source is **groundwater** which comes from underground aquifers, wells, and springs. Groundwater has long been considered more ideal for human use since it has been filtered through soil and rock, and will thus require less treatment. Surface water is often full of dirt, microbes, and pollutants which requires an extensive filtration and disinfection process in order to be drinkable (Frumkin, 2016).

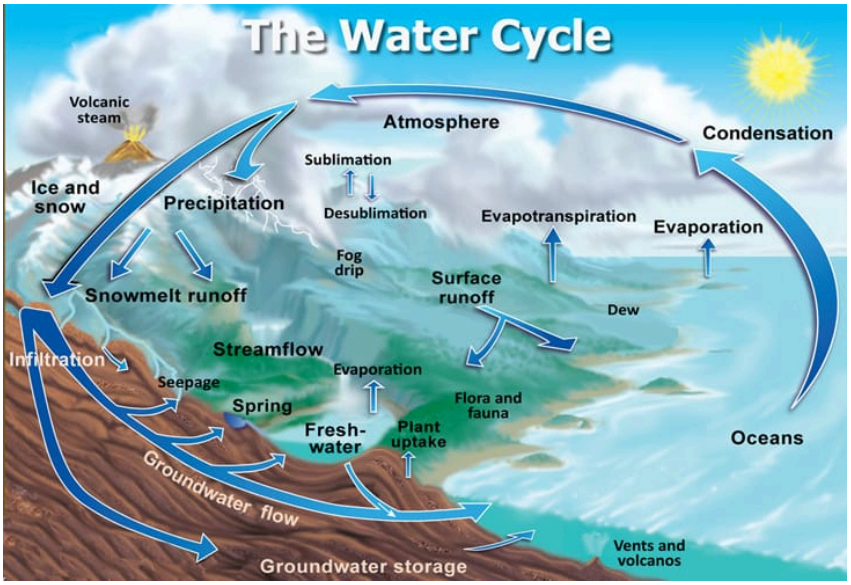


Figure 17.1.5.8.1: Water Cycle Summary.. (Copyright; John Evans and Howard Periman, USGS, Public domain, via Wikimedia Commons)

Drinking water can get contaminated by pollutants, chemicals, or biological contaminants from a variety of sources. **Point source** contamination occurs when there is a single source or multiple identifiable sources - such as a specific pipe dumping industrial chemicals into a stream, or several septic tanks leaching fecal matter into groundwater. **Nonpoint source** contamination occurs from an array of different sources - such as pesticides from agricultural runoff, or when rainwater picks up gasoline and oil on roadways. There are many different types of contaminants; they may be organic or inorganic chemicals, biological contaminants (such as bacteria, viruses, or protozoa), and even pharmaceuticals - which can lead to antibiotic resistance (see chapter on infectious diseases). Drinking water must therefore be properly filtered, disinfected, transported (via well-maintained pipes), and regularly tested in order to prevent toxic exposures or waterborne illnesses in humans and animals (Frumkin, 2016).

Particularly in developing countries around the world, many infectious diseases and toxic exposures can be prevented with improved access to water, sanitation, and hygiene practices. Combined, these are called **WASH.** The WHO estimates that despite major progress in the last 30 years, diseases caused by unsafe WASH still account for over 1.4 million deaths (in 2019), the majority of those related to diarrheal diseases - which affect hundreds of thousands of young children each year (WHO, 2023a). Sanitation and the proper treatment and disposal of wastewater also significantly impact exposure to pathogens. While wastewater can be an important source of water recycling (such as greywater from sinks and showers), many countries may lack sewage facilities, and open defecation is still practiced in many low-income countries, particularly in rural areas. Overall, inadequate sanitation accounted for the highest percentage of diarrheal disease deaths (38%). Yet sanitation is closely related to safe drinking water, which accounted for 35% of diarrheal disease deaths (WHO, 2023a). Open defecation or inadequate disposal of fecal matter can easily contaminate surface water, which may be collected downstream for drinking and agricultural uses. Proper handwashing behaviors (i.e. using soap, washing after potential fecal contact or before preparing food), are also extremely effective at reducing pathogen transmission. Both the resources - soap and water - and the education (knowing why it is important) are necessary to change behaviors. Yet even in high income countries these behaviors are not universally practiced

(WHO, 2023a).

Although improving WASH is of particular importance in low and middle income countries, there are many potential sources of contamination in high income countries as well. In the U.S. there are two laws that primarily govern safe water sources: the Clean Water Act (CWA, 1972), and the Safe Drinking Water Act (SDWA, 1974, amended in 1986 and 1996). The CWA empowers the EPA to regulate surface water for fishing and recreation, as well as wastewater management - requiring industries and municipalities to pre-treat any wastewater before it enters into waterways. This law also prevents oil spills that could affect inland water and tasks the EPA with responding to those that do happen. The SDWA governs the treatment and delivery of drinking water to municipalities; protecting surface and groundwater sources of drinking water, as well as enforcing health standards for all public drinking water systems (Frumkin, 2016, and EPA, 2013). Even with these protections in place, water contamination still occurs, and tends to most often impact historically marginalized communities.

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17.1.5.8.1: Flint Water Crisis

17.1.5.8.2: Case Study- The Jackson Water Crisis

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17.1.5.8.1: Flint Water Crisis



Figure 17.1.5.8.1.1: Water tower at the water treatment plant in Flint, Michigan. (Unknown, United States Environmental Protection Agency, Public domain, via Wikimedia Commons. April 11th, 2016.)

The story of the Flint Michigan water crisis is one of a human-made public health catastrophe that could have been avoided at several junctions. Flint, Michigan is a majority Black city. In 2014, 40% of the residents there lived in poverty (Murembya, & Guthrie, 2016). Flint was having a financial crisis, and an emergency manager was appointed by Michigan's governor. One of the ways proposed to save money was to switch Flint's water source: from the Detroit Water and Sewerage Department (DWSD) to the Karegnondi Water Authority (KWA), which was building pipeline from Lake Huron - where Flint, Detroit and other towns already sourced their drinking water. Upon hearing of this plan, the DWSD terminated its contract with Flint effective 2014, but the KWA pipeline wouldn't be ready until 2016 (Dixon, n.d., Kennedy, 2016). Until the pipeline was completed however, they needed an alternative water source for the city of Flint. For this, they turned to the Flint River, which had been the city's water source up until the 1960's (Kennedy, 2016).

Instead of treating the water or testing to ensure that the water would not corrode the city's aging pipe system, city officials took a "wait and see" approach. Barely a month after the switch, residents in Flint began to complain about their tap water's color and odor. Some people developed rashes or hair loss by showering or bathing in it (Runwal, 2024). By August, officials had detected E. coli bacteria, which prompted them to increase the chlorine levels and issue boil advisories to residents. Meanwhile, an outbreak of Legionnaire's disease, caused by the bacteria *Legionella pneumophila, was* correlated to the water source switch and improper chlorination (Zahran et al., 2018), causing the deaths of at least 12 people (Runwal, 2024). By January of 2015, other compounds (by products of disinfection which are carcinogenic) had also been found in the water - this violated the SDWA and forced the city to take some action (Kennedy, 2016).

In February, high levels of lead were found in the water of a resident's home. While the EPA issued an internal memo expressing concerns about lead contamination, the city officials in the Michigan's Department of Environmental Quality (MDEQ) downplayed the reports and insisted that Flint's water was safe. Meanwhile, researchers from Virginia Tech University were finding dangerously high lead levels in the water supply and blood levels in children (Kennedy, 2016). Lead is a neurotoxin which is especially harmful for children: it can cause learning disabilities, behavioral problems, as well as affecting growth and potentially causing anemia or in some kids - seizures. If ingested by pregnant women it can harm the growth of the fetus and lead to premature birth. And in adults, exposure to lead is associated with cardiovascular, kidney, and reproductive problems (EPA, 2016). In September of 2015, the city finally issued a lead warning to the city, and in October a state of emergency was declared and Flint switched back to the Detroit water supply (Kennedy, 2016). But the hazards were not over.

The pipes that brought water to the city were old, and made of lead and galvanized iron. Since the Flint river already had higher levels of chloride, this began to corrode the pipes, and the chlorine added to reduce the *E. coli* bacteria corroded the pipes even more. By the time the water was switched back to the Lake Huron source, it was too late - in April of 2016 the water was declared still unsafe to drink by Virginia Tech researchers (Kennedy, 2016). Many Flint residents have continued to drink bottled water as the pipes are slowly replaced throughout the city - even though the free bottled water program ended in 2018 (Runwal, 2024). Many of the city and public health officials were criminally indicted for not following proper procedures and covering up reports of

contamination, and even Governor Rick Snyder had charges related to his apparent inaction for 17 months during the water crisis. Yet many of these cases were thrown out on technicalities by the Michigan State Supreme Court, leaving Flint's residents doubting anyone will be held accountable (White, 2022). The state of Michigan was ordered to pay out $600 million in a settlement to Flint's residents - a portion of which will also cover legal fees (White, 2021).

In late 2019, PBS's investigatory news show Frontline broadcast this documentary on the Flint water crisis, why it happened, and what it means for the rest of the country. If you would like to understand more about the Flint Water Crisis, you can view it here (optional).

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17.1.5.8.2: Case Study- The Jackson Water Crisis



Figure 17.1.5.8.2.1: A Mississippi National Guard soldier takes water to a person's car at the Mississippi State Fairgrounds in Jackson, Mississippi, Sept. 1, 2022. Nearly 600 Mississippi National Guardsmen were set up across seven sites through Jackson for people to collect bottled water and non-potable water from water buffalo trucks during the water crisis. (Copyright; Staff Sgt. Connie Jones, U.S. Army National Guard, CC BY 2.0, via Wikimedia Commons.)

The residents of Jackson, Mississippi are no strangers to boil-water advisories. The city has dealt with infrastructure problems for years; massive leaks, *E. coli* and lead concerns, and a lack of funding and staffing to maintain its aging water and sanitation facilities (Pettus, 2022). A cold snap in 2021, and heavy winter storms in 2022 caused pipes to burst and shut off water supplies to thousands (Adams, 2023). When heavy rains caused the nearby river to overflow in the summer of 2022, one of the city's two water treatment facilities was compromised (Breslow, 2022). Since low water pressure allows bacteria and other contaminants to seep in through cracks in the aging pipes, residents were under yet another boil-water advisory, and bottled water was distributed (Pettus, 2022).

Jackson's chronic water crisis demonstrates the complex interplay of social determinants of health, environmental health, public health policies, and politics. To begin with, 80% of the 150,000 residents in Jackson, Mississippi are Black, and a quarter of them (25%) are at or below the poverty threshold (Pettus, 2022). Mississippi has a long history of racism and white supremacy, with Jackson at the center of the Freedom Riders protest, when civil rights activists were arrested for riding segregated public transportation from DC (Contributors to Wikimedia projects, 2024). Jim Crow laws, housing discrimination and underinvestment in communities of color have disproportionately exposed Black populations to environmental hazards (USGCRP, 2023c). After the integration of schools in the 1960s, white families moved out of Jackson *en masse* over the next several decades - so called "white flight" to the surrounding suburbs (Wiggins & Morrow, 2022). For these and other reasons, tax income to the city has declined, and Jackson has long had problems with finding money to fix its infrastructure (Pettus, 2022), some of which is over 100 years old (SPLC, 2023). Jackson's history of discrimination and underinvestment are compounded by emerging environmental factors. Climate change is contributing to more rainfall and severe storms - including hurricanes and more severe flooding in the southeast U.S. region (USGCRP, 2023c). While an EPA investigation into the recent water crisis concluded that state agencies did not racially discriminate against Jackson's residents in distributing federal funds for infrastructure updates (Muhammad & Judin, 2024), it is clear that a combination of systemic and historic racism, poverty, policies, and climate change are contributing to the struggles Jackson is facing in providing clean water to its residents.

You may also want to view this brief news story from PBS News Hour (September 12, 2022) about the Jackson water crisis.

YouTube Video

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17.1.5.9: WASTE MANAGEMENT

Modern humans create much more waste than our animal counterparts and even our human predecessors. According to the EPA, the average American produces nearly 5lbs of trash per day, the majority of which is paper and food waste. Compare that with 1960 - when the average was only 2.68lbs of trash per person, per day (EPA, 2023a). Obviously the amount of garbage the U.S. is producing has increased substantially over the last 70 years. This waste is usually categorized as one of the following: municipal solid waste, special waste, or hazardous waste, with certain considerations for the disposal of each (Frumkin, 2016). But once it is removed from household or industrial trash bins, it doesn't just disappear. What do we do with it? Do we store it somewhere? Recover it and use it to make other products? Pay another country to take it? And what is the effect of all of this refuse on the environment and the planet as a whole?



Figure 17.1.5.9.1: Trash Day - Arlington, Massachusetts, USA. Left to right: recycling, compost, trash, yard waste. (Copyright; Daderot, CC0, via Wikimedia Commons, June 2023.)

San Francisco has set the goal of becoming a "zero waste city" -- with nothing or almost nothing going to landfills. While we haven't reached this goal yet, San Francisco recycles and composts more waste than any other city in the US! See this short news story from CBS to learn more about San Francisco's waste management program. As you learn more about waste management in the following pages, you can refer back to this example from San Francisco.

YouTube Video

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17.1.5.9.1: Types of Trash/Municipal Waste

17.1.5.9.2: Recycling and Composting

17.1.5.9.3: Sanitary Landfills and Combustion

17.1.5.9.4: Hazardous Waste, RCRA and CERCLA

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17.1.5.9.1: Types of Trash/Municipal Waste

Garbage is categorized as municipal solid waste (MSW), special waste, or hazardous waste according to specific characteristics. MSW includes nearly all household trash: paper, plastic, glass, aluminum, food scraps, textiles (old clothing etc.), yard trimmings, and wood (Frumkin, 2016). But this trash generated by homes, businesses and schools actually accounts for only about 2-5% of the total amount of waste products produced in the U.S. (Seabert et al., 2021). Special waste accounts for almost anything that isn't the typical household waste but also doesn't fall into the hazardous waste category. This includes:

- Medical waste: medical devices, syringes, sharps, blood-soaked bandages, gloves, gowns - anything that comes in contact with blood or bodily fluids. This must be disposed of separately to general MSW in order to protect workers from contracting infectious diseases. Typically this waste is incinerated before being disposed of along with MSW (Frumkin, 2016).
- Construction debris: any building materials (other than asbestos), such as drywall, wood, metal, tile, cement etc. are typically disposed of at special construction waste sites or along with MSW. Asbestos has to be carefully removed and disposed of in order to prevent inhalation which can cause cancers and other lung diseases such as mesothelioma (EPA, 2013a).
- Mining waste: which can be liquids or fine, ground up rocks called "tailings", which can contain heavy metals and byproducts from mining such as sulfuric acid or cyanide. If mining waste storage dams break they can wreak havoc and cause damage to the local environment, or release toxic substances into rivers and lakes (*Tailings*, 2017).
- Agricultural waste: solid animal waste or runoff from farms may include pesticides, pathogens, or antibiotics (which may encourage antibiotic resistant microbes) (Frumkin, 2016). Growing and processing grains, legumes, fruit and vegetable products also generates plant waste, which could be useful for biofuels or compost (Sadh et al., 2018).
- Radioactive waste: may include the nuclear fuel and waste products or clothing and protective gear that has come in contact with it. While the U.S. struggles to find a permanent solution for disposing of nuclear waste (high-level radioactive waste), the less dangerous, low-level reactive waste is typically disposed of in special landfills (Frumkin, 2016).
- Sewage sludge: is typically separated from wastewater as part of the treatment process, and chemically treated to remove pathogens. These solids are either put in landfills or used in agriculture as fertilizer (Frumkin, 2016).
- eWaste (electronic waste): includes computers, phones, printers, televisions, gaming devices, or anything with electronic components that are non working or obsolete. These may still contain valuable materials that can be extracted and recycled, but if disposed of improperly can leach heavy metals into the environment (Seabert et al., 2021).

The best solution for waste is simply not to make it in the first place. For example, offices can convert to modern technology and use electronic communications and documents (such as email and electronic signatures) to reduce paper waste production. Food production companies can utilize less plastic packaging. Companies that ship products can combine shipments and reduce unnecessary paper and cardboard use. Reducing the production of waste would be the best option, followed by recycling or recovering "waste" to be reused for other purposes. For example, old tires can be broken down into crumb rubber and used to make playground equipment, truck bed liners, and other products that benefit from the elasticity of the rubber (Frumkin, 2016). Some waste can be used to generate energy through combustion, or the conversion of food waste into compost or animal feed. If nothing more can be used from the waste or if it is too hazardous to keep around, then treatment and proper disposal are the only other options (EPA, 2018). See Fig. \({17{.}1{.}5{.}9{.}1{.}\eatSpaces{1} \endSpaces}\ below for a diagram of the waste management hierarchy.

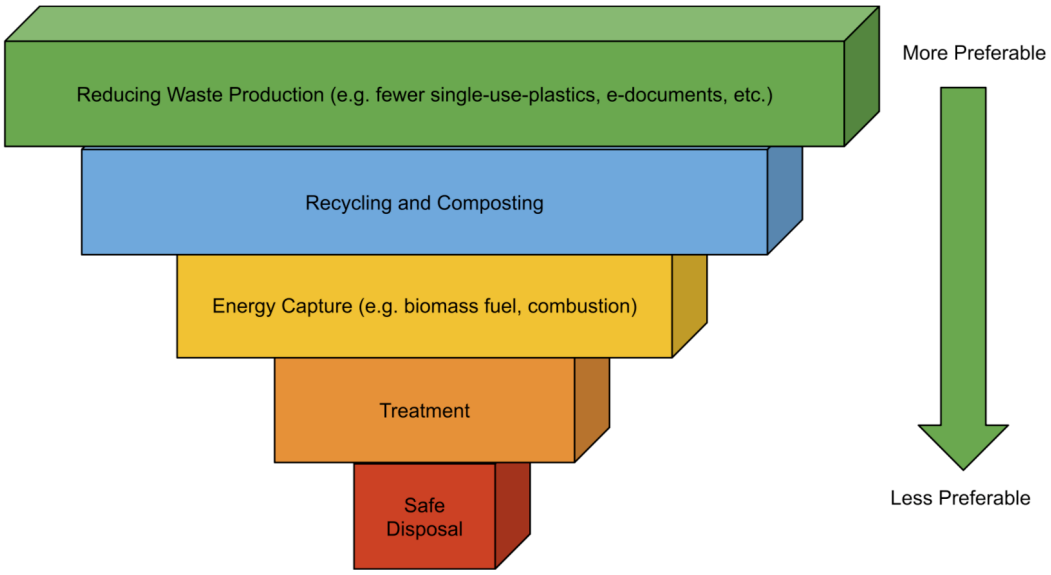


Figure 17.1.5.9.1.1: Waste Management Hierarchy. Adapted from https://www.epa.gov/trinationalanalysis/waste-management.

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17.1.5.9.2: Recycling and Composting

In 2018, the United States generated 292.4 million tons of MSW, and recycled or composted 94 million tons of it - amounting to about 32.1% of the total. While some other methods were also used to recover energy or create animal feed, over ½ of all waste still ended up in a landfill. While this may not seem like progress, the amount of MSW discarded in landfills has remained relatively constant since 1990 - in spite of population growth - while other methods like recycling and composting have grown (EPA, 2023a). While metals (like steel and aluminum), glass and paper products (including cardboard), are relatively easy to recycle, plastics are much less commonly recycled. Approximately 9% of the world's plastic containers, bottles, bags and other materials are recycled; 50% end up in landfills, another 20% are mismanaged (burned or dumped, potentially ending up in lakes and rivers), and 0.5% end up in the ocean (Ritchie et al., 2023). See Fig. 17.1.5.9.2.1 below.

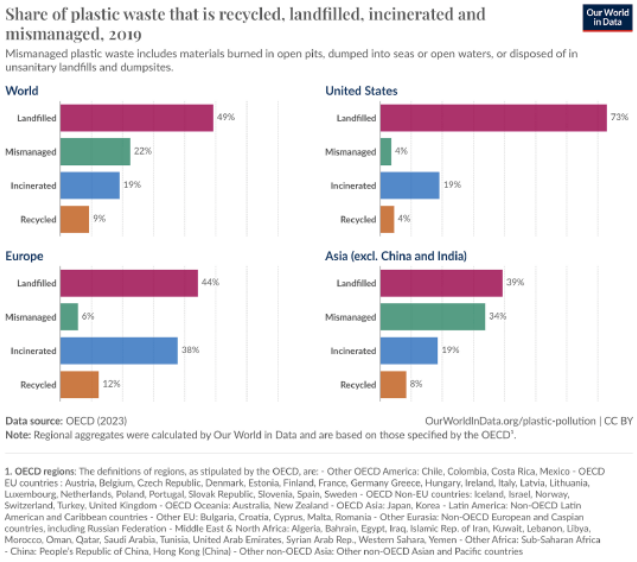


Figure1 17.1.5.9.2.1: Plastic Pollution.. (Copyright; CC-BY OurWorldInData.org/plastic-pollution)

Plastic pollution is particularly hazardous because of the characteristics of plastic that make it so desirable. Plastic is durable, and doesn't break down easily. It may take a plastic water bottle floating in the ocean nearly 450 years to decompose (Harris, 2023), broken down by UV rays into smaller and smaller pieces called microplastics. The **Great Pacific Garbage Patch** is really a misnomer because it's not an island or "patch" of trash floating in the Pacific Ocean: much of the plastic pollution is microplastics, swirling around the ocean currents like a plastic soup (Evers, 2024). These microplastics can get into our food and water sources, be ingested by birds and fish, and make their way up the food chain into human tissues. Microplastics have been found in the human gastrointestinal tract and in placental tissue (Ragusa et al., 2021). We may even be breathing in microplastics in the air, which can get into lungs and eventually the bloodstream. Exposure to microplastics and the chemicals that make them could have profound effects on human health, particularly in the immune system response to plastic toxins, chronic inflammation, and a myriad of other subsequent health problems (Prata et al., 2020). The best way to manage plastic waste is not to rely on recycling, but to produce less of it in the first place.

Composting is another way to manage biodegradable waste such as food waste. In the U.S., it is estimated that 30-40% of the food supply ends up as waste - much of that at the retail or consumer level (USDA, n.d.). Food waste may include inedible food scraps such as eggshells or fruit rinds, but it also includes food that could have been consumed but perhaps was spoiled or uneaten. Not only does the food wasted cost energy to grow and transport, it also produces methane gas while decomposing in a landfill - contributing to GHG production and climate change. Food waste can be reduced at the retail and consumer levels by only producing and purchasing what is needed, donating leftover food and preventing spoilage. Composting is also a much better use of food waste, as it produces usable fertilizer for agricultural and landscaping purposes (EPA, 2015). While backyard composting can support a home garden, industrial or large-scale composting has much greater potential for managing food waste, yard waste, sludge and other agricultural or industrial wastes. Bacteria and fungi feed off of the waste products, creating heat which destroys undesirable microbes and weed seeds, and turns the solids into excellent fertilizer for plants. When those raw materials are chipped up into smaller pieces, combined in appropriate ratios, and well-aerated, the composting process can be completed more quickly and produce high-quality soil amendment (Sherman, 2020). As of 2022, California requires that organics

be disposed of separately to recyclables and MSW in order to be composted or used to generate biofuel (CalRecycle, 2024).

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17.1.5.9.3: Sanitary Landfills and Combustion

Much of the trash we produce ends up in landfills, which are essentially encapsulated and buried under layers of dirt. In order to protect groundwater and surface water from potentially toxic **leachate** -liquids that accrue from the decomposition of waste - the sanitary landfill needs to be lined with plastic and have adequate drainage. The leachate may be collected and treated before it too is stored. Additionally, decomposition of waste produces gasses and heat - which can cause emissions or even catch fire if not properly vented. Sometimes the methane produced by a landfill can be collected, treated, and used for energy. After waste is dumped into the landfill, it needs to be covered with soil in order to prevent pests (rodents, birds, or insects) from getting into it or the wind from blowing it out of the landfill (Frumkin, 2016). It may seem obvious that landfills are limited by capacity and location: no one wants to live near a landfill, and what should be done once the landfill is full?

Combustion of waste is another option. Although open incineration of trash was often practiced in backyards up until the mid 20th century, this practice creates high levels of pollution - particulate matter and GHGs - that pose a risk to the community and planet. The Clean Air Act of 1970 essentially put an end to this practice in the U.S., although it is still common in other developing countries. Incinerators in the U.S. can be used to produce energy and get rid of waste, but they must have expensive technology to reduce air pollution. The resulting ash can also become problematic to dispose of (Frumkin, 2016, Seabert et al., 2021).

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17.1.5.9.4: Hazardous Waste, RCRA and CERCLA

Hazardous waste is typically industrially-produced waste that is ignitable, corrosive, reactive, or toxic; meeting specific criteria established by the EPA. Two key federal laws regulate hazardous waste: the Resource Conservation and Recovery Act (RCRA, 1976) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980), also known as the "Superfund". The first, RCRA, gave the EPA authority for regulating both hazardous and solid waste management, including setting standards for sanitary landfills. It requires tracking of hazardous materials from "cradle to grave", or from production, to transportation, use, and eventually disposal and treatment (Frumkin, 2016). The most common method for disposing of hazardous waste is underground injection, where hazardous waste is deposited into deep wells in the ground. Care must be taken, however, that groundwater aquifers are protected (Seabert et al., 2021). The second law, CERCLA, set up a fund to address already existing hazardous waste sites that had been abandoned, and created the ATSDR (see Clean Air, above). To create this fund, taxes are levied on the industries most commonly responsible which produce petroleum and other toxic chemicals. If the polluter can be found, they are held responsible for paying for the cleanup, but if not, then the superfund does. The EPA has identified over 300,000 waste sites, but only about 2,000 of them were deemed hazardous enough to go on the National Priority List (NPL) and be targeted for cleanup (Frumkin, 2016, Seabert et al., 2021). As of June, 2024, the current list has 1340 sites, 457 deleted sites (where cleanup and remediation has been completed), and 39 proposed sites to be added to the NPL (EPA, 2024).

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17.1.5.10: Food and Drug Safety

Long before the CWA and SDWA, the U.S. government recognized the need to regulate food and drug safety. The United States Department of Agriculture (USDA) was established by President Abraham Lincoln in 1862. In 1906 the Pure Food and Drugs Act was passed, requiring accurate labeling of food, drug, cosmetic and liquor products. The same year, the Federal Meat Inspection Act required that meat was processed in sanitary facilities - tasking the USDA with inspecting and enforcing these requirements. In 1938, congress passed the Federal Food, Drug and Cosmetic Act, which gave the newly rebranded Food and Drug Administration (FDA) the responsibility of establishing food safety standards (USDA, 2018). Today, the USDA is responsible for meat and dairy products, the EPA governs pesticides and fertilizers, and the FDA takes care of the remaining food products, drugs, and cosmetics.

Food borne disease outbreaks are defined as 2 or more cases of a similar illness that results from eating a particular food. Foodborne illnesses are typically caused by pathogens like bacteria, viruses, or other parasites that have gotten into the food source - often due to water or equipment contamination, unsafe cooking or serving practices (like failing to cook food thoroughly or leaving at room temperature for too long), or behaviors (such as failure of staff to wash hands). Pasteurization of dairy products is highly protective against bacterial outbreaks in dairy, and the sale of “raw” milk is illegal for this reason (Seabert et al., 2021). Although rare, there is also the possibility for intentional poisoning or bioterrorism, as happened in 1984 when a religious cult in Oregon intentionally contaminated a local city’s salad bars and water supply with *Salmonella* bacteria (Oh, 2017). Local and state public health agencies are typically responsible for investigating foodborne illness outbreaks, but they work closely with the USDA and FDA inspectors (Seabert et al., 2021). While Hollywood has perpetuated an image of the ill-tempered health inspector threatening to close down a beloved restaurant, these public servants actually protect the public from a plethora of potentially deadly disease outbreaks.

Pesticides are any materials used to kill, repel, or change the behavior of a pest that could potentially harm humans. This includes herbicides (which kill unwanted plants, or weeds), insecticides (which kill insects), fungicides (which kill fungi), rodenticides (which kill rodents), and even antimicrobials (which kill bacteria and viruses) (Frumkin, 2016). Technically, a pest is any animal, insect, or plant that poses a threat to humans - everything from the mosquitos that transmit malaria, to cockroaches in a kitchen, to rats in subway stations, or dandelion weeds in a front lawn. Pesticides must often be used with other tactics (like barriers for example) in order to prevent resistance developing in the target pest.

Pesticides can be either synthetic (man-made), or naturally-derived. Some synthetic pesticides have been found to have acute and chronic neurotoxic effects, and tend to linger in the environment (like DDT, which was banned in 1972) (EPA, 1972). Just because a pesticide is naturally-derived does not make it safe - arsenic and nicotine sulfate are naturally derived but are very toxic. In agricultural practice, the USDA regulates pesticides which can be used for conventional and organic agriculture. While conventional growers can use synthetic or natural pesticides, organic producers must only use products from a list published by the Organic Materials Review Institute (OMRI), which are mostly natural in origin, with a few exceptions (Andrews & Rose, 2018).

Most exposure to pesticides falls into two categories: residential and occupational. Residential exposure occurs when pesticides are used to prevent insects, rodents, or weeds around the home or yard. These can cause accidental poisoning (particularly in children), and are sometimes used in intentional poisoning (suicide/homicide) attempts. Occupational risk is highest for agricultural workers who administer the pesticide, and thus have more concentrated exposure. They may also expose family members if the pesticide lingers on clothing or materials brought home (Frumkin, 2016). As with any substance, the dose makes the poison, so amount and duration of exposure are important variables in identifying the toxicity of a substance. The EPA has categories of pesticides based on their toxicity levels with the following labels:

- Caution = relatively low toxicity.
- Warning = moderate toxicity.
- Danger = high toxicity (Frumkin, 2016, Andrews & Rose, 2018).

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17.1.5.11: Climate Change and Environmental Health

The changes to climate due to carbon pollution (CO_2, methane and other so-called "greenhouse gasses") create a number of hazards to human health. This is a pressing concern within the field of environmental health.

Here is a short video explanation of climate change, from National Geographic:

In the following pages, you will read about climate's connection to health:

- What is climate change
- Climate's effects on health
- Prevention climate change and adapting to climate change
- Co-benefits of action on climate change
- Climate policies

Research about climate change:

Over the years, there have been a number of reliable scientific reports about climate change, ranging from individual research studies in journals, to comprehensive assessments of risk conducted by the US government, to international reports under the auspices of the UN. You might find it beneficial to browse through these resources.

USA, 2024: The Fifth National Climate Assessment.

Under the United Nations: The Intergovernmental Panel on Climate Change (which has issued a number of reports).

American Public Health Association: Hub for climate, health, and equity.

These resources offer a glimpse of the variety of effects of climate change on health, including

- Heat-related illness
- Spread of vectors (mosquitoes, ticks, etc.) and infectious diseases
- Air pollution and particulate matter
- Water-borne diseases
- Changes in the food supply
- Extreme weather and disasters (floods, fires, storms, etc.)
- Mental health effects

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17.1.5.12: Climate Change

One of the most pressing concerns in environmental health is the effects of climate change on the planet, and human and animal populations. **Climate change** refers to the shifts in climate over time in various regions across the globe. Many of these shifts are due to **global warming**, or the observable increase in average temperature of the earth. The term “global warming” sometimes causes confusion because people think it means all temperatures will be higher throughout the year. Instead, it’s better to think of global warming as the driver of climate change, because the increasing average global temperature is causing shifts to different regional climates across the globe - including more severe storms, droughts, and permanent changes to ecosystems.

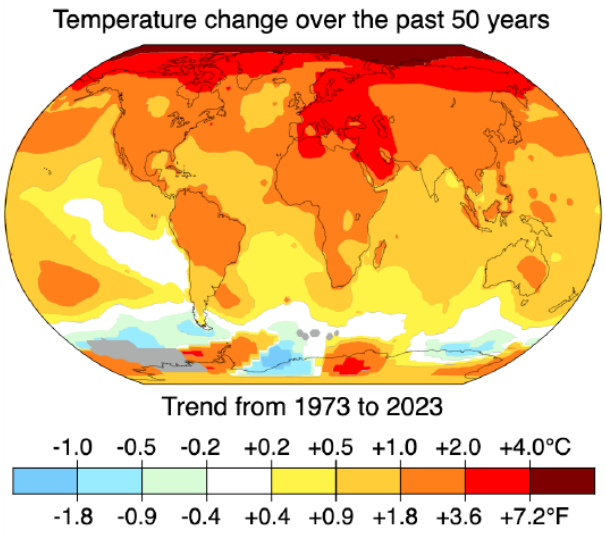


Figure 17.1.5.12.1: Change in Average Temperature With Fahrenheit. (Copyright; CC0, NASA’s Scientific Visualization Studio, Key and Title by uploader

How do we know that the earth is warming? Evidence from ice cores collected from Greenland and Antarctica, plus ambient temperature data collected since 1958 demonstrate that although the earth has gone through cycles of warming and ice ages, human activity since the industrial revolution has caused much more warming in the last 150 years than occurred in the ~800,000 years prior. Images from space show ice sheets and glaciers melting and shrinking, dumping fresh water into the ocean. And since the middle of the last century, scientists have tracked a 2 °F increase in the average temperature of the planet, with the most significant increase happening in the last 4 decades (NASA, 2024).



Figure 17.1.5.12.2: Melting Canadian glacier. (Katherine

Lean, CDC/ CDC Connects, 2017.)

This glacier located along the Icefields Parkway, near Banff National Park, Canada, is melting, showcasing the effect global climate change is having on the environment. The glaciers in this area have been studied since the 1950s, making them some of the longest scientifically observed glaciers in the world. Photo Credit:

This most recent and rapid global warming is considered to be **anthropogenic** (caused by human activity), not something that would typically happen from natural sources alone. Anthropogenic factors include the release of **Greenhouse Gasses (GHG)**. These GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O),and are released into the atmosphere from the burning of fossil fuels for energy, as well as from modern agricultural practices. Trees actually remove CO_2 from the atmosphere and store it in their trunks - so forests become “carbon sinks”. Deforestation therefore also contributes to global warming by cutting into carbon sinks - thus decreasing the amount of CO_2 collected (Burke & Weill, 2023). These GHGs left floating in the atmosphere trap heat from the sun and reflect it back down to the earth, causing an increase in the average temperature - much like a greenhouse uses glass walls to trap heat from the sun and keep the interior warmer for plants. Since the 1970s, the release of GHGs has increased much faster than in years prior, with the largest spike happening after the turn of the 21st century (Frumkin, 2016). Part of this is due to global population growth, which certainly contributes to the demand for energy production and thus the burning of fossil fuels to make it. However, the largest contributors to GHG tend to be the wealthiest countries, and per-capita GHG emissions are higher for more economically developed countries than for less economically developed countries. So it’s not just that more people require more energy, it’s also the behaviors and demands of wealthy societies that are driving GHG emissions. Still, as a few countries like Germany and the Netherlands have demonstrated, quality of life can be maintained while reducing GHG emissions through the use of technology and renewable energy sources (Ritchie & Roser, 2020). See figures 17.1.5.12.3 and 17.1.5.12.4 below.

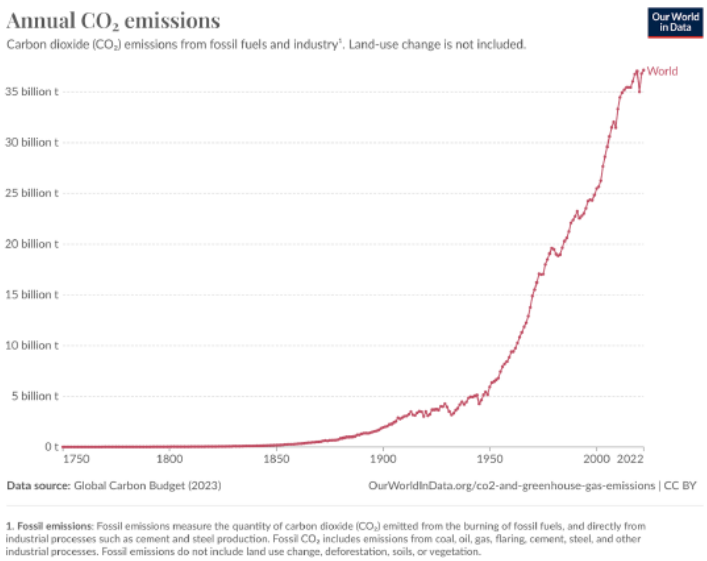


Figure 17.1.5.12.3: Annual CO_2 emissions from fossil fuels and

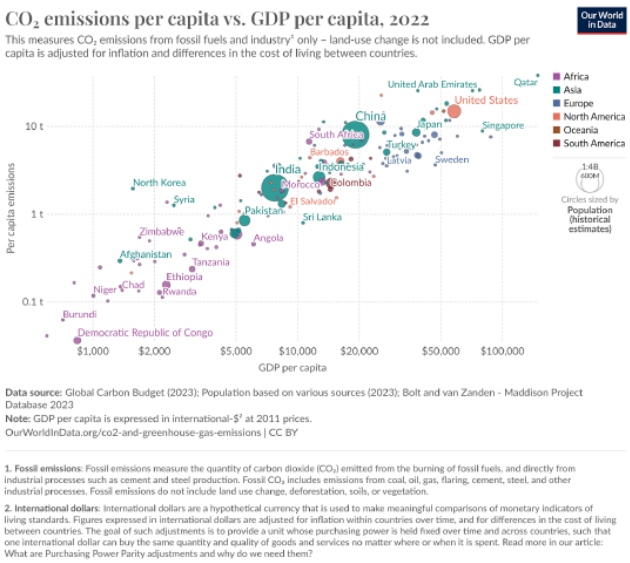


Figure 17.1.5.12.4: CO_2 emissions per capita vs. gross domestic product (GDP) per capita. (Copyright; CC-BY Our World in Data)

industry. (Copyright; CC-BY Our World in Data)

Increasing the Earth's average surface temperature has several consequences. When the ocean warms even just a little, it expands. As ice sheets and glaciers on land melt, they also contribute to rising sea levels. (Melting icebergs don't contribute to increased sea levels, as their volume is already accounted for - like ice cubes in a glass of water). Increases in ocean temperature can cause the "bleaching" of coral reefs, essentially killing them and the marine life that rely on them for food and shelter (NOAA, 2023). On land, the higher temperatures cause more evaporation of water from plants and soil, leading to droughts. Warming air can also hold onto more water vapor, which can also cause more extreme weather - like severe rainstorms, hurricanes, and flooding (Frumkin, 2016). As warm air travels toward the poles, it shifts the cold air from the polar vortex (low pressure air at the north and south poles) which can cause severe winter storms - like the unexpected snowstorms experienced in Texas in 2021 which caused massive failures in the power grid (Burke & Weill, 2023). While some rain is needed for vegetation growth, very wet springs followed by dry summers cause all that vegetation to dry out. In 2021 during the summer, dry timber and windy conditions led to mega wildfires in the Sierra Nevada mountains (Sierra Nevada Conservancy, 2022). Droughts can not only dry out plants, but also make the soil less permeable, causing flooding when substantial rains do fall, and allowing precious rainwater to wash away into the ocean instead of sinking into groundwater aquifers (Fry & Reyes-Velarde, 2019). And if heavy rains follow a wildfire, they can cause mudslides that change terrain and threaten homes and roads (Burke & Weill, 2023). .

Climate change might include changes in temperature, rain or snowfall, drought, or wind that influence the overall climate for that region. **Climate** is a term used to describe *average* weather patterns. Southern California for example has a mostly mediterranean (arid or semi-arid) climate around the coastal cities and Los Angeles, gradually shifting to a desert climate in the Mojave desert and inland regions. Los Angeles has pretty mild temperature changes over the seasons, with some rainfall in the winter, and dry, sunny summers. The desert areas get much less rain of course, and have more temperature extremes, getting hotter in the summer and colder in the winter. **Weather** is made up of the temperature, atmospheric pressure, precipitation, wind, and humidity at any given time and can change rapidly. Certain weather patterns may be predictable for a particular climate, but the two are not the same by definition. Over time, if the climate changes in a specific area, there may be more extreme weather patterns, and there will be changes in the overall ecology of that region - which may positively or negatively influence its ability to support life of the plants and animals who live there (Burke & Weill, 2023).

In our California example, the average temperature in the Los Angeles (LA) region has already increased since the middle of the 20th century, and is expected to be 4-5 °F warmer by the middle of the century. This increase in temperature is causing more of the snowpack to melt from the nearby mountains, and more of the water sources across the state to evaporate. The combination of warm, dry summers and substantial rainstorms in the winter will cause more vegetation to grow in the spring and become dry, wildfire fuel in the summer. Subsequent rains will increase the risk of mudslides and soil erosion. Along the coast, higher sea levels will threaten coastal communities, which, along with mudslides can cause severe danger to lives and homes (California Climate Adaptation Strategy, 2024). Central California has a mediterranean climate similar to LA, which is conducive to growing fruit and nut orchards and crops that require rain in the winter and warm sun in the summer. If the entire climate in central CA becomes more desert-like, it will severely impact the state's large agricultural economy. For example, almond orchards in CA produce 80% of the world's almonds - but these trees require many years to mature and need water year round (Chea, 2021).

The distinction between **climate** and **weather** is an important one. Climate is the average of weather conditions (temperature,

rainfall, etc.) over a 30-year period. Weather is what we call the atmospheric conditions at any given moment -- sun, rain, heat, snow, etc. The focus on climate over weather in studying what's happening on earth is akin to public health's focus on population health over individual health. For example, a 5% increase in the number of days an individual misses work or school due to illness might not be a big deal -- but a 5% increase across a population is a very big deal. Similarly, while any given day in San Francisco the temperature goes up or down 2 degrees Celcius (about 5 degrees Fahrenheit) and no one thinks twice, when the climate heats up by 2 degrees Celsius, it is a very big deal indeed.

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- 28.4: Superphylum Lophotrochozoa- Flatworms, Rotifers, and Nemerteans by OpenStax is licensed CC BY 4.0. Original source: https://openstax.org/details/books/biology-2e.

17.1.5.13: The Health Effects of Climate Change

As global warming causes a cascade of climate changes and weather pattern disruptions, these too cause changes to the ecological systems in which we live, which in turn affect human health. Besides the dangers of extreme weather events, which can be deadly on their own, climate change will affect both physical and human health in many ways. According to the most recent (5th) National Climate Assessment from the U.S. Global Change Research Program:

Health risks from a changing climate include higher rates of heat-related morbidity and mortality; increases in the geographic range of some infectious diseases; greater exposure to poor air quality; increases in some adverse pregnancy outcomes; higher rates of pulmonary, neurological, and cardiovascular diseases; and worsening mental health (USGCRP, 2023b)

And these risks to health are not equal across America or across the globe. Social determinants of health also influence which populations will be at higher risk for experiencing the health effects of climate change, with the most severe impacts being felt by communities and countries with less wealth, fewer resources, less education, and those historically marginalized by the rest of society. Even within relatively wealthy countries, the populations most at risk include the elderly, unhoused, children, pregnant people, and those with chronic conditions and disabilities (USGCRP, 2023b).

While warmer temperatures in some areas actually increase the capacity to grow food, they can harm crops and farmers in other regions, and disrupt the food supply chain. The northern regions in Siberia (Russia) and Canada are now warm enough to grow crops that would not have survived before (like soy and wheat), but South Asia, South America, and Africa will experience significant losses to dietary staples (wheat, corn, etc.). Warmer weather also encourages the growth of pests, fungi, and other plant diseases, causing more crop losses (Frumkin, 2016). Warmer ocean temperatures threaten fish and shellfish, which are important sources of protein for many Indigenous communities (USGCRP, 2023b). And although CO_2 can be removed from the air by certain trees and plants, it can also change the nutrient content in some food sources like rice and soybeans. Meanwhile, weeds, allergy-producing plants (like ragweed), and poisonous plants (like poison ivy) thrive in the heat and higher CO_2 (Frumkin, 2016). Food insecurity is already high in many of the same places experiencing negative agricultural effects of climate change.

Foodborne, waterborne, and vector borne pathogens are likely to increase with climate change via several pathways. Many bacteria and fungi thrive in warm, humid climates, and many vectors (like mosquitos) breed in standing water. Water sources can be contaminated with runoff from heavy rains and flooding, and can contribute to food contamination via irrigation and washing of plants. Water shortages may also prompt people to turn to other sources of water like nearby lakes and streams, which are more likely to be contaminated with runoff and/or pathogens. And higher temperatures also promote harmful algal blooms (colonies of algae), both in freshwater (lakes) and saltwater (oceans), which can be harmful to humans and other marine organisms. Vectors like mosquitoes and ticks have spread further as other regions warm, bringing with them diseases like malaria, West Nile virus, dengue fever, and chikungunya. Even fungal diseases like Valley Fever are expected to spread north with drought conditions (Frumkin, 2016, USGCRP, 2023).

Many regions are experiencing higher-than average temperatures, and more frequent heat waves, or extreme heat events (EHE). In the summer of 2023, Phoenix experienced a record 31-day streak of temperatures over 110 °F (The Associated Press, 2023). While the American Southwest is not stranger to hot summers, other regions also experienced severe heat waves for which they have little history or preparation. In 2021, the Northwestern states and Canada (typically a cooler, “oceanic” climate) experienced a “heat dome” which caused high temperatures over the summer (Zhang et al., 2023). Similar heatwaves have hit Australia, China, Japan, and Europe (Zachariah et al., 2023), and can be particularly dangerous in regions that aren’t typically prepared for hot summers with air conditioning in buildings and public transportation. EHEs can cause acute heat-related illnesses (HRIs) such as heat exhaustion, dehydration, and heat stroke, and they also increase risks for cardiovascular events and kidney problems in those with chronic diseases like diabetes, as well as health complications for infants and pregnant people.

People most at risk for HRIs are older folks, young children, and pregnant people, as well as those who take certain medications, those who lack housing or air conditioning, and those who work outside. Social determinants of health also impact disparities in HRIs. If folks lack the money to pay for high electric bills, they may not run their air conditioning during the summer months. And poorer, urban communities may actually experience hotter conditions than wealthier suburban neighborhoods. A lack of tree cover/greenspace and more cement can create “urban heat islands” up to 4°F hotter, and less likely to cool down at night. But plants that provide shade and absorb CO_2 need irrigation, which is why wealthier neighborhoods tend to have more of them (Dialesandro et al., 2021, USGCRP, 2023b). See Figure 11.3 below for region-specific climate change effects in the U.S.

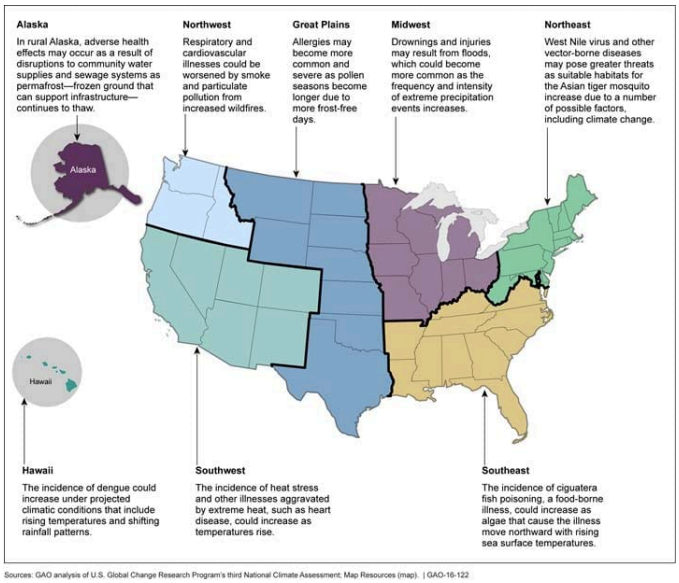


Figure 17.1.5.13.1: Examples of Potential Health Impacts from Climate Change in the United States, by Region. U.S. Government Accountability Office from Washington, DC, United States. (Public domain, via Wikimedia Commons. November 10, 2015)

Figure 11.3 Examples of Potential Health Impacts from Climate Change in the United States, by Region. U.S. Government Accountability Office from Washington, DC, United States, Public domain, via Wikimedia Commons. November 10, 2015.

Climate change affects mental health in several ways. People may lose everything in a natural disaster like a hurricane, wildfire, or flood. They may lose friends and family members, pets, photographs, homes and vehicles, and entire communities. They might lose their jobs and livelihoods to a natural disaster, or a change in climate - particularly in agricultural economies. Experiencing environmental trauma can have a severe and long-lasting impact on mental health, often causing post-traumatic stress disorder (PTSD) and heightened anxiety for many years (USGCRP, 2023). Historically minoritized communities and those who have fewer resources to begin with are often those the most harmed. For example in 2005, Hurricane Katrina devastated parts of New Orleans. The areas hardest hit were home to majority Black residents due to historical redlining practices which had segregated homeownership to certain parts of the city. These neighborhoods were below sea level, and so experienced the worst flooding (Burke & Weill, 2023). And the recovery has been just as difficult - nearly 175,000 Black New Orleans residents were displaced, and 75,000 have still not returned almost 2 decades later. Housing costs increased, flood insurance became expensive, and the federal program designed to fund rebuilding efforts ended up being sued for shortchanging poorer recipients and trying to collect overpayments (SPLC, 2023).

What happened after Hurricane Katrina is perhaps a microcosm of the displacement of communities due to climate change. Severe weather and natural disasters may destroy neighborhoods, towns, and even cities, forcing inhabitants to move elsewhere. Likewise, heatwaves and droughts may make agriculture unsustainable in certain regions, forcing people to migrate. Indigenous peoples already experience disparate impacts which threaten traditional ways of life, as well as the destruction of culturally and spiritually significant landscapes (USGCRP, 2023b). These and other socioeconomic impacts threaten civil and international conflict, and will likely disrupt global economies - all of which will have cascading effects on human health. See Fig. 17.1.5.13.2 below for a diagram outlining these health effects of climate change.

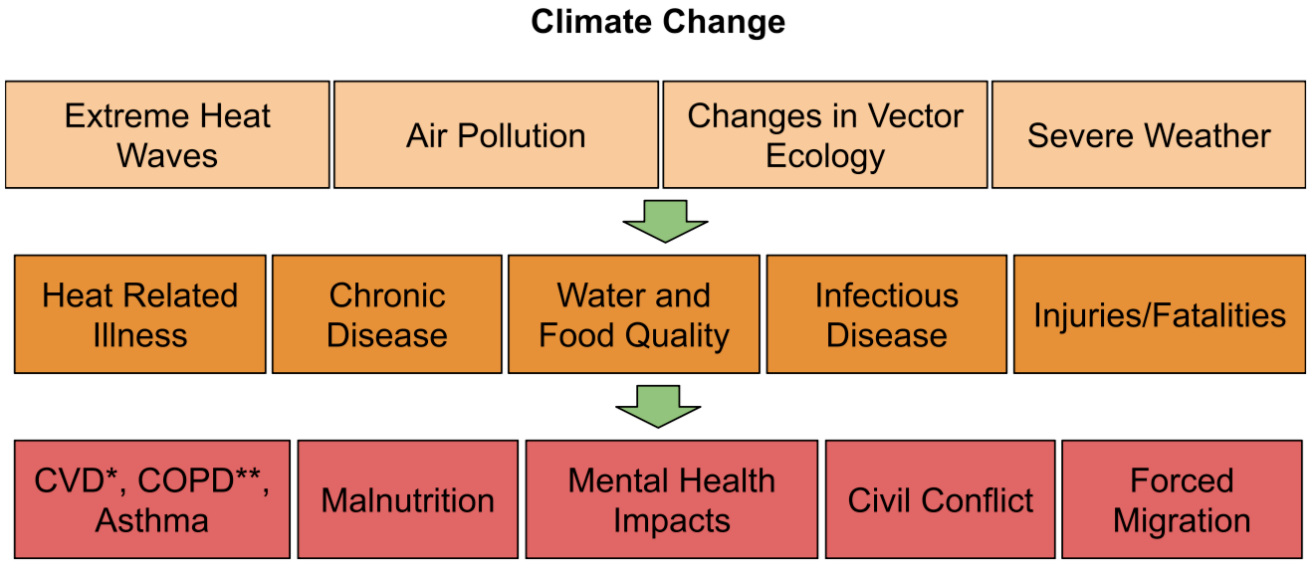


Figure 17.1.5.13.2: Health Effects of Climate Change. *Cardiovascular Disease (CVD). **Chronic Obstructive Pulmonary Disease (COPD).

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17.1.5.14: Preventing Climate Change and Adapting to Climate Change

There are (at least) two major approaches to addressing the vast health risks of climate change. Public health professionals play a role in both of these approaches, alongside other scientists, activists and others. Public health voices have been particularly prominent in finding ways to adapt to climate change here in California, for example.

One approach is to try to PREVENT the planet from warming, or from warming as much or as quickly.

- This would include putting less carbon into the air (through alternative energy or reduced use of petroleum products).
- It could include planting trees and gardens, or other ways of capturing carbon from the environment and storing it, to slow the warming of the climate.

Another approach is to ADAPT to the reality of climate change and try to ameliorate or reduce the health effects of this warming.

- This approach is fundamentally different -- although not contradictory (one can support both approaches).
- This approach says, how do we save lives, given that mosquitoes and other vectors are moving into new regions, natural disasters are becoming more common, crops are failing in many parts of the world, and all the other specific ways that the increased variability in the climate are ALREADY impacting health.

As you can imagine, there are MANY things we can do to help our communities be more resilient in the face of one of the greatest creeping threats to human health.

Can you think of more ways we can use ideas, tools, policies or programs that we've seen throughout the semester to help adapt to a changing climate here in California? You might think of things we saw in the Environmental Health chapter, or way back at controlling infectious and noninfectious diseases, or community organizing techniques, or adding the specific health needs of elders -- or any other topic we've touched on this semester. They all can play a part in responding to climate change.

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17.1.5.15: Co-Benefits of Taking Steps to Address Climate Change

The "good news" of taking action to reduce (mitigate) climate change and to adapt to a changing climate is that some steps to reduce carbon pollution can improve health in two ways. Obviously, by reducing climate change effects, that is good for human health. But some steps also have co-benefits for health -- side effects that improve health in other ways.

For example, walking or riding a bike avoids the carbon exhaust of driving -- and it is good for circulatory health (heart and arteries), and good for mood.

Eating more vegetables and less meat is good for the planet -- and good for digestion and reducing obesity.

Burning less coal slows climate change -- and also reduces asthma and heart disease associated with soot.

Please watch this short video from the World Health Organization on health action to respond to or prevent climate change, and its co-benefits.

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17.1.5.16: CLIMATE CHANGE POLICY

In December of 2015, 196 countries signed the Paris Agreement - a legally binding international treaty to address climate change. This treaty mandates that signatory countries set their own goals to reduce their impact on climate change, while recognizing that low-income countries may need extra funding and support in order to join in climate mitigation efforts to reduce their GHG emissions, as well to adapt to the adverse effects of climate change they are already experiencing. The long-term target of the Paris Agreement is to keep the increase in Earth's average temperature (compared to pre-industrial levels) well below 2 ℃, while pursuing the target of at or below 1.5 ℃ - since warming below 2℃ will still cause substantial climate change impacts like droughts, floods, and extreme storms. The agreement includes nationally determined contributions (NDCs) by each country; commitments to take economy-wide steps to lower GHG emissions (UNFCCC, 2015). As of the early 2020's warming is already at 1.2 ℃, yet if all of the long-term targets for GHG emissions the Paris Agreement were implemented in full and on time, it is possible that warming could be kept at or below that dire 2 ℃ mark by 2100 - but unlikely that warming could be kept under 1.5 ℃. To reach this more aggressive goal, signatory countries would have to move up their net zero emissions targets, cut CO_2 emissions by 45% and other GHG emissions substantially by the year 2030, and support other countries in doing so as well (especially low-income countries) (Meinshausen et al., 2022). Unfortunately, the United States is behind on its NDC of lowering GHG emissions by 50-52% below 2005 levels by 2030, despite positive projections assumed from implementing the Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) signed into law by President Joseph Biden. In order to close the gap, the Environmental Protection Agency (EPA) could use the Clean Air Act (see below) to set more aggressive standards for lowering pollution across industries, and the federal government could expand funding for forestry and agricultural incentives to promote mitigation and sequestration (removal of GHGs) (Clean Air Task Force, 2023).

Climate Policy in Recent US Policy

In August 2022, Congress passed the Inflation Reduction Act, which was biggest piece of legislation on climate in decades. It invested more money for addressing climate change and reducing carbon emissions than ever before. Here is a 5-minute video explanation from PBS NewsHourfrom when the law was new. The goal set the US on track for a 40% reduction in emissions.

However, with elections come many changes to policy. The current Trump Administration has been emphasizing investments and incentives for the gas and oil industries, and rollbacks to many of the climate measures in the Inflation Reduction Act (like incentives to buy electric cars). It is too early to measure the impact of these changes, but it seems likely that the 40% reduction in emissions that was forecase in 2022 will not be reached this decade.

17.1.5.16.1: The Paris Agreement

17.1.5.16.2: Climate Change Policy in California

17.1.5.16.3: Emergency preparedness (whether emergency is climate related or not)

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17.1.5.16.1: The Paris Agreement

In December of 2015, 196 countries signed the Paris Agreement - a legally binding international treaty to address climate change. This treaty mandates that signatory countries set their own goals to reduce their impact on climate change, while recognizing that low-income countries may need extra funding and support in order to join in climate mitigation efforts to reduce their GHG emissions, as well to adapt to the adverse effects of climate change they are already experiencing. The long-term target of the Paris Agreement is to keep the increase in Earth's average temperature (compared to pre-industrial levels) well below 2 ℃, while pursuing the target of at or below 1.5 ℃ - since warming below 2℃ will still cause substantial climate change impacts like droughts, floods, and extreme storms. The agreement includes nationally determined contributions (NDCs) by each country; commitments to take economy-wide steps to lower GHG emissions (UNFCCC, 2015). As of the early 2020's warming is already at 1.2 ℃, yet if all of the long-term targets for GHG emissions the Paris Agreement were implemented in full and on time, it is possible that warming could be kept at or below that dire 2 ℃ mark by 2100 - but unlikely that warming could be kept under 1.5 ℃. To reach this more aggressive goal, signatory countries would have to move up their net zero emissions targets, cut CO_2 emissions by 45% and other GHG emissions substantially by the year 2030, and support other countries in doing so as well (especially low-income countries) (Meinshausen et al., 2022). Unfortunately, the United States is behind on its NDC of lowering GHG emissions by 50-52% below 2005 levels by 2030, despite positive projections assumed from implementing the Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) signed into law by President Joseph Biden. In order to close the gap, the Environmental Protection Agency (EPA) could use the Clean Air Act (see below) to set more aggressive standards for lowering pollution across industries, and the federal government could expand funding for forestry and agricultural incentives to promote mitigation and sequestration (removal of GHGs) (Clean Air Task Force, 2023).

The United States has been in and out of the Paris Agreement. It was signed during the Obama Administration, then the first Trump Administration withdrew the US from the agreement, then the Biden Administration rejoined, then the second Trump Administration withdrew. This inconsistency may weaken US influence in future climate-related negotiations. US nonparticipation in the Paris Agreement is projected to slow the world's progress toward the goal of no more than a 2° C. rise in temperature of the overall climate, compared with pre-industrial levels, by taking off the table more than a third of the projected reduction in emissions under the Paris Agreement (Larch & Wanner, 2024).

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17.1.5.16.2: Climate Change Policy in California

In the state of California (CA), “The 100 Percent Clean Energy Act of 2018,” Senate Bill 100 (SB 100, De León) requires all electricity generation to be produced by zero-carbon sources by 2045, and at least 60% of the state’s electricity should be generated via renewable resources by 2030. Renewable energy resources include solar, wind, geothermal, bioenergy, fuel cells, and existing hydroelectric and nuclear power plants (no new nuclear power plants are to be built). According to the initial multi-agency assessment report, CA will need to triple its current electricity capacity to meet demands, and triple its solar and wind build rate. Battery storage build rates need to increase by nearly 8 times the current rate. These and other considerations to maintain a “flexible” grid will cost nearly $4.6 billion dollars by 2045. Yet, the report is positive that the goal of 100% renewable energy for electricity customers and state agencies is doable by the target year (Gill, Gutierrez, & Weeks, 2021). At the same time, the Clean Air Resources Board also enacted a rule to require all new cars and light trucks sold in CA must be fully electric or plug-in hybrids by 2035. Projections estimate that this will cut GHG emissions from motor vehicles in half by 2040, and substantially reduce cardiopulmonary deaths, emergency room visits, and asthma attacks related to smog for CA residents (CARB, 2022).

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17.1.5.16.3: Emergency preparedness (whether emergency is climate related or not)

Public health plays a key role in emergency preparedness for all kinds of disasters -- whether they are climate related or not. The need for a public health role in assessing risks, ensuring the availability of adequate medical resources, and carrying out prevention and intervention strategies seems to get highlighted in each major disaster (natural or human-caused) that occurs.

- The health dangers to the rescue and cleanup crews at the site of the World Trade Center after the September 11, 2001 attacks plus the mysterious anthrax attack through the mail that killed several people and threatened more in Washington, DC pointed to the need for public health expertise in responding to these disasters and planning for future bioterrorism attacks.
- The huge health inequities related to Hurricane Katrina in New Orleans in 2005 revealed the need to attend to vulnerable populations when managing emergencies and, on the prevention end, to involve communities in developing emergency plans that will actually work for them.
- The relative public health success in managing the pandemic of H1N1 flu in 2009-2010 showed that advance planning works -- the death count from this relatively mild but highly contagious flu strain was kept low through rapid public health action (around 284,000 deaths worldwide, according to the World Health Organization, cited by the Mayo Clinic).
- Obviously, the covid-19 pandemic that began in late 2019 and by 2020 was causing major disruptions and deaths worldwide pointed to both the value of emergency planning where it worked to prevent worse outcomes and the shortfalls of existing plans, given that this coronavirus has caused more than 7 million deaths worldwide to date.

Some of the roles that public health organizations can play in emergency preparedness include

- Surveillance. The public health practice of routine monitoring of disease outbreaks can assist in identifying a potential emergency in its earliest stages -- whether the pathogen is naturally occurring or spread through bioterrorism. With climate change, we expact vector-borne diseases (like malaria and dengue) to spread into new regions as mosquitoes, ticks and other disease-carrying animals migrate to newly-warm areas. Surveillance will be key to detecting these outbreaks early.
- Epidemiological and laboratory investigation of pathogens. Epidemiological investigation and analysis can determine the identity, source, and mode of transmission for disease agents (pathogens). Understanding how a disease spreads is essential to developing effective interventions to stop the spread. Laboratory capacity to test rare or unusual agents is not found everywhere -- different laboratories have different specializations -- yet the network of public health laboratories together need to be ready for any emerging threat.
- Risk communications. In an emergency, communication is more vital than ever. Public health communications to the public should be clear, concise, and accurate. When information changes -- as it undoubtedly will -- the change in message to the community must be explained adequately. (Otherwise, the public may be confused or distrust the messages.) Public health can also assist with interagency communication and coordination during an emergency.
- Planning. Involving key stakeholders, including vulnerable communities, in making emergency preparedness plans is a strength of public health planning efforts. Planning can help ensure that emergency medical services and hospital capacity can respond to a health emergency, including providing for the safety of medical personnel. Public health emergency preparedness can include running possible scenarios, establishing action protocols, training personnel, maintaining relationships among partnering agencies, and analyzing the vulnerability of specific communities. Where possible, planning efforts can help vulnerable communities reduce their exposure, for example, reducing the risk of wildfire, preparing cooling stations in advance of heatwaves so vulnerable people have a place to go to cool off, or reducing construction in flood zones.
- Community-wide response. Public health agencies can play a role in coordinating community-wide responses to an emergency, where many different entities are involved.
- Stockpiling supplies. In preparation for pandemic flu, the US, for example, stockpiled antiviral medications effective against the flu. These were not effective against covid, yet may still be a welcome forethought should the avian flu H1N5 evolve to be easily transmitted among humans, a public health nightmare. Stockpiles of masks, respirators, and other supplies is also warranted.

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17.1.5.17: Additional Resources

The resources on this page are intended as optional tools for you to review key points of this chapter and/or deepen your knowledge in specific areas.

Overview of the Environment Affects Health

This episode from Crash Coaurse (remember them from Chapter One?) provides a good summary of the environment affects human health, recapping many of the key points in this chapter, including air pollutants, water pollutants, climate change, and environmental justice.

YouTube Video

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More about ozone

Every semester, I've noticed some students get confused about **ozone**! Ozone is a three-atom modecule of oxygen (O_3). We can't use it to breathe (we breathe ithe two-atom version, O_2). Ozone is produced through a variety of industrial processes and also naturally. Having *some* ozone around isn't a threat (remember, "the dose makes the poison.") Having high concentrations of **surface-level ozone** -- meaning, ozone in the air we walk around in at the surface of the earth -- is problematic, though. It increases the risk of many lung diseases and can actually injure our lungs. That's why ozone is a criteria pollutant that the EPA closely monitors -- one of six criteria pollutants that are common and especially important to human health.

But what about the ozone layer? Ozone in the upper atmosphere is very important to protecting humans from harmful radiation from the sun. Ozone in the upper atmosphere is like sunscreen for the planet -- it protects us all from cancer. The upper atmosphere is far from where we walk around breathing, so ozone up there is no threat to human health -- in fact, quite the opposite.

What's the hole in the ozone layer, and what's happening with it? Due to the use of certain chemicals (CFCs) in lots of manufactured products (from hair spray to refrigerators), CFC pollution has caused a breakdown of ozone in the upper atmosphere, especially over Antartica, where a hole in the ozone layer was discovered in the 1980's. **In a rare example of international cooperation on environmental dangers**, every country in the world signed the Montreal Protocol, agreeing to stop using CFCs. The hole in the ozone layer is recovering and is expected to close sometime in the middle of the 2100's. Success is in progress!

You can see more about this through this 2-minute NASA video, or this 8-minute Vox explainer video. Both are OPTIONAL.

YouTube Video

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Is the hole in the ozone layer connected to climate change? Not much! They are two different problems, with different causes. There are a *few* connections between the two, though, which you can read about at this NASA blog post if you are curious.

History of Environmental Health:

This 2011 video offers a historical view of environmental health. Some of the early successes of this branch of public health are ones we take for granted now, yet had a huge impact in their day. This video lacks closed captions -- it is an optional, supplementary resource.

American Public Health Association: Environment • Health • You from Lila Films on Vimeo.

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17.1.5.18: References - if not already on each page

The following list of references is for the Environmental Health chapter of Erin Calderone's *Public Health 101*. Significant portions of that book are included in this chapter, and while in general I have placed the references at the bottom of each page, for some pages they can be found in this list instead.

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18: PERSONAL SAFETY

18.1: Preventing Injuries and Violence

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18.1: PREVENTING INJURIES AND VIOLENCE

Learning Outcomes

By the end of this chapter you will be able to:

- Recognize the common types of unintentional and intentional injuries
- Identify ways to reduce chances of unintentional and intentional injuries
- Explain how risk from injury changes throughout life stages.

What steps can you take to reduce the chances of accidental injuries?

How can you reduce chances of injuries from violence?

There are many choices you make in life that impact your health and well-being and some of those choices, like smoking cigarettes, have a direct connection to a negative health implication, like lung cancer. Although the choices you make may or may not directly impact the possibility of suffering intentional and unintentional injuries, understanding the most common reasons for injury can help you increase your safety.

18.1.1: Introduction to Intentional and Unintentional Injuries

18.1.2: Unintentional Injuries

18.1.3: Intentional Injuries - Violence

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18.1.1: Introduction to Intentional and Unintentional Injuries

Throughout the world, injuries, both unintentional and violence-related, take the lives of 4.4 million people each year (nearly 8% of all deaths). For people ages 5-29, three of the top five causes of death are injury-related. In the United States, unintentional injuries are the leading cause of death in children, adolescents, and adults younger than 45 years. In 2018, unintentional injuries were the cause of 24.8 million people to visit their doctor and 97.9 million to visit the emergency room with an additional 1.2 million visited the emergency room due to an assault. Unintentional injuries ranked as the 4th overall leading cause of death in 1980, increased to the 3rd leading cause of death by 2018, and moved back to 4th in 2020 when COVID took the 3rd ranking. Some good news is that data from 1950-2018 show a reduction in deaths due to unintentional injuries from 78 per 100,000 to 48 per 100,000, however homicide has remained relatively the same from 5.1 to 5.9 per 100,000 people [1].

Injuries and violence cost billions of dollars each year in health care costs, lost productivity and law enforcement. There are also numerous costs to personal well-being including:

- Premature death
- Years of potential life lost
- Disability and disability-adjusted life years lost
- Poor mental health
- Increased risk of suicide
- High medical costs
- Lost productivity
- Chronic diseases like heart disease, diabetes and cancer
- Social problems such as poverty, crime and violence

Both intentional and unintentional injuries are public health concerns that are addressed worldwide and in the U.S. The National Center for Injury Prevention and Control (NCIPC) was launched in 1992 to focus specifically on injuries as an important topic for public health. The NCIPC, along with the CDC and NIH, provide research-based evidence and resources to meet goals to reduce injuries.

Table 18.1.1.1 *: Year 2020 Intentional and Unintentional Death Rates*[2]

Cause of Death	Number of Deaths	Deaths per 100,000 people
Unintentional fall deaths	42,112	12.8
Motor Vehicle traffic deaths	40,698	12.4
Unintentional Poisoning deaths	87,404	26.5
All poisoning deaths	97,034	29.5
Firearm homicides	19,384	5.9
All firearm deaths	45,222	13.7
All homicide deaths	24,576	7.5
Firearm suicides	24,292	7.4
Suffocation suicides	12,495	3.8
Poisoning suicides	5,528	1.7
All suicides	45,979	14.0
All injury deaths	278,345	84.5
All unintentional deaths	200,995	61

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18.1.2: Unintentional Injuries

Unintentional injuries are often referred to as “accidents,” meaning something that was not intended. These include falls, drowning, motor vehicle crashes, fires, and poisoning.

Falls

For adults over 65 years, falls are the leading cause of death due to injury. In 2019 older adult falls caused 34,000 deaths, 3 million visits to the emergency room, and over 800,000 hospitalizations attributing to over $50 billion in medical costs annually. It is estimated that more than one out of four older people fall each year with one out of five falls causing serious injury. Traumatic brain injuries (TBI) and hip fractures are the most common serious injuries. The injuries associated with falls impact a persons quality of life making it hard for a person to get around, do everyday activities, or live on their own. Many people who fall, even if they’re not injured, become afraid of falling. This fear may impact their quality of life by causing a person to cut down on their everyday activities. When a person is less active, they become weaker and this increases their chances of falling.

Fall risk and prevention tips include:

- Lower body weakness, difficulties with walking and balance, or foot pain or poor footwear
  - Do exercises that make your legs stronger and improve your balance. Tai Chi is a good example of this kind of exercise.
  - Ask your doctor or healthcare provider to evaluate your risk for falling and talk with them about specific things you can do.
- Vitamin D deficiency (that is, not enough vitamin D in your system)
  - Ask your doctor or healthcare provider about taking vitamin D supplements.
- Use of medicines, such as tranquilizers, sedatives, or antidepressants. Even some over-the-counter medicines can affect balance and how steady you are on your feet.
  - Ask your doctor or pharmacist to review your medicines to see if any might make you dizzy or sleepy. This should include prescription medicines and over-the counter medicines.
- Vision problems
  - Have your eyes checked by an eye doctor at least once a year, and be sure to update your eyeglasses if needed.
  - If you have bifocal or progressive lenses, you may want to get a pair of glasses with only your distance prescription for outdoor activities, such as walking. Sometimes these types of lenses can make things seem closer or farther away than they really are.
- Home hazards or dangers such as broken or uneven steps, and throw rugs or clutter that can be tripped over.
  - Get rid of things you could trip over.
  - Add grab bars inside and outside your tub or shower and next to the toilet.
  - Put railings on both sides of stairs.
  - Make sure your home has lots of light by adding more or brighter light bulbs.
  - Keep items you use often in cabinets you can reach easily without using a step stool.
  - Use non-slip mats in the bathtub and on shower floors.

Drowning

Drowning is the process of experiencing respiratory impairment from submersion or immersion in liquid. Drowning can happen in seconds and is often silent. It can happen to anyone, any time there is access to water. Not all drownings are fatal, drowning injuries can cause brain damage and other serious outcomes, including long-term disability. Drowning kills nearly 4,000 people each year in the United States and is the leading cause of injury death for children 1 to 4 years of age. For every child who dies from drowning, another eight receive emergency department care for non-fatal drowning. Not all drownings are fatal, drowning injuries can cause brain damage and other serious outcomes, including long-term disability.

Drowning risk and prevention tips include:

- Not being able to swim
  - Adults and children should participate in formal swim lessons.
- Missing or ineffective fences around water

    - A four-sided isolation fence which separates the pool area from the house and yard reduces a child's risk of drowning by 83% compared to three-sided property-line fencing (which encloses the entire yard, but does not separate the pool from the house).
- Lack of close supervision
    - Drowning can happen quickly and quietly anywhere there is water, especially to unsupervised children. It happens in lakes and oceans, pools, bathtubs, and even buckets of water. Drowning can occur when lifeguards are present.
    - Use the buddy system! Always swim with another person.
- Location
    - The highest risk locations for drowning vary by age. Among infants under 1 year old, two thirds of all drownings occur in bathtubs. Most drownings happen in home swimming pools among children ages 1-4. More than half of fatal and nonfatal drownings among people 15 years and older occur in natural waters like lakes, rivers, or oceans.
    - It is important to know the risks or natural water, such as ocean rip currents.
- Not wearing life jackets
    - Life jackets can prevent drowning during water activities, especially boating and swimming.The U.S. Coast Guard reported 613 boating-related deaths in 2019, 79% of these deaths were drowning related, and of those who died from drowning 86% were not wearing life jackets.
- Drinking alcohol or using drugs
    - Among adolescents and adults, alcohol use is involved in:
        - up to 70% of deaths associated with water recreation,
        - nearly 1 in 4 emergency department visits for drowning, and
        - about 1 in 5 reported boating deaths.

Motor Vehicle Crashes

In 2021, more than 43,000 people died in motor vehicle crashes in the United States, that is more than 117 people killed in crashes every day. There were over 2.1 million emergency department visits for injuries from motor vehicle crashes in 2020. Deaths from crashes in 2021 resulted in over $430 billion in total costs—including medical costs and cost estimates for lost quality of life and lives lost. Motor vehicle injuries are often associated with distracted, impaired, or inexperienced drivers.

Distracted Drivers

- Distracted driving is doing another activity that takes the driver's attention away from driving that can increase the chance of a motor vehicle crash. There are three main types of distracted driving: visual (taking your eyes off the road), manual (taking your hands off the wheel), and cognitive (taking your mind off driving).
- In 2021, 3,100 people were killed and about 424,000 were injured in crashes involving a distracted driver. Not all persons killed by distracted drivers were in cars, about 1 in 5 were walking, riding their bikes, or otherwise outside a vehicle.
- Prevention: Do not multitask while driving. Whether it's adjusting your mirrors, selecting music, eating, making a phone call, or reading a text or email—do it before or after your trip, not during.

At 55 mph, sending or receiving a text is like driving the length of a football field with your eyes closed.

Child Passenger Safety

- Motor vehicle injuries are a leading cause of death among children in the United States. But many of these deaths can be prevented. Always buckling children in age- and size-appropriate car seats, booster seats, and seat belts reduces serious and fatal injuries by up to 80%.

Seatbelts

- Although most drivers follow these safety measures on every trip, there are still millions who don't. In fact, it is estimated that 2,549 lives (of people 5 years and older) could have been saved in 2017 alone if all motor vehicle occupants were restrained on every trip.

Teen Drivers

- In 2019, almost 2,400 teens in the United States aged 13–19 were killed and about 258,000 were treated in emergency departments for injuries suffered in motor vehicle crashes. That means that every day, about seven teens died due to motor vehicle crashes, and hundreds more were injured. In addition, motor vehicle crash deaths among teens 15–19 years of age

resulted in about $4.8 billion in medical and work loss costs for crashes that occurred in 2018.
- Teens who are at especially high risk for motor vehicle crashes are: Males, teens driving with teen or young adult passengers, and newly licensed teens.
- Risk factors include: Inexperience, nighttime and weekend driving, not using a seat belt, distracted driving, speeding, alcohol/drug use

Older drivers

- In 2019, about 8,000 older adults (aged 65+) were killed in traffic crashes, and more than 250,000 were treated in emergency departments for crash injuries. This means that each day, more than 20 older adults are killed and almost 700 are injured in crashes. Drivers aged 70+ have higher crash death rates per mile driven than middle-aged drivers (aged 35-54). Higher crash death rates among this age group are primarily due to increased vulnerability to injury in a crash. Across all age groups, males have substantially higher death rates than females.
- Age-related declines in vision and cognitive functioning (ability to reason and remember), as well as physical changes, might affect some older adults' driving abilities.

Impaired driving

- Every day, 29 people in the United States die in motor vehicle crashes that involve an alcohol-impaired driver, this is one death every 50 minutes. The annual cost of alcohol-related crashes totals more than $44 billion.
- Drugs other than alcohol (legal and illegal) are involved in about 16% of motor vehicle crashes. In 2018, 12.6 million people reported driving under the influence of marijuana or other illicit drugs.
- Drugs other than alcohol (legal and illegal) are involved in about 16% of motor vehicle crashes.

Pedestrian Safety

- More than 7,000 pedestrians were killed on our nation's roads in crashes involving a motor vehicle in 2020. That's about one death every 75 minutes.
- Alcohol, speeding, and location are major risk factors for pedestrian deaths caused by motor vehicles.
- Adults aged 65 years and older accounted for 20% of all pedestrian deaths in 2020, yet were only about 17% of the U.S. population.
- Pedestrian injuries can be reduced by: increasing your visibility, using cross walks, using designated sidewalks/paths, avoiding distractions while walking like headphones, and avoid walking when impaired.

Motorcycle Safety

- More than 5,500 motorcyclists died on our nation's roads in 2020, and more than 180,000 were treated in emergency departments for crash injuries.
- Motorcycle helmets are important to save lives. In 2017, helmets saved an estimated 1,872 lives and an additional 749 more lives could have been saved if all motorcyclists had worn helmets. Motorcycle helmets are 37 percent (for riders) and 41 percent (for passengers) effective in preventing deaths. Helmets reduce the risk of head injury by 69%.

Bicycle Safety

- Bicycle trips make up only 1% of all trips in the United States. However, bicyclists account for over 2% of people who die in a crash involving a motor vehicle on our nation's roads. Nearly 1,000 bicyclists die and over 130,000 are injured in crashes that occur on roads in the United States every year.
- Adults ages 55-69 have the highest bicycle death rates and adolescents, teens, and young adults have the highest rates of bicycle-related injuries treated in emergency departments (EDs).
- Male bicyclists have death rates 6 times higher and injury rates 5 times higher than females.

Fires

Fire is fast, in less than 30 seconds a small flame can turn into a major fire. In 2019, there were 1,291,500 fires which caused 3,704 deaths, 16,600 injuries, and accounts for $14.8 billion.

Home fire safety:

- Smoke alarms

    - Put smoke alarms on every level of your home and inside/outside of all sleeping areas.
    - Test them often to make sure they work and replace them after 10 years.
- In the kitchen
    - Do not leave the room when cooking, if you leave the kitchen turn off the burners.
    - Move flammable objects away from the cooking area.
    - Turn pot handles toward the back of the stove to avoid unintentionally knocking them.
- Home heating
    - Move flammable objects away from fireplaces, wood stoves, space heaters, or radiators.
    - Never use an extension cord with a space heater.
    - Ensure space heaters have an auto turn off if tipped over.
    - Have your chimney inspected.
- Smoking in the house
    - If you smoke in your home you have an increased risk of home fires.
    - Never smoke in bed or when drowsy
    - Ensure all cigarettes are completely put out- use water to ensure!
- Young children and older adults
    - Keep children away for anything that gets hot.
    - Keep matches and lighters out of reach of children.
    - Teach children how to escape the home if you cannot help them in the event of a home fire.
    - Older adults may need assistance to escape a home fire.

Poisoning

Poisoning is one of the top three causes of fatal unintentional injuries. In response to public health concerns regarding poisoning, in 1980 the National Capital Poison Center (NCPC) was founded, which is an independent, not-for-profit 501(c)(3) organization. There are 2 ways to get help from Poison Control: online at webPOISONCONTROL® or by phone at 1-800-222-1222.

As the primary organization providing help with poisoning, the NCPC data provides a picture of the commonality of injuries associated with poisoning. In 2020, the 55 U.S. poison control centers provided telephone guidance for over 2.1 million human poison exposures, which included:

- 6.4 poison exposures/1000 population,
- 37.9 poison exposures in children younger than 6 years/1000 children,
- 1 poison exposure reported to U.S. poison control centers every 15 seconds.
- In 2020, adults comprised almost half of all exposures (47%), followed by children younger than 6 (39%), then teens (8%).

Common types of poisoning include food poisoning, poisonous plants, and carbon monoxide poisoning.

Food poisoning symptoms can be anywhere from mild to very serious and may include: Upset stomach, stomach, cramps, nausea, vomiting, diarrhea, and fever. Some foods are more associated with foodborne illnesses and food poisoning than others, such as raw animal foods. While certain foods are more likely to make you sick, any food can get contaminated in the field, during processing, or during other stages in the food production chain, including through cross-contamination with raw meat in kitchens.

Many native and exotic plants are poisonous to humans when ingested or if there is skin contact with plant chemicals. However, the most common problems with poisonous plants arise from contact with the sap oil of several native plants that cause an allergic skin reaction—poison ivy, poison oak, and poison sumac.

Everyone is at risk for Carbon monoxide (CO) poisoning. CO, an odorless, colorless gas, that can cause sudden illness and death. CO is found in fumes produced any time you burn fuel in cars or trucks, small engines, stoves, lanterns, grills, fireplaces, gas ranges, or furnaces. CO can build up indoors and poison people and animals who breathe it. The most common symptoms of CO poisoning are headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion. CO symptoms are often described as “flu-like.” If you breathe in a lot of CO it can make you pass out or kill you. People who are sleeping or drunk can die from CO poisoning before they have symptoms. It is important to use Carbon Monoxide detectors to know if CO is present.

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18.1.3: Intentional Injuries - Violence

There are many forms of intentional injury, or violence. The CDC approaches violence using the “Social-Ecological Model: a Framework for Prevention”. The framework encourages viewing violence and violence prevention as a multifaceted interconnected dynamic including the individual, their relationships, their community, and our society.

- The Individual
  - Individuals factors such as age, education, income, substance use, or history of abuse impact the risk of violence. A focus on attitudes, beliefs, behaviors, along with training on conflict resolution, safe dating, and healthy relationship may positively impact their risk of violence.
- Relationships
  - A person’s closest social circle-peers, partners and family members-influences their behavior and contribute to their experience. Parenting, mentors, effective communication, and problem solving may support effective relationships to prevent violence.
- Community
  - Where a person lives, works, or goes to school can impact their risk of violence. Creating safe physical and social environments may reduce violence in the community.
- Societal
  - A focus on society asks us to understand and look at how our society either encourages or inhibits violence, for example how social or cultural norms use violence to resolve conflicts or how wealth and health inequalities impact violence risk.

Community Violence

Community violence is interpersonal violence generally outside the home that is perpetrated by individuals who are not intimately related to the victim and who may or may not know each other. Examples include assaults, homicides, fights among groups, and shootings in public places, such as schools and on the streets. Acts of community violence include but are not limited to riots, sniper attacks, gang wars, drive-by shootings, bullying, workplace assaults, terrorist attacks, torture, bombings, war, ethnic cleansing, and widespread sexual, physical, and emotional abuse.

Young people are disproportionately impacted by violence in their communities, including firearm injuries and deaths. Violence is a leading cause of death and nonfatal injuries among adolescents and young adults; over half of US homicides in 2019 occurred among those ages 15 to 34. Unfortunately, data show significant increases in homicide rates in 2020 compared to 2019.

People’s health outcomes are influenced by the conditions in which they live, work, play, and learn. These conditions are called social determinants of health. Systemic racism, bias, and discrimination; economic instability; concentrated poverty; and limited housing, education, and healthcare access drive health inequities, such as violence. Communities of color often disproportionately experience these negative conditions, placing residents at greater risk for poor health outcomes. For example, Black or African American, American Indian, and Alaskan Native, and Hispanic or Latino persons have higher homicide rates than other racial and ethnic demographic groups. Research indicates that youth and young adults (ages 10-34), particularly those in communities of color, are disproportionately impacted.

Community violence can cause significant physical injuries and mental health conditions such as depression, anxiety, and post-traumatic stress disorder (PTSD). Living in a community experiencing violence is also associated with increases in risk of developing chronic diseases, as concerns about violence may prevent someone from engaging in healthy behaviors, such as walking, bicycling, using parks and recreational spaces, and accessing healthy food outlets. Violence scares people out of participating in neighborhood activities; limits business growth and prosperity; strains education, justice, and medical systems; and slows community progress.

The Division of Violence Prevention (DVP) at the Centers for Disease Control and Prevention (CDC) is focused on preventing community violence by identifying and implementing science-based programs, policies, and practices with partners and communities to disseminate, implement, and scale-up strategies based on the best available evidence to create safer communities, such as:

- Changing social norms through street outreach/violence interruption programs.
- Changing the physical environment through Crime Prevention Through Environmental Design (CPTED).

- Preventing future risk and lessening the harms of violence exposure through hospital-community partnerships, and treatment services such as Trauma-Focused Cognitive Behavior Therapy ®(TF-CBT) and Multisystemic Therapy® (MST).
- Strengthening economic supports through job training and summer jobs programs.
- Strengthening youth's skills through universal school-based programs to help youth develop skills to prevent violence and engage in healthy behaviors.
- Connecting youth to caring adults and activities such as mentoring and after-school programs.

Intimate and Partner Violence

Intimate partner violence (IPV) is abuse or aggression that occurs in a romantic relationship. "Intimate partner" refers to both current and former spouses and dating partners. **IPV is common.** It affects millions of people in the United States each year and often starts early and continues throughout life. When IPV occurs in adolescence, it is called teen dating violence (TDV). About 1 in 4 women and nearly 1 in 10 men have experienced contact sexual violence, physical violence, and/or stalking by an intimate partner during their lifetime and reported some form of IPV-related impact. About 11 million women and 5 million men who reported experiencing contact sexual violence, physical violence, or stalking by an intimate partner in their lifetime said that they first experienced these forms of violence before the age of 18. Youth from groups that have been marginalized, such as sexual and gender minority youth, are at greater risk of experiencing sexual and physical dating violence.

IPV can vary in how often it happens and how severe it is and might include:

- **Physical violence** is when a person hurts or tries to hurt a partner by hitting, kicking, or using another type of physical force.
- **Sexual violence** is forcing or attempting to force a partner to take part in a sex act, sexual touching, or a non-physical sexual event (e.g., sexting) when the partner does not or cannot consent.
- **Stalking** is a pattern of repeated, unwanted attention and contact by a partner that causes fear or concern for one's own safety or the safety of someone close to the victim.
- **Psychological aggression** is the use of verbal and non-verbal communication with the intent to harm another partner mentally or emotionally and/or to exert control over another partner.

IPV Prevention includes:

Teach safe and healthy relationship skills

- Social-emotional learning programs for youth
- Healthy relationship programs for couples

Engage influential adults and peers

- Men and boys as allies in prevention
- Bystander empowerment and education
- Family-based programs

Disrupt the developmental pathways toward partner violence

- Early childhood home visitation
- Preschool enrichment with family engagement
- Parenting skill and family relationship programs
- Treatment for at-risk children, youth and families

Create protective environments

- Improve school climate and safety
- Improve organizational policies and workplace climate
- Modify the physical and social environments of neighborhoods

Strengthen economic supports for families

- Strengthen household financial security
- Strengthen work-family supports

Support survivors to increase safety and lessen harms

- Victim-centered services
- Housing programs
- First responder and civil legal protections
- Patient-centered approaches
- Treatment and support for survivors of IPV, including TDV
- Workplace Injuries

Sexual Violence

Sexual violence is sexual activity when consent is not obtained or freely given. It is a serious public health problem in the United States that affects millions of people each year in the United States and profoundly impacts lifelong health, opportunity, and well-being. Researchers know the numbers underestimate this problem because many cases are unreported. Victims may be ashamed, embarrassed, or afraid to tell the police, friends, or family about the violence. Victims may also keep quiet because they have been threatened with further harm if they tell anyone or do not think anyone will help them.

Sexual violence impacts every community and affects people of all genders, sexual orientations, and ages. Anyone can experience or perpetrate sexual violence. The perpetrator of sexual violence is usually someone the victim knows, such as a friend, current or former intimate partner, coworker, neighbor, or family member. Sexual violence can occur in person, online, or through technology, such as posting or sharing sexual pictures of someone without their consent, or non-consensual sexting.

The data shows:

- **Sexual violence is common.** More than 1 in 3 women and 1 in 4 men have experienced sexual violence involving physical contact during their lifetimes. Nearly 1 in 5 women and 1 in 38 men have experienced completed or attempted rape, and 1 in 14 men was made to penetrate someone (completed or attempted) during his lifetime.
- **Sexual violence starts early.** One in 3 female rape victims experienced it for the first time between 11-17 years old and 1 in 8 reported that it occurred before age 10. Nearly 1 in 4 male rape victims experienced it for the first time between 11-17 years old and about 1 in 4 reported that it occurred before age 10.
- **Sexual violence is costly.** Recent estimates put the lifetime cost of rape at $122,461 per victim, including medical costs, lost productivity, criminal justice activities, and other costs.

Sexual Violence Prevention includes:

Promote Social Norms that Protect Against Violence

- Bystander approaches
- Mobilizing men and boys as allies

Teach Skills to Prevent Sexual Violence

- Social-emotional learning
- Teaching healthy, safe dating and intimate relationship skills to adolescents
- Promoting healthy sexuality
- Empowerment-based training

Provide Opportunities to Empower and Support Girls and Women

- Strengthening economic supports for women and families
- Strengthening leadership and opportunities for girls

Create Protective Environments

- Improving safety and monitoring in schools
- Establishing and consistently applying workplace policies
- Addressing community-level risks through environmental approaches

Support Victims/Survivors to Lessen Harms

- Victim-centered services
- Treatment for victims of SV
- Treatment for at-risk children and families to prevent problem behavior including sex offending

Firearm Violence

A firearm injury is a gunshot wound or penetrating injury from a weapon that uses a powder charge to fire a projectile. Weapons that use a power charge include handguns, rifles, and shotguns. Injuries from air- and gas-powered guns, BB guns, and pellet guns are not considered firearm injuries as these types of guns do not use a powder charge to fire a projectile.

Firearm violence is a serious public health problem that impacts the health and safety of Americans. Important gaps remain in our knowledge about the problem and ways to prevent it. Addressing these gaps is an important step toward keeping individuals, families, schools, and communities safe from firearm violence and its consequences.

Firearm injuries are a serious public health problem. In 2020, there were 45,222 firearm-related deaths in the United States, that's about 124 people dying from a firearm-related injury each day. More than half of firearm related deaths were suicides and more than 4 out of every 10 were firearm homicides.

More people suffer nonfatal firearm-related injuries than die. More than seven out of every 10 medically treated firearm injuries are from firearm-related assaults. Nearly 2 out of every 10 are from unintentional firearm injuries. There are few intentionally self-inflicted firearm-related injuries seen in hospital emergency departments. Most people who use a firearm in a suicide attempt, die from their injury.

Firearm injuries affect people in all stages of life. In 2020, firearm-related injuries were among the 5 leading causes of death for people ages 1-44 in the United States.

Some groups have higher rates of firearm injury than others. Men account for 86% of all victims of firearm death and 87% of nonfatal firearm injuries. Rates of firearm violence also vary by age and race/ethnicity. Firearm homicide rates are highest among teens and young adults 15-34 years of age and among Black or African American, American Indian or Alaska Native, and Hispanic or Latino populations. Firearm suicide rates are highest among adults 75 years of age and older and among American Indian or Alaska Native and non-Hispanic white populations.

There are many types of firearm injuries, which can be fatal or nonfatal:

- **Intentionally self-inflicted**
  - Includes firearm suicide or nonfatal self-harm injury from a firearm
- **Unintentional**
  - Includes fatal or nonfatal firearm injuries that happen while someone is cleaning or playing with a firearm or other incidents of an accidental firing without evidence of intentional harm
- **Interpersonal violence**
  - Includes firearm homicide or nonfatal assault injury from a firearm
- **Legal intervention**
  - Includes firearm injuries inflicted by the police or other law enforcement agents acting in the line of duty
    - For example, firearm injuries that occur while arresting or attempting to arrest someone, maintaining order, or ensuring safety
  - The term *legal intervention* is a commonly used external cause of injury classification. It does not indicate the legality of the circumstances surrounding the death.
- **Undetermined intent**
  - Includes firearm injuries where there is not enough information to determine whether the injury was intentionally self-inflicted, unintentional, the result of legal intervention, or from an act of interpersonal violence.

It is important to store all firearms safely when not in use. Putting a firearm out of sight or out of reach is **not safe storage and not enough** to prevent use by children or unauthorized adults.

Drug Overdose

Drug overdoses are now the leading cause of injury deaths in the United States, and most overdoses involve opioids. More than

932,000 people have died since 1999 from a drug overdose. In 2020, 91,799 drug overdose deaths occurred in the United States. The age-adjusted rate of overdose deaths increased by 31% from 2019 (21.6 per 100,000) to 2020 (28.3 per 100,000). Opioids, mainly synthetic opioids (other than methadone), are currently the main driver of drug overdose deaths. 82.3% of opioid-involved overdose deaths involved synthetic opioids. Research shows that people who have had at least one overdose are more likely to have another. In 2020, an **estimated 41.1 million Americans** needed substance use disorder treatment, but **only 2.6 million people** with a substance use disorder in the past year received treatment.

Prevention Startegies include:

- **Increase and maximize** use of prescription drug monitoring programs, which are state-run databases that track prescriptions for controlled substances and can help improve opioid prescribing, inform clinical practice, and protect those at risk.
- **Learn** about the risks of prescription opioids and about the help and resources that are available for someone who may be struggling with opioid use disorder.
- **Treat opioid use disorder** by increasing access to substance use disorder treatment services, including Medication-Assisted Treatment (MAT) and Medications for Opioid Use Disorder (MOUD).
- **Reverse overdose** by expanding access to naloxone, a drug used to reverse overdose, for community members (family members and neighbors) and service providers (i.e., first responders).

Child Abuse and Neglect

Child abuse and neglect are serious public health problems that can have long-term impact on health, opportunity, and wellbeing. At least 1 in 7 children have experienced child abuse or neglect in the past year in the United States. however this is likely an underestimate because many cases are unreported. In 2020, 1,750 children died of abuse and neglect in the United States. Experiencing poverty can place a lot of stress on families, which may increase the risk for child abuse and neglect. Rates of child abuse and neglect are 5 times higher for children in families with low socioeconomic status. In the United States, the total lifetime economic burden associated with child abuse and neglect was about $592 billion in 2018. This economic burden rivals the cost of other high-profile public health problems, such as heart disease and diabetes.

This issue includes all types of abuse and neglect of a child under the age of 18 by a parent, caregiver, or another person in a custodial role (such as a religious leader, a coach, a teacher) that results in harm, the potential for harm, or threat of harm to a child. There are four common types of abuse and neglect:

- **Physical abuse** is the intentional use of physical force that can result in physical injury. Examples include hitting, kicking, shaking, burning, or other shows of force against a child.
- **Sexual abuse** involves pressuring or forcing a child to engage in sexual acts. It includes behaviors such as fondling, penetration, and exposing a child to other sexual activities.
- **Emotional abuse** refers to behaviors that harm a child's self-worth or emotional well-being. Examples include name-calling, shaming, rejecting, withholding love, and threatening.
- **Neglect** is the failure to meet a child's basic physical and emotional needs. These needs include housing, food, clothing, education, access to medical care, and having feelings validated and appropriately responded to.

Risk Factors for Victimization include

Individual Risk Factors

- Children younger than 4 years of age
- Children with special needs that may increase caregiver burden (e.g., disabilities, mental health issues, and chronic physical illnesses)

Risk Factors for Perpetration

- Caregivers with drug or alcohol issues
- Caregivers with mental health issues, including depression
- Caregivers who don't understand children's needs or development
- Caregivers who were abused or neglected as children
- Caregivers who are young or single parents or parents with many children
- Caregivers with low education or income

- Caregivers experiencing high levels of parenting stress or economic stress
- Caregivers who use spanking and other forms of corporal punishment for discipline
- Caregivers in the home who are not a biological parent
- Caregivers with attitudes accepting of or justifying violence or aggression

Family Risk Factors

- Families that have household members in jail or prison
- Families that are isolated from and not connected to other people (extended family, friends, neighbors)
- Families experiencing other types of violence, including relationship violence
- Families with high conflict and negative communication styles

Community Risk Factors

- Communities with high rates of violence and crime
- Communities with high rates of poverty and limited educational and economic opportunities
- Communities with high unemployment rates
- Communities with easy access to drugs and alcohol
- Communities where neighbors don't know or look out for each other and there is low community involvement among res
- dents
- Communities with few community activities for young people
- Communities with unstable housing and where residents move frequently
- Communities where families frequently experience food insecurity

Prevention Strategies include:

Strengthen economic supports to families

- Strengthening household financial security
- Family-friendly work policies

Change social norms to support parents and positive parenting

- Public engagement and education campaigns
- Legislative approaches to reduce corporal punishment

Provide quality care and education early in life

- Preschool enrichment with family engagement
- Improved quality of child care through licensing and accreditation

Enhance parenting skills to promote healthy child development

- Early childhood home visitation
- Parenting skill and family relationship approaches

Intervene to lessen harms and prevent future risk

- Enhanced primary care
- Behavioral parent training programs
- Treatment to lessen harms of abuse and neglect exposure
- Treatment to prevent problem behavior and later involvement in violence

Suicide

Suicide is death caused by injuring oneself with the intent to die. A suicide attempt is when someone harms themselves with any intent to end their life, but they do not die as a result of their actions.

Suicide rates increased 30% between 2000–2018, and declined in 2019 and 2020. Even with the decline in 2020, Suicide was

still a leading cause of death in the United States, with nearly 46,000 deaths in 2020. This is about one death every 11 minutes. In 2020, suicide was among the top 9 leading causes of death for people ages 10-64 and was the second leading cause of death for people ages 10-14 and 25-34. The number of people who think about or attempt suicide is even higher. In 2020, an estimated 12.2 million American adults seriously thought about suicide, 3.2 million planned a suicide attempt, and 1.2 million attempted suicide.

Americans with higher than average rates of suicide are veterans, people who live in rural areas, and workers in certain industries and occupations like mining and construction. Young people who identify as lesbian, gay, or bisexual have higher rates of suicidal thoughts and behavior compared to their peers who identify as heterosexual. People who have experienced violence, including child abuse, bullying, or sexual violence have a higher suicide risk.

Suicide and suicide attempts cause serious emotional, physical, and economic impacts. People who attempt suicide and survive may experience serious injuries that can have long-term effects on their health. They may also experience depression and other mental health concerns. The good news is that more than 90% of people who attempt suicide and survive never go on to die by suicide.

Suicide and suicide attempts affect the health and well-being of friends, loved ones, co-workers, and the community. When people die by suicide, their surviving family and friends may experience shock, anger, guilt, symptoms of depression or anxiety, and may even experience thoughts of suicide themselves.

Being connected to family and community support and having easy access to health care can decrease suicidal thoughts and behaviors.

Suicide Prevention strategies include:

- Strengthen economic supports
  - Strengthen household financial security
  - Housing stabilization policies
- Strengthen access and delivery of suicide care
  - Coverage of mental health conditions in health insurance policies
  - Reduce provider shortages in underserved areas
  - Safer suicide care through systems change
- Create protective environments
  - Reduce access to lethal means among persons at risk of suicide
  - Organizational policies and culture
  - Community-based policies to reduce excessive alcohol use
- Promote connectedness
  - Peer norm programs
  - Community engagement activities
- Teach coping and problem-solving skills
  - Social-emotional learning programs
  - Parenting skill and family relationship programs
- Identify and support people at risk
  - Gatekeeper training
  - Crisis intervention
  - Treatment for people at risk of suicide
  - Treatment to prevent re-attempts
- Lessen harms and prevent future risk
  - Postvention
  - Safe reporting and messaging about suicide

Need help? Know someone who does?

Contact the National Suicide Prevention Lifeline

- Call 1-800-273-TALK (1-800-273-8255)
- Use the online Lifeline Crisis Chatexternal icon

Both are free and confidential. You'll be connected to a skilled, trained counselor in your area.

For more information, visit the National Suicide Prevention Lifelineexternal icon.

You can also connect 24/7 to a crisis counselor by texting the Crisis Text Line.external icon Text HOME to 741741.

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18.1.4: End-of-Chapter Material

Key takeaways for this Chapter

- Unintentional injuries have routinely been ranked 3rd-4th for overall causes death.
- For people ages 5-29, three of the top five causes of death are injury-related
- Common unintentional injuries result from falls, drowning, motor vehicle crashes, fires, and poisoning.
- Common intentional injuries results from community violence, intimate partner violence, sexual violence, firearm violence, drug overdoses, child abuse/neglect, and suicide.
- Understanding how injuries occur can help you to make safer choices for yourself and help others who may need assistance.

Reference

1. National Center for Health Statistics. Health, United States, 2019: Table 005. Hyattsville, MD. 2021. Available from: https://www.cdc.gov/nchs/hus/contents2019.htm.
2. Suggested Citation: Centers for Disease Control and Prevention, National Center for Health Statistics. National Vital Statistics System, Mortality 1999-2020 on CDC WONDER Online Database, released in 2021. Data are from the Multiple Cause of Death Files, 1999-2020, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed at http://wonder.cdc.gov/ucd-icd10.html on Jun 7, 2022 6:31:25 PM

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18.1.5: Preventing Violence and Injury- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

5 dangerous things you should let your kids do

My son was a Columbine shooter. This is my story

The beauty of human skin in every color

The difference between being “not racist” and antiracist

The multibillion-dollar US prison industry — and how to dismantle it

The shadow pandemic of domestic violence during COVID-19

What if mental health workers responded to emergency calls?

What happens when you have a concussion?

The neuroscience of restorative justice

The surprising connection between brain injuries and crime

Why children stay silent following sexual violence

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18.2: OCCUPATIONAL HEALTH CONCERNS

Occupational health "is an area of work in public health to promote and maintain highest degree of physical, mental and social well-being of workers in all occupations." (WHO. 2025). Occupational health workers aim to prevent physical and psychological illness on the job, as well as to prevent injuries. As you can see, this is quite a broad topic, and more than we can cover on one page. Here we will look at some connections between occupational health and environmental health. Later, in the chapter on injury prevention, we will take a closer look preventing injuries on the job.

Biological, chemical, and physical hazards on a job site can contribute to worker illness. Perhaps the most iconic example is black lung disease -- a disease common among coal miners who inhale coal dust and other minerals, greatly affecting their respiratory health and often shortening their lives.

The same principles of risk assessment for environmental health apply to risk assessment for occupational health -- it's just more focused on the workplace. Public health workers focused on occupational health would scan for dangers in the indoor air in the workplace, in the water (if relevant), and in exposures to hazardous waste or other dangerous substances.

The next two pages highlight some key occupational health policy to protect worker health -- improvements that were often won through the collective power of unions, as well as through public health action -- and a brief overview of common occupational illnesses and injuries.

References

World Health Organization. (2025). Occupational health. https://www.who.int/health-topics/occupational-health

18.2.1: Occupational Health Policy

18.2.2: Workplace Injuries and Illnesses

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18.2.1: Occupational Health Policy

Occupational health hazards have been recognized since antiquity, but it wasn't until the industrial revolution that there was widespread awareness of the need to regulate workplaces. Initially these efforts were based on sanitation, cleanliness, and reducing worker injuries - which were common in many factories (Seabert et al., 2021). After decades of industrial tragedies including deaths nearly every other day in steel mills, a plethora of coal mine accidents, the Triangle Shirtwaist factory fire, the Hawk's Nest Tunnel disaster, and others, worker's unions and environmentalists worked together to lobby congress for worker's protections in the 1960's (Frumkin, 2016). The Occupational Safety and Health Act (OSH Act) has only been around for just over 50 years, as it was signed into law by President Richard Nixon in 1970. It began by setting standards for worker exposure to specific environmental hazards, such as asbestos, lead, and cotton dust. Since then more standards have been established to protect workers from injuries, bloodborne pathogens, and other environmental toxins (OSHA, n.d. -b). The OSH Act also established the Occupational Safety and Health Administration (OSHA) to set and enforce these standards, and the National Institute for Occupational Safety and Health (NIOSH) to conduct research and make recommendations for these health standards (Seabert et al., 2021). Because of these laws and oversight agencies, it is widely accepted that employers are responsible for providing "safe workplaces, free of recognized serious hazards" (Frumkin, 2016).



Figure 18.2.1.1: Hydraulic fracking operation at night. (CDC/ Theresa Roebuck, 2016)

"This 2016 image depicted the process of hydraulic fracturing, or fracking, a 24/7 activity, and showed how the need for occupational health and safety never stops. NIOSH researchers from the Western States Division, and the Division of Applied Research and Technology, were the first to systematically document hazardous exposures to workers at fracking sites, including exposures to respirable crystalline silica (RCS), diesel particulate matter, and volatile organic compounds. This sand mover operator was monitoring the sand level in the blender tub, framed in the bottom left handrail. His half-face cartridge respirator may not have been providing a high enough assigned protection factor to protect him from the elevated concentration of RCS, to which he was exposed. This photograph was taken in Encinal, Texas, during a test of a NIOSH-developed engineering control, known as the NIOSH mini-baghouse retrofit assembly, installed to reduce RCS emissions."

Prior to the industrial revolution, common law principles held the worker at fault for any injuries they received while on the job, and some employers went so far as to require "death contracts" as an acknowledgement of the employee of the potential dangers - and perhaps deadliness - of their work. In the late 19th century, Prussia was the first country to create worker's liability and insurance laws in an effort to maintain the loyalty of the working class while squashing Marxist and socialist political movements. Other European countries and the U.S. followed suit, although it took until 1948 for the last state to enact worker's compensation laws. While these laws did provide for monetary compensation in the form of employer-funded insurance policies, they also protected the companies from the threat of lawsuits (Guyton, 1999). Currently, each state in the U.S. has its own worker's compensation system, rules, and regulations, which may cover or exclude certain injuries or illnesses (Frumkin, 2016). Notably, in many states, agricultural employers are exempt from the requirements to provide workers' compensation, even though agricultural work is some of the most dangerous. Fourteen states (including California) do require workers' compensation for agricultural

businesses, and enforce penalties for non-compliance (Mikolajczyk, 2022).

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- 29.8: The Evolution of Primates by OpenStax is licensed CC BY 4.0. Original source: https://openstax.org/details/books/biology-2e.

18.2.2: Workplace Injuries and Illnesses

Workplace injuries include both relatively minor injuries like cuts or bruises, and major injuries like amputations, fractures, loss of an eye, or severe burns and acute poisoning. Non-fatal injuries are most commonly slips, trips, and falls, or contact with equipment (CDC/NIOSH, 2022). Motor vehicle accidents are the most common source of fatal workplace injuries, but deaths from violence and unintentional overdoses have also increased over the last several years (BLS, 2023). In 2022, workplace injuries and deaths in the U.S. had a price tag of 167 billion dollars; including the lost productivity, medical expenses, and administrative costs. Compared to the number of people in the workforce, that's just over $1000 per worker. There were also 108 million days of work lost to injuries that happened in 2022 or in years prior (National Safety Council, 2024a).

Workplace illnesses are often more difficult to connect to workplace exposures since symptoms can often take many years to develop. These include skin diseases, loss of hearing from industry noise, or cancers developed from exposure to environmental toxins used in industrial processes. Workplace-related respiratory conditions include (among others) silicosis - which is developed from inhaling silica dust commonly from grinding or sanding rocks or cement, coal worker's pneumoconiosis - aka black lung disease, and asbestosis - caused by inhaling asbestos fibers (Seabert et al., 2021). Those working outdoors such as farmers, construction workers, and firefighters are also at higher risk for heat-related illness such as heat stroke and heat exhaustion - particularly in the summer months (Riley et al., 2018).

In 2022, the BLS reported 5,486 fatal work injuries, an increase of 5.7% from 2021. The BLS also reported 2.8 million nonfatal work-related injuries and illnesses in private industry, up 7.5% from 2021. Including government jobs as well, the rate of nonfatal injury and illness was 3% of all workers for 2022 (BLS, 2023a). The highest rates of nonfatal work-related injuries and illnesses were found in transportation and warehousing, as well as agriculture, forestry, fishing and hunting. The highest total numbers of nonfatal injuries and illnesses were recorded for the healthcare and social assistance sector however, likely due to the high number of workers employed in those occupations. See Fig. 18.2.2.1 below.

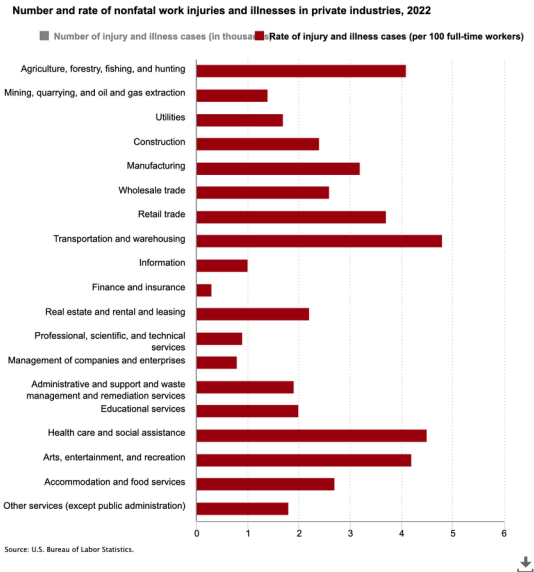


Figure 18.2.2.1: Rate of nonfatal injuries and illnesses (per 100 full-time workers), by private industries, 2022.(CC0, U.S. Bureau of Labor Statistics.)

According to the BLS, the fatal injury rate in 2022 was 3.7 per 100,000 full-time equivalent (FTE) workers. However, this rate was higher for African American or Black workers (4.2 per 100,000 FTE workers) and Hispanic or Latino workers (4.6 per 100,000 FTE workers). Those between the ages of 55-64 have the highest number of fatalities (BLS, 2023b). These demographic differences may indicate disparities in exposures to hazards, or perhaps a lack of protections in certain sectors of industry.

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19: MAKING SMART HEALTH CHOICES

Learning Objectives

By the end of this chapter you will be able to:

- Deduce whether health information is valid and reliable.
- Utilize tools to critically analyze health websites.
- Compare complementary and western medicine.
- Explain common challenges associated with Aging.

What will you do to make sure you are not tricked by health fraud?

Have you considered being an organ donor?

How will you plan for retirement?

What will you do to stay healthy as you age?

Every year we get one year older chronologically, does this mean we also get one year older biologically? Our biological age is the age of our body and this is not dependent on our chronological age. You can be a 30 year old who is very healthy and has a biological age closer to 20 year old, or you can be a 30 year old who lives an unhealthy lifestyle and has a biological age closer to 40. Our biological age is highly influenced by the lifestyle choices we make.

In 1900, people lived on average just 47.3 years and by the year 2000, Americans lived an average of 76.8 years. Life expectancy nearly doubled in just 100 years. The leading causes of death in 1900 were highly related to infectious disease. Through numerous public health measures life expectancy has drastically increased and the leading causes of death have transitioned to be more related to a persons lifestyle choices.

The good news is that Americans are living longer lives, but the bad news is that the increase in our older population brings an increase in chronic diseases, such as hypertension, diabetes, arthritis, and dementia. It is estimated that 80% of older adults have a chronic health condition. With so many older adults having chronic health conditions we know there will continue to be an increased need for caregivers. This creates a potential problem because although our older population is growing, or birth rates are declining which may reduce the amount of people to serve as caretakers.

19.1: Health Literacy

19.2: Healthcare

19.3: Health Care Choices - The Affordable Health Care Act (ACA)

19.4: Health Insurance - Key Terms

19.5: Choices in Medical Care

19.6: Health Disparity

19.7: Aging

19.8: Dealing with Death

19.9: End-of-Chapter Material

19.10: Health Care and Aging- Optional Continued Learning

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19.1: Health Literacy

Chapter one of this book provided a brief introduction to health literacy, this chapter expands on the importance of critically consuming health information throughout your life and as you age. The CDC defines personal health literacy as the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others.

Finding reliable health information

Millions of consumers get health information from magazines, TV or the Internet. Some of the information is reliable and up to date; some is not. How can you tell the good from the bad to make sure you are making your own health decisions based on the best information?

First, recognize that content on the Internet is unregulated; anyone can publish anything on the Internet. There is sound medical information on the Internet along with dangerous information. You need to be able to tell the difference.

Ask yourself the following:

- Why did the person create the page?
- What's in it for them?
- Are they trying to sell me something?

The following tips can help you to find current, unbiased information based on research[1].

- Consider the source–Use recognized authorities
  - Know who is responsible for the content.
  - Look for an "about us" page. Check to see who runs the site: is it a branch of the Federal Government, a non-profit institution, a professional organization, a health system, a commercial organization or an individual.
  - There is a big difference between a site that says, "I developed this site after my heart attack" and one that says, "This page on heart attack was developed by health professionals at the American Heart Association."
  - Web sites should have a way to contact the organization or webmaster. If the site provides no contact information, or if you can't easily find out who runs the site, use caution.
- Focus on quality–All Web sites are not created equal
  - Does the site have an editorial board? Is the information reviewed before it is posted?
  - This information is often on the "about us" page, or it may be under the organization's mission statement, or part of the annual report.
  - See if the board members are experts in the subject of the site. For example, a site on osteoporosis whose medical advisory board is composed of attorneys and accountants is not medically authoritative.
  - Look for a description of the process of selecting or approving information on the site. It is usually in the "about us" section and may be called "editorial policy" or "selection policy" or "review policy."
  - Sometimes the site will have information "about our writers" or "about our authors" instead of an editorial policy. Review this section to find out who has written the information.
- Be a cyber skeptic–Quackery abounds on the Web
  - Does the site make health claims that seem too good to be true? Does the information use deliberately obscure, "scientific" sounding language? Does it promise quick, dramatic, miraculous results? Is this the only site making these claims?
  - Beware of claims that one remedy will cure a variety of illnesses, that it is a "breakthrough," or that it relies on a "secret ingredient."
  - Use caution if the site uses a sensational writing style (lots of exclamation points, for example.)
  - A health Website for consumers should use simple language, not technical jargon.
  - Get a second opinion! Check more than one site.
- Look for the evidence–Rely on medical research, not opinion
  - Does the site identify the author? Does it rely on testimonials?
  - Look for the author of the information, either an individual or an organization. Good examples are "Written by Jane Smith, R.N.," or "Copyright 2013, American Cancer Society."

    - If there are case histories or testimonials on the Web site, look for contact information such as an email address or telephone number. If the testimonials are anonymous or hard to track down ("Jane from California"), use caution.
- Check for currency–Look for the latest information
    - Is the information current?
    - Look for dates on documents. A document on coping with the loss of a loved one doesn't need to be current, but a document on the latest treatment of AIDS needs to be current.
    - Click on a few links on the site. If there are a lot of broken links, the site may not be kept up-to-date.
- Beware of bias–What is the purpose? Who is providing the funding?
    - Who pays for the site?
    - Check to see if the site is supported by public funds, donations or by commercial advertising.
- Advertisements should be labeled. They should say "Advertisement" or "From our Sponsor."
    - Look at a page on the site, and see if it is clear when content is coming from a non-commercial source and when an advertiser provides it. For example, if a page about treatment of depression recommends one drug by name, see if you can tell if the company that manufactures the drug provides that information. If it does, you should consult other sources to see what they say about the same drug.
- Protect your privacy–Health information should be confidential
    - Does the site have a privacy policy and tell you what information they collect?
    - There should be a link saying "Privacy" or "Privacy Policy." Read the privacy policy to see if your privacy is really being protected. For example, if the site says "We share information with companies that can provide you with useful products," then your information isn't private.
    - If there is a registration form, notice what types of questions you must answer before you can view content. If you must provide personal information (such as name, address, date of birth, gender, mother's maiden name, credit card number) you should refer to their privacy policy to see what they can do with your information.
- Consult with your health professional–Patient/provider partnerships lead to the best medical decisions.

Health Fraud

When you see statements like "miracle cure," "revolutionary scientific breakthrough," or "alternative to drugs or surgery," what you should be thinking is, "bogus product," "Danger," or "Health fraud alert!"

Health fraud scams have been around for hundreds of years[2]. The snake oil salesmen of old have morphed into the deceptive, high-tech marketers of today. They prey on people's desires for easy solutions to difficult health problems, from losing weight to curing serious diseases like cancer. According to the Food and Drug Administration (FDA), a health product is fraudulent if it is deceptively promoted as being effective against a disease or health condition but has not been scientifically proven safe and effective for that purpose. Health fraud scams can do more than waste your money, they can cause serious injury or even death.

Scammers promote their products through newspapers, magazines, TV infomercials and cyberspace. You can find health fraud scams in retail stores and on countless websites, in popup ads and spam, and on social media sites like Facebook and Twitter. It is important to understand the signs of fraudulent health product.

The FDA provides the following list of 6 Tip-offs to Rip-offs:

1. One product does it all. Be suspicious of products that claim to cure a wide range of diseases. The agency continues to send warning letters and take enforcement action as appropriate against companies marketing fake cure-all products. These miracle cures don't exist – they're bogus – and the only thing these companies are selling is false hope.
2. Personal "success" testimonials. Success stories, such as, "It cured my diabetes" or "It immediately stopped my COVID-19 infection," are easy to make up and are not a substitute for scientific evidence. Reviews found on popular online marketplaces and social media can be fake.
3. Quick fixes. Few diseases or conditions can be treated quickly, even with legitimate products. Beware of language such as, "Lose 30 pounds in 30 days," "protects from viral infections," or "eliminates skin cancer in days."
4. "All natural" cure or treatment. Don't be fooled by descriptions like "all-natural cure." Such phrases are often used in health fraud as an attention-grabber to suggest that a product is safer than conventional treatments. These terms don't necessarily equate to safety. Some plants found in nature (such as poisonous mushrooms) can be harmful or even kill when consumed. Moreover, the FDA has found numerous products promoted as "all-natural" cures or treatments that contain hidden and dangerously high doses of prescription drug ingredients or other active pharmaceutical ingredients.
5. "Miracle cure." Alarms should go off when you see this claim or others like it such as, "new discovery," "guaranteed results," or "secret ingredient." If a real cure for a serious disease were FDA-approved, it would be widely reported through the media and prescribed by licensed health professionals—not plastered on advertisements in social media and messaging

apps, or buried in websites, print ads, and TV infomercials.
6. Conspiracy theories. Claims like “This is the cure our government or Big Pharma doesn’t want you to know about” are used to distract consumers from the obvious, common-sense questions about the so-called miracle cure.

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19.2: Healthcare

Health Insurance in the U.S.

No one plans to get sick or hurt, but most people need medical care at some point. Health insurance covers essential health benefits critical to maintaining your health and treating illness and accidents, for example getting free preventive care, like vaccines, screenings, and some check-ups, even before you meet your deductible. Health insurance protects you from unexpected, high medical costs by paying less for covered in-network health care, even before you meet your deductible. People without health coverage are exposed to these costs, which can sometimes lead into extreme debt or even into bankruptcy.

The U.S. does not have universal health coverage, meaning the government does not provide health insurance for every person, rather the U.S. health system is a mix of public and private, for-profit and nonprofit insurers and health care providers[5]. The federal government provides Medicare, medicaid and the Children's Health Insurance Program (CHIP). Private insurance is provided primarily by employers and people can also purchase their own health insurance coverage. Although there are options for health insurance, there are still about 8.5% of Americans who are un-insured, which is a reduction from 16% in 2010 before the passing of the Patient Protection and Affordable Care Act.

Medicare is health insurance for:

- People 65 or older (eligible to sign up for Medicare 3 months before turning 65)
- Those with a disability, End-Stage Renal Disease (ESRD), or ALS (also called Lou Gehrig's disease) may be able to sign up before 65.

Medicaid is a joint federal and state program that:

- Helps with medical costs for some people with limited income and resources.
- Offers benefits not normally covered by Medicare, like nursing home care and personal care services.

The Children's Health Insurance Program (CHIP) is a joint federal and state program that:

- provides health coverage to eligible children, through both Medicaid and separate CHIP programs.

Managed Care Plans

- Managed care plans are a type of health insurance. They have contracts with health care providers and medical facilities to provide care for members at reduced costs. These providers make up the plan's network. How much of your care the plan will pay for depends on the network's rules.
    - With an Health Maintenance Organizations (HMO) you choose a primary care doctor who coordinates most of your care. HMO's usually only pay for care within their specified network of doctors/providers. HMO plans typically have lower monthly premiums. You can also expect to pay less out of pocket.
    - With a Preferred Provider Organizations (PPO) you tend to have higher monthly premiums in exchange for the flexibility to use providers both in and out of network without a referral. Out-of-pocket medical costs can also run higher with a PPO plan.
    - Point of Service (POS) plans let you choose between an HMO or a PPO each time you need care.

If you're unemployed, or your employer does not provide health insurance, you may be able to get an affordable health insurance plan through the Health Insurance Marketplace. The Health Insurance Marketplace was developed in response to the Patient Protection and Affordable Care Act passed in 2010. Its primary goal is to achieve universal health insurance coverage by facilitating cooperation among employers, citizens, and the government. Its other objectives are to make healthcare more affordable while simultaneously increasing healthcare quality and reducing unnecessary spending[6].

The Affordable Care Act (ACA) created a dramatically different marketplace for individual health insurance through three key reforms: prohibiting insurers from considering subscribers' health status or risk; providing substantial subsidies for millions of people to purchase individual coverage, many for the first time in their lives; and creating an "exchange" structure that facilitates comparison shopping. Due to the ACA the uninsured rate has dropped from 16 percent in 2010 to 8.5%.

Universal Healthcare

The World Health Organization states that:

- Half of the world's population do not have access to the health care they need.
- 100 million people are driven into poverty each year through out-of-pocket health spending.
- 75% of national health policies strategies and plans are aimed at moving towards universal health coverage.
- Over 930 million people spend at least 10% of their household income on health care.

In an effort to bring healthcare to all people across the world, The World Health Organization (WHO) is encouraging all countries of the world to adopt Universal Health Coverage (UHC). The WHO is providing support and technical expertise to advance universal health coverage in 115 countries, representing a population of at least 3 billion people. The goal is to bridge global commitments with country action to achieve universal health coverage.

The WHO defines universal healthcare as "ensuring that all people have access to needed health services (including prevention, promotion, treatment, rehabilitation and palliation) of sufficient quality to be effective while also ensuring that the use of these services does not expose the user the financial hardship. It includes the full range of essential health services, from health promotion to prevention, treatment, rehabilitation, and palliative care."

Many countries offer universal healthcare, these include:

- Australia (Healthcare System in Australia)
- Canada (Canadian Health Care System)
- France (French Healthcare System)
- Germany (German Healthcare System – GKV)
- Ireland (Healthcare System in Ireland)
- Italy (Healthcare System in Italy)
- Japan (Japanese Healthcare System)
- New Zealand (New Zealand's Healthcare System)
- Portugal (Healthcare System in Portugal)
- Spain (Healthcare System in Spain)
- Sweden (Sweden's Healthcare System)
- United Kingdom (Healthcare System in the UK)

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19.3: Health Care Choices - The Affordable Health Care Act (ACA)

Health care choices in the United States can be broadly divided into two main categories: public health care (government-funded) and private health care (privately funded). The two main publicly funded health care programs are Medicare, which provides health services to people over 65 years old as well as people who meet other standards for disability, and Medicaid, which provides services to people with very low incomes who meet other eligibility requirements. Other government-funded programs include service agencies focused on Native Americans (the Indian Health Service), Veterans (the Veterans Health Administration), and children (the Children's Health Insurance Program).

Health care in the United States is a complex issue, and it will remain complex with the continued enactment of the Patient Protection and Affordable Care Act (PPACA). This Act, sometimes called "ObamaCare" for its most noted advocate, former President Barack Obama, represents large-scale federal reform of the United States' health care system. It expands eligibility to programs like Medicaid and CHIP, helps guarantee insurance coverage for people with pre-existing conditions, and establishes regulations to make sure that the premium funds collected by insurers and care providers go directly to medical care. It also includes an individual mandate, which requires everyone to have insurance coverage or pay a penalty. A series of provisions, including significant subsidies, are intended to address the discrepancies in income that are currently contributing to high rates of uninsurance and underinsurance.

How much do you know the Affordable Health Care Act?

You need to be fully informed about what the PPACA provides. Here is a list of key changes to the United States health care system as a result of the PPACA:

- Insurers are prohibited from denying coverage to individuals due to pre-existing conditions.
- Premiums must be the same for everyone of a given age, regardless of preexisting conditions.
- Dependents are permitted to remain on their parents' insurance plan until their 26th birthday.
- Individuals are required to buy health insurance or pay a penalty (known as the individual mandate). This applies to everyone not covered by an employer sponsored health plan, Medicaid, Medicare or other public insurance programs (such as Tricare). Also exempt were those facing a financial hardship or who were members in a recognized religious sect exempted by the Internal Revenue Service.
- Essential health benefits must be provided. The National Academy of Medicine defines the law's "essential health benefits" as "ambulatory patient services; emergency services; hospitalization; maternity and newborn care; mental health and substance use disorder services, including behavioral health treatment; prescription drugs; rehabilitative services and devices; laboratory services; preventive and wellness services and chronic disease management; and pediatric services, including oral and vision care" and others rated Level A or B by the U.S. Preventive Services Task Force. In determining what would qualify as an essential benefit, the law required that standard benefits should offer at least that of a "typical employer plan".
- Additional preventive care and screenings for women. This includes Well-woman visits, gestational diabetes screening for pregnant women, domestic and interpersonal violence screening and counseling, FDA-approved contraception methods, and contraceptive education and counseling, breastfeeding support, supplies, and counseling, HPV DNA testing, for women 30 or older, sexually transmitted infections counseling, and HIV screening and counseling for sexually active women. This mandate applies to all employers and educational institutions except for religious organizations. These regulations were included on the recommendations of the Institute of Medicine.
- Annual and lifetime coverage caps on essential benefits were banned.
- Prohibits insurers from dropping policyholders when they get sick.
- All health policies sold in the United States must provide an annual maximum out of pocket (MOOP) payment cap for an individual's or family's medical expenses (excluding premiums). After the MOOP payment cap is reached, the insurer must pay all remaining costs.
- Preventive care, vaccinations and medical screenings cannot be subject to co-payments, co-insurance or deductibles. Specific examples of covered services include: mammograms and colonoscopies, wellness visits, gestational diabetes screening, HPV testing, STI counseling, HIV screening and counseling, contraceptive methods, breastfeeding support/ supplies and domestic violence screening and counseling.
- The law established four tiers of coverage: bronze, silver, gold and platinum. All categories offer the essential health benefits.

The categories vary in their division of premiums and out-of-pocket costs: bronze plans have the lowest monthly premiums and highest out-of-pocket costs, while platinum plans are the reverse. The percentages of health care costs that plans are expected to cover through premiums (as opposed to out-of-pocket costs) are, on average: 60% (bronze), 70% (silver), 80% (gold), and 90% (platinum).

- Insurers are required to implement an appeals process for coverage determination and claims on all new plans.
- Employer mandate. Businesses that employ 50 or more people but do not offer health insurance to their full-time employees pay a tax penalty if the government has subsidized a full-time employee's healthcare through tax deductions or other means. This is commonly known as the employer mandate. This provision was included to encourage employers to continue providing insurance once the exchanges began operating. Approximately 44% of the population was covered directly or indirectly through an employer.
- Insurers must spend at least 80–85% of premium dollars on health costs; rebates must be issued to policyholders if this is violated.

Many Americans worry that governmental oversight of health care represents a federal overstepping of constitutional guarantees of individual freedom. Others welcome a program that they believe will make health care accessible and affordable to everyone.

Watch this tour of the HealthCare.gov website to find out more.

Covered California

In California, the health care marketplace is called Covered California. This is where Californians can shop and compare health insurance plans under the Patient Protection and Affordable Care Act. The Department of Health Care Services sponsors Covered California to help health insurance shoppers get the coverage and care that is right for them. Visit CoveredCA.com for more information.

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19.4: Health Insurance - Key Terms

Part of health literacy is understanding key health insurance terms. This will allow for educated decisions when choosing a health insurance plan. Below are some basic key terms that are helpful to understand when researching health insurance plans:

In-Network Providers: health care providers who are contracted with your health insurance plan to provide services at a contracted or discounted rate.

Out-of-Network Providers: health care providers who are not contracted with your health insurance plan. Out-of-network coinsurance usually costs you more than in-network coinsurance because there is no contracted or discounted rate.

Exclusive Provider Organization (EPO): A managed care plan where services are covered only if you use doctors, specialists, or hospitals in the plan's network (except in an emergency).

Health Maintenance Organization (HMO): A type of health insurance plan that usually limits coverage to care from doctors who work for or contract with the HMO. It generally won't cover out-of-network care except in an emergency. An HMO may require you to live or work in its service area to be eligible for coverage. HMOs often provide integrated care and focus on prevention and wellness.

Point of Service (POS): A type of plan where you pay less if you use doctors, hospitals, and other health care providers that belong to the plan's network. POS plans require you to get a referral from your primary care doctor in order to see a specialist.

Preferred Provider Organization (PPO): A type of health plan where you pay less if you use providers in the plan's network. You can use doctors, hospitals, and providers outside of the network without a referral for an additional cost.

Premium: The amount paid for your health insurance every month. In addition to your premium, you usually have to pay other costs for your health care, including a deductible, copayments, and coinsurance.

Deductible: The amount you pay for covered health care services before your insurance plan starts to pay. With a $2,000 deductible, for example, you pay the first $2,000 of covered services yourself.

Many health insurance plans cover certain services such as check-ups, disease management, and preventive services before the deductible has been met. Family plans often have both an individual deductible, which applies to each person, and a family deductible, which applies to all family members.

Generally, plans with lower monthly premiums have higher deductibles. Plans with high monthly premiums usually have lower deductibles. Those who use their health insurance often would probably be wise to choose a plan with a slightly higher premium but a lower deductible, which may save money in the long-term.

After paying the deductible, you will usually pay only a copayment or coinsurance for covered services. Your insurance company pays the rest.

Copayment: A fixed amount ($20, for example) you pay for a covered health care service after you've paid your deductible. Let's say your health insurance plan's allowable cost for a doctor's office visit is $100. Your copayment for a doctor visit is $20. If you've paid your deductible: You pay $20, usually at the time of the visit. If you haven't met your deductible: You pay $100, the full allowable amount for the visit.

Copayments (sometimes called "copays") can vary for different services within the same plan, like drugs, lab tests, and visits to specialists.

Coinsurance: The percentage of costs of a covered health care service you pay (20%, for example) after you've paid your deductible. Let's say your health insurance plan's allowed amount for an office visit is $100 and your coinsurance is 20%. If you've paid your deductible: You pay 20% of $100, or $20. The insurance company pays the rest. If you haven't met your deductible: You pay the full allowed amount, $100.

Out-of-pocket maximum: The most you have to pay for covered services in a plan year. After you spend this amount on deductibles, copayments, and coinsurance, your health plan pays 100% of the costs of covered benefits.

Although this is not an all-encompassing list of key terms for health insurance, these are some of the terms you are likely to encounter when shopping for health insurance.

More in-depth information can be found at Healthcare.gov/glossary.

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19.5: Choices in Medical Care

Choosing the right medical professional can be difficult and will vary depending on your day-to-day health status. Below is a brief list of medical professionals you can visit for a variety of health issues:

Primary Care Practitioner (PCP) is a medical professional whom you can go to for routine ailments, preventive care, general medical advice, and appropriate referrals. The primary care provider for most people is a medically trained family practitioner, an internist, or a pediatrician.

Conventional or Allopathic medicine, or traditional Western medical practice, is based on scientifically validated methods and procedures and involves the application of the scientific method; cause and effect.

Complementary medicine and alternative medicine; unconventional practices used alongside or instead of conventional medicine. Examples include chiropractic's, massage therapy, acupuncture, acupressure, and herbal remedies.

Other PCP include

Osteopath: general practitioner who receives medical training similar to MD , but is more involved in musculoskeletal focus than internal focus.

Nurse practitioners are professional nurses with advanced training obtained through either a master's degree program or specialized nurse practitioner program. They have the authority and training to conduct diagnostic tests and prescribe medications (in some states). Nurses may also earn the clinical doctor of nursing degree (ND), a doctorate of nursing science (DNS or DNSc), or a research-based doctorate (PhD) in nursing.

Physician assistants must work under the supervision of a physician and are legally permitted to prescribe drugs in all states.

Other practitioners:

Nurses are highly trained and strictly regulated practitioners who provide a wide range of services including patient education, counseling, community health and disease prevention information, and administration of medications.

Licensed registered nurses (RN) have completed either a 4-year program leading to a Bachelor of Science degree (BSN) or a 2-year associate degree program.

Licensed practical or vocational nurses (LPN or LVN) have completed a one- to two-year training program.

Ophthalmologist holds a medical degree and can perform surgery. An optometrist evaluates visual problems but is not a trained physician.

Podiatrist: specialize in care of the foot; extensive training similar to MD; can prescribe and perform surgery.

Dentists are specialists who diagnose and treat diseases of the teeth, gums, and oral cavity. Orthodontists are specialists in the alignment of teeth. Oral surgeons perform surgical procedures to correct problems of the mouth, face, and jaw.

Questions are the Answer

Whichever health care professional you choose to visit, your health depends on good communication. Asking questions and providing information to your doctor and other care providers can improve your care. Quality health care is a team effort. You play an important role. One of the best ways to communicate with your doctor and health care team is by asking questions. Because time is limited during medical appointments, you will feel less rushed if you prepare your questions before your appointment.

- Your doctor wants your questions.
- Doctors know a lot about a lot of things, but they don't always know everything about you or what is best for you.

- Your questions give your doctor and health care team important information about you, such as your most important health care concerns.
- That is why they need you to speak up.

Health Facilities

Health facilities are places that provide health care. They include hospitals, clinics, outpatient care centers and specialized care centers, such as birthing centers and psychiatric care centers. When you choose a health facility, you might want to consider

- How close it is
- Whether your health insurance will pay for services there
- Whether your health care provider can treat you there
- The quality of the facility

Quality is important. Some facilities do a better job than others. One way to learn about the quality of a facility is to look at report cards developed by state and consumer groups.

Look for a hospital that:

- Is accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO).
- Is rated highly by the State and by consumer groups or other organizations.
- Has a lot of experience and success in treating your condition.
- Monitors quality of care and works to improve quality.

In choosing a nursing home or other long-term care facility, look for one that:

- Has been found by State agencies and other groups to provide quality care.
- Provides a level of care, including staff and services, that will meet your needs.

Choosing the right medications: Brand Name vs. Generic

You may need to take medicines every day, or only once in a while. Either way, you want to make sure that the medicines are safe and will help you get better. In the United States, the Food and Drug Administration is in charge of assuring the safety and effectiveness of both prescription and over-the-counter medicines.

Even safe drugs can cause unwanted side effects or interactions with food or other medicines you may be taking. They may not be safe during pregnancy. To reduce the risk of reactions and make sure that you get better, it is important for you to take your medicines correctly.

Understanding Generic Drugs

Generic drugs are important options that allow greater access to health care for all Americans. They are copies of brand-name drugs and are the same as those brand name drugs in dosage form, safety, strength, route of administration, quality, performance characteristics and intended use.

Health care professionals and consumers can be assured that FDA approved generic drug products have met the same rigid standards as the innovator drug. All generic drugs approved by FDA have the same high quality, strength, purity and stability as brand-name drugs. And, the generic manufacturing, packaging, and testing sites must pass the same quality standards as those of brand name drugs.

Generic Drugs: Questions and Answers

What are generic drugs?

A generic drug is identical -- or bioequivalent -- to a brand name drug in dosage form, safety, strength, route of administration, quality, performance characteristics and intended use. Although generic drugs are chemically identical to their branded counterparts, they are typically sold at substantial discounts from the branded price. According to the Congressional Budget Office, generic drugs save consumers an estimated $8 to $10 billion a year at retail pharmacies. Even more billions are saved

when hospitals use generics.

Are generic drugs as effective as brand-name drugs?

Yes. A generic drug is the same as a brand-name drug in dosage, safety, strength, quality, the way it works, the way it is taken and the way it should be used.

FDA requires generic drugs have the same high quality, strength, purity and stability as brand-name drugs.

Not every brand-name drug has a generic drug. When new drugs are first made they have drug patents. Most drug patents are protected for 20 years. The patent, which protects the company that made the drug first, doesn't allow anyone else to make and sell the drug. When the patent expires, other drug companies can start selling a generic version of the drug. But, first, they must test the drug and the FDA must approve it.

Creating a drug costs lots of money. Since generic drug makers do not develop a drug from scratch, the costs to bring the drug to market are less; therefore, generic drugs are usually less expensive than brand-name drugs. But, generic drug makers must show that their product performs in the same way as the brand-name drug.

How are generic drugs approved?

Drug companies must submit an abbreviated new drug application (ANDA) for approval to market a generic product. The Drug Price Competition and Patent Term Restoration Act of 1984, more commonly known as the Hatch-Waxman Act, made ANDAs possible by creating a compromise in the drug industry. Generic drug companies gained greater access to the market for prescription drugs, and innovator companies gained restoration of patent life of their products lost during FDA's approval process.

New drugs, like other new products, are developed under patent protection. The patent protects the investment in the drug's development by giving the company the sole right to sell the drug while the patent is in effect. When patents or other periods of exclusivity expire, manufacturers can apply to the FDA to sell generic versions.

The ANDA process does not require the drug sponsor to repeat costly animal and clinical research on ingredients or dosage forms already approved for safety and effectiveness. This applies to drugs first marketed after 1962.

What standards do generic drugs have to meet?

Health professionals and consumers can be assured that FDA approved generic drugs have met the same rigid standards as the innovator drug. To gain FDA approval, a generic drug must:

- contain the same active ingredients as the innovator drug (inactive ingredients may vary)
- be identical in strength, dosage form, and route of administration
- have the same use indications
- be bioequivalent
- meet the same batch requirements for identity, strength, purity, and quality
- be manufactured under the same strict standards of FDA's good manufacturing practice regulations required for innovator products

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19.6: Health Disparity

Despite prevention efforts, some groups of people are affected by HIV/AIDS, viral hepatitis, STI's, and TB, more than other groups of people. The occurrence of these diseases at greater levels among certain population groups more than among others is often referred to as a health disparity. Differences may occur by gender, race or ethnicity, education, income, disability, geographic location and sexual orientation among others. Social determinants of health like poverty, unequal access to health care, lack of education, stigma, and racism are linked to health disparities.

Health in the United States is a complex and often contradictory issue. One the one hand, as one of the wealthiest nations, the United States fares well in health comparisons with the rest of the world. However, the United States also lags behind almost every industrialized country in terms of providing care to all its citizens. The following sections look at different aspects of health in America.

Health by Race and Ethnicity

When looking at the social epidemiology of the United States, it is hard to miss the disparities among races. The discrepancy between African Americans and white Americans shows the gap clearly; in 2008, the average life expectancy for white males was approximately five years longer than for African American males: 75.9 compared to 70.9. An even stronger disparity was found in 2007: the infant mortality rate for African Americans was nearly twice that of white Americans at 13.2 compared to 5.6 per 1,000 live births (U.S. Census Bureau 2011). According to a report from the Henry J. Kaiser Foundation (2007), African Americans also have higher incidence of several other diseases and causes of mortality, from cancer to heart disease to diabetes. In a similar vein, it is important to note that ethnic minorities, including Mexican Americans and Native Americans, also have higher rates of these diseases and causes of mortality than whites. Lisa Berkman (2009) notes that this gap started to narrow during the Civil Rights movement in the 1960s, but it began widening again in the early 1980s.

What accounts for these perpetual disparities in health among different ethnic groups?

Much of the answer lies in the level of health care that these groups receive. The National Healthcare Disparities Report (2010) shows that even after adjusting for insurance differences, racial and ethnic minority groups receive poorer quality of care and less access to care than dominant groups. The Report identified these racial inequalities in care: Black Americans, American Indians, and Alaskan Natives received inferior care than Caucasian Americans for about 40 percent of measures Asian ethnicities received inferior care for about 20 percent of measures Among whites, Hispanic whites received 60 percent inferior care of measures compared to non-Hispanic whites (Agency for Health Research and Quality 2010). When considering access to care, the figures were comparable.

Health by Socioeconomic Status

Discussions of health by race and ethnicity often overlap with discussions of health by socioeconomic status, since the two concepts are intertwined in the United States. As the Agency for Health Research and Quality (2010) notes, "racial and ethnic minorities are more likely than non-Hispanic whites to be poor or near poor," so many of the data pertaining to subordinate groups is also likely to be pertinent to low socioeconomic groups. Marilyn Winkleby and her research associates (1992) state that "one of the strongest and most consistent predictors of a person's morbidity and mortality experience is that person's socioeconomic status (SES). This finding persists across all diseases with few exceptions, continues throughout the entire lifespan, and extends across numerous risk factors for disease."It is important to remember that economics are only part of the SES picture; research suggests that education also plays an important role. Phelan and Link (2003) note that many behavior-influenced diseases like lung cancer (from smoking), coronary artery disease (from poor eating and exercise habits), and AIDS initially were widespread across SES groups. However, once information linking habits to disease was disseminated, these diseases decreased in high SES groups and increased in low SES groups. This illustrates the important role of education initiatives regarding a given disease, as well as possible inequalities in how those initiatives effectively reach different SES groups.

Health by Gender

Women are affected adversely both by unequal access to and institutionalized sexism in the health care industry. According a recent report from the Kaiser Family Foundation, women experienced a decline in their ability to see needed specialists between 2001 and 2008. In 2008, one quarter of females questioned the quality of her health care (Ranji and Salganico 2011). In this report, we also see the explanatory value of intersection theory. Feminist sociologist Patricia Hill Collins developed this theory, which suggests we cannot separate the effects of race, class, gender, sexual orientation, and other attributes. Further examination of the lack of confidence in the health care system by women, as identified in the Kaiser study, found, for example, women categorized as low income were more likely (32 percent compared to 23 percent) to express concerns about health care quality, illustrating the multiple layers of disadvantage caused by race and sex.

We can see an example of institutionalized sexism in the way that women are more likely than men to be diagnosed with certain kinds of mental disorders. Psychologist Dana Becker notes that 75 percent of all diagnoses of Borderline Personality Disorder (BPD) are for women according to the Diagnostic Statistical Manual of Mental Disorders. This diagnosis is characterized by instability of identity, of mood, and of behavior, and Becker argues that it has been used as a catch-all diagnosis for too many women. She further decries the pejorative connotation of the diagnosis, saying that it predisposes many people, both within and outside of the profession of psychotherapy, against women who have been so diagnosed (Becker).

Many critics also point to the medicalization of women's issues as an example of institutionalized sexism. Medicalization refers to the process by which previously normal aspects of life are redefined as deviant and needing medical attention to remedy. Historically and contemporaneously, many aspects of women's lives have been medicalized, including menstruation, pre-menstrual syndrome, pregnancy, childbirth, and menopause.

The medicalization of pregnancy and childbirth has been particularly contentious in recent decades, with many women opting against the medical process and choosing a more natural childbirth. Fox and Worts (1999) find that all women experience pain and anxiety during the birth process, but that social support relieves both as effectively as medical support. In other words, medical interventions are no more effective than social ones at helping with the difficulties of pain and childbirth. Fox and Worts further found that women with supportive partners ended up with less medical intervention and fewer cases of postpartum depression. Of course, access to quality birth care outside of the standard medical models may not be readily available to women of all social classes.

Summary

Despite generally good health in the U.S. compared with less-developed countries, America is still facing challenging issues such as a prevalence of obesity and diabetes. Moreover, Americans of historically disadvantaged racial groups, ethnicities, socioeconomic status, and gender experience lower levels of health care. Mental health and disability are health issues that are significantly impacted by social norms.

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19.7: Aging

More than 10,000 people turn 65 every day in the United States, and people are living longer, healthier lives. Healthy lifestyles, planning for retirement, and knowing your options for health care and long-term care are more important than ever before.

Across the world, the number and proportion of people aged 60 years and older in the population is increasing. In 2019, the number of people aged 60 years and older was 1 billion. This number will increase to 1.4 billion by 2030 and 2.1 billion by 2050. This increase is occurring at an unprecedented pace and will accelerate in coming decades, particularly in developing countries. This historically significant change in the global population requires adaptations to the way societies are structured across all sectors. For example, health and social care, transportation, housing and urban planning. Working to make the world more age-friendly is an essential and urgent part of our changing demographics.

- Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%.
- By 2020, the number of people aged 60 years and older will outnumber children younger than 5 years.
- In 2050, 80% of older people will be living in low- and middle-income countries.
- The pace of population ageing is much faster than in the past.
- All countries face major challenges to ensure that their health and social systems are ready to make the most of this demographic shift.

Adopting healthy habits and behaviors, staying involved in your community, using preventive services, managing health conditions, and understanding all your medications can contribute to a productive and meaningful life.

Cognitive Health

Cognitive health — the ability to clearly think, learn, and remember — is an important component of performing everyday activities. Cognitive health is just one aspect of overall brain health. Brain health refers to how well a person's brain functions across several areas.

Aspects of brain health include:

- Cognitive health: how well you think, learn, and remember
- Motor function: how well you make and control movements, including balance
- Emotional function: how well you interpret and respond to emotions (both pleasant and unpleasant)
- Tactile function: how well you feel and respond to sensations of touch — including pressure, pain, and temperature

Alzheimer's Disease & Related Dementias

Alzheimer's disease is the most common cause of dementia in older adults. It is a progressive brain disorder that slowly destroys memory and thinking skills. It is not a normal part of aging. Memory problems are typically one of the first signs of Alzheimer's disease. Scientists believe that a combination of genetic, lifestyle, and environmental factors influence when Alzheimer's disease begins and how it progresses. Current treatment approaches focus on helping people maintain mental function, manage behavioral symptoms, and slow or delay the symptoms of disease.

Eyes and Vision

As you age, it is normal to notice changes in your vision.

A few common changes for older adults include:

- Losing the ability to see up close
- Having trouble distinguishing colors, such as blue from black
- Needing more time to adjust to changing levels of light

The following eye problems can lead to vision loss and blindness in older adults. They may have few or no early symptoms. Regular eye exams are your best protection.

- **Age-related macular degeneration (AMD)** can harm the sharp, central vision needed to see objects clearly and to do common things like driving and reading. Your eye care professional will ask about your family history and look for signs of AMD during a dilated eye exam. Treatments are available, and special dietary supplements can help lower your chance of it getting worse.
- **Diabetic retinopathy** may occur if you have diabetes. It develops slowly, often with no early warning signs. If you have diabetes, be sure to have a dilated eye exam at least once a year. Keeping your blood sugar, blood pressure, and cholesterol under control can prevent diabetic retinopathy or slow its progress in early stages. Laser surgery in later stages can sometimes prevent it from getting worse.
- **Cataracts** are cloudy areas in the eye's lens causing blurred or hazy vision. Some cataracts stay small and don't change your eyesight much. Others become large and reduce vision. Cataract surgery can restore good vision and is a safe and common treatment. If you have a cataract, your eye care professional will watch for changes over time to see if you would benefit from surgery.
- **Glaucoma** is usually caused by too much fluid pressure inside the eye. If not treated, it can lead to vision loss and blindness. People with glaucoma often have no early symptoms or pain. You can help protect yourself by having dilated eye exams yearly. Glaucoma can be treated with prescription eye drops, lasers, or surgery.
- **Dry eye** occurs when tear glands don't work well. You may feel stinging or burning, a sandy feeling as if something is in the eye, or other discomfort. Dry eye is common as people get older, especially for women. Your eye care professional may tell you to use a home humidifier or air purifier, special eye drops (artificial tears), or ointments to treat dry eye. For more severe cases, treatment options might include prescription medication, tear duct plugs, or surgery.

Hearing

Hearing loss is a common problem caused by noise, aging, disease, and heredity. People with hearing loss may find it hard to have conversations with friends and family. They may also have trouble understanding a doctor's advice, responding to warnings, and hearing doorbells and alarms. Approximately one in three people between the ages of 65 and 74 has hearing loss, and nearly half of those older than 75 has difficulty hearing. But, some people may not want to admit they have trouble hearing.

Some people have a hearing problem and don't realize it.

You should see your doctor if you:

- Have trouble hearing over the telephone
- Find it hard to follow conversations when two or more people are talking
- Often ask people to repeat what they are saying
- Need to turn up the TV volume so loud that others complain
- Have a problem hearing because of background noise
- Think that others seem to mumble
- Can't understand when women and children speak to you

Common types of hearing loss include:

- **Sudden sensorineural hearing loss**, or sudden deafness, is a rapid loss of hearing. It can happen to a person all at once or over a period of up to 3 days. It should be considered a medical emergency. If you or someone you know experiences sudden sensorineural hearing loss, visit a doctor immediately.
- Age-related hearing loss comes on gradually as a person gets older and usually occurs in both ears. It seems to run in families and may occur because of changes in the inner ear and auditory nerve. The loss is gradual, so someone with presbycusis (age-related hearing loss) may not realize that he or she has lost some of his or her ability to hear.
- Tinnitus is also common in older people. It is typically described as ringing in the ears, but it also can sound like roaring, clicking, hissing, or buzzing. It can come and go. It might be heard in one or both ears, and it may be loud or soft. Tinnitus is sometimes the first sign of hearing loss in older adults.

Healthy Aging

Many factors influence healthy aging. Some of these, such as genetics, are not in our control. Others — like exercise, a healthy diet, going to the doctor regularly, and taking care of our mental health — are within our reach. Research supported by National Institute on Aging (NIA) and others has identified actions you can take to help manage your health, live as independently as possible, and maintain your quality of life as you age, these include both physical and mental health strategies.

Take care of your physical health:

- Get moving: Exercise and physical activity
  - Physical activity is a cornerstone of healthy aging.
  - As people age, muscle function often declines. Older adults may not have the energy to do everyday activities and can lose their independence. However, exercise can help older adults maintain muscle mass as they age.
  - A study of adults 40 and older found that taking 8,000 steps or more per day, compared to only taking 4,000 steps, was associated with a 51% lower risk of death from all causes[7].
- Healthy eating: Make smart food choices
  - Making smart food choices can help protect you from certain health problems as you age and may even help improve brain function.
  - A 2021 study analyzing the eating patterns of more than 21,000 participants found that people closely following the Mediterranean-style pattern had a significantly lower risk of sudden cardiac death[8].
  - A low-salt diet called Dietary Approaches to Stop Hypertension (DASH) has also been shown to deliver significant health benefits
- Getting a good night's sleep
  - Getting enough sleep helps you stay healthy and alert. Even though older adults need the same seven to nine hours of sleep as all adults, they often don't get enough.
  - A study, which looked at data from nearly 8,000 people, showed that those in their 50s and 60s who got six hours of sleep or less a night were at a higher risk of developing dementia later in life[9].
- Quit smoking
  - It doesn't matter how old you are or how long you've been smoking, research confirms that even if you're 60 or older and have been smoking for decades, quitting will improve your health. Quitting smoking at any age will:
    - Lower your risk of cancer, heart attack, stroke, and lung disease
    - Improve your blood circulation
    - Improve your sense of taste and smell
    - Increase your ability to exercise
    - Set a healthy example for others
- Alcohol and other substances
  - Like all adults, older adults should avoid or limit alcohol consumption. In fact, aging can lead to social and physical changes that make older adults more susceptible to alcohol misuse and abuse and more vulnerable to the consequences of alcohol.
- Go to the doctor regularly
  - Going to the doctor for regular health screenings is essential for healthy aging.
  - A 2021 study found that getting regular check-ups helps doctors catch chronic diseases early and can help patients reduce risk factors for disease, such as high blood pressure and cholesterol levels. People who went to the doctor regularly also reported improved quality of life and feelings of wellness[10].

Take care of your mental health:

- Social isolation and loneliness
  - As people age, changes such as hearing and vision loss, memory loss, disability, trouble getting around, and the loss of family and friends can make it difficult to maintain social connections. This makes older adults more likely to be socially isolated or to feel lonely.
  - A 2021 study of more than 11,000 adults older than age 70 found that loneliness was associated with a greater risk of heart disease[11].
- Stress
  - Research shows that constant stress can change the brain, affect memory, and increase the risk of developing Alzheimer's or related dementias.
  - A meta-analysis funded by the National Institute of Mental Health supports the notion that stress and anxiety rewire the brain in ways that can impact memory, decision-making, and mood[12].
- Depression and overall mood
  - Although depression is common in older adults, it can be difficult to recognize. For some older adults with depression, sadness is not their main symptom. Instead, they might feel numb or uninterested in activities and may not be as willing to talk about their feelings.
  - A 2020 longitudinal study demonstrated a link between positive mood and better cognitive control[13].
- Leisure activities and hobbies

- Your favorite activities are not only fun — they may also be good for your health. Research shows that people who participate in hobbies and social and leisure activities may be at lower risk for some health problems.
- A study showed that older adults who spent at least an hour reading or engaged in other hobbies had a decreased risk of dementia compared to those who spent less than 30 minutes a day on hobbies[14].

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19.8: Dealing with Death

It is a fact that we will one day die, how will you prepare for that day?

Advance Care Planning

Advance care planning involves learning about the types of decisions that might need to be made, considering those decisions ahead of time, and then letting others know—both your family and your health care providers—about your preferences. These preferences are often put into an *advance directive*, a legal document that goes into effect only if you are incapacitated and unable to speak for yourself. An advance directive also allows you to express your values and desires related to end-of-life care. There are two main elements in an advance directive—a living will and a durable power of attorney for health care. A living will is a written document that helps you tell doctors how you want to be treated if you are dying or permanently unconscious and cannot make your own decisions about emergency treatment. A durable power of attorney for health care is a legal document naming a health care proxy, someone to make medical decisions for you at times when you are unable to do so.

Organ and Brain Donation

Data shows that 90% of adults support organ donation but only 60% are actually signed up as donors.

Organ donation is the act of taking healthy organs and tissues from one person and giving them to someone else. Making the decision to donate your organs is one of the most generous gifts you can give. There is no age limit for donation or to sign up. In 2021, one out of every three people who donated organs was over the age of 50. You're never too old to make a difference — as of 2021, the oldest organ donor in the United States was 92.

While many people think that signing up to be an organ donor includes donating their brain, the purpose and the process of brain donation are different. Rather than helping to keep others alive, such as with kidney donation, brain donation helps advance scientific research. One donated brain can make a huge impact, potentially providing information for hundreds of studies.

Why donate:

- 106,008 men, women, and children are on the national transplant waiting list.
- Every 9 minutes another person is added to the transplant waiting list.
- 17 people die each day waiting for an organ transplant.
- Every donor can save 8 lives and enhance over 75 more.

Become and offiicial organ donor

Are you ready to save lives? You can provide lifesaving organs to as many as eight people. ***Every registration counts.***

Sign Up To Be An Organ Donor

Retirement and Savings

Retirement requires a lot of planning and consideration. In addition to finances, you need to think about when and where you'll retire. Experts advise that you may need as much as 80 percent of your pre-retirement income to continue your current standard of living. The exact amount will depend on your individual needs.

As you plan, consider these important questions:

- At what age do you plan to retire?
- Can you participate in an employer's retirement savings plan? This includes 401(k) plans and traditional pension plans.

- If you have a spouse or partner, will they retire when you do?
- Where do you plan to live when you retire? Will you downsize, rent, or own your home?
- Do you expect to work part-time?
- Will you have the same medical insurance you had while working? Will your insurance coverage change?
- Do you want to travel or pursue a costly, new hobby?
- Will you qualify for social security?

Social Security provides you with a source of income when you retire or if you can't work due to a disability. It can also support your legal dependents (spouse, children, or parents) with benefits in the event of your death.

While you work, you pay Social Security taxes. This tax money goes into a trust fund that pays benefits to:

- Those who are currently retired
- To people with disabilities
- To the surviving spouses and children of workers who have died

Each year you work, you'll get credits to help you become eligible for benefits when it's time for you to retire.

Saving for retirement

Get tips for building your retirement savings in the Department of Labor's (DOL) Top 10 Ways to Prepare for Retirement

Use a retirement calculator to find out the best age to claim your Social Security benefits.

Make a plan with the Retirement Saving worksheet

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19.9: End-of-Chapter Material

Key takeaways for this Chapter

- We are living much longer.
- You can easily be tricked by health fraud, so it is important to be a critical consumer of health information.
- The U.S. does not have universal healthcare, so it is important that you ensure you have healthcare either through employment, by purchasing your own insurance, or through government programs.
- Both western and eastern medicine can be helpful depending on your health status and goals.
- As you age, be aware of changes to your mind and body.
- Aging is highly dependent on your lifestyle choices.
- It is important to start planning for end of life to ensure your wishes are known.
- Plan for retirement early in your employment career to ensure you are taking the necessary steps to meet your retirement goals.

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19.10: Health Care and Aging- Optional Continued Learning

The videos below provide an opportunity to expand on your learning from the chapter. As you watch the video, make a list of what you notice and what you wonder. This is a great strategy to listen purposefully, engage with the content, and look for deeper opportunities for self growth, self-reflection, and learning.

What do you **notice**?

- How does this topic support, expand, or challenge the content in the chapter?
- How does this topic connect to health topics from other chapters?
- How does this topic connect with your prior learning, your experiences, your work, your family, or your life in general?
- How does this topic help you to more fully understand health and wellness?

What do you **wonder**?

- How has this topic sparked your curiosity?
- What would you like to know more about?
- What questions did you have as you reviewed the topic?
- What other popular and scholarly sources support or refute this topic?

Videos for continued learning and application

Note: These videos are intended to more fully reflect on health. You might agree or disagree with the videos and that is ok! Utilize these videos to critically think through the topics and identify other sources, both scholarly and popular, to convey your learning.

Essential questions to ask your future self

How healthy living nearly killed me

How humanity doubled life expectancy in a century

How the COVID-19 vaccines were created so quickly

How to find meaning after loss

How to live to be 100+

How to support yourself (and others) through grief

It's our city. Let's fix it

The emotions behind your money habits

The profound power of gratitude and "living eulogies"

The science of preserving sight

What Americans agree on when it comes to health

What I learned from 2,000 obituaries

What if our health care system kept us healthy?

What really happens to your body during menopause

What to trust in a "post-truth" world

Why do our bodies age?

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20: WELLNESS FOR PROFESSIONALS

Welcome to Wellness for Helping Professions!

We are glad you are here! This text is designed to be a starting point for those who want to explore, understand, and improve their personal wellness, with a specific focus on those who work and care for others. The format of the course is centered around trying various self-care activities followed by reflection. Some of these activities may be ones you engage with regularly while others may allow you to step outside your comfort zone. As you engage with each of these self-care practices, it is our hope that you will learn to identify your own sources of stress, build healthier habits that help you thrive, and develop a toolbox of activities that can help ground you as you work with and care for others.



Figure : Self-care practices are essential to manage stress and keep you grounded as you work with others. (Photo by Jorge Urosa from Pexels.)

Course Goals

The course goals (learning outcomes) will be that the student will be able to:

1. **Assess** and **identify** their own wellness needs
2. **Identify** different approaches to meet different wellness needs
3. **Create** a plan for ongoing responsiveness to assess needs and implement practices for wellness
4. **Create** new habits related to wellness
5. **Demonstrate** an awareness of ethical, professional, and Christ-like behaviors related to self-care

Course Recommendations and Structure

There are some recommendations on how you can gain the most from this course:

- Be willing to commit to being an active participant in all activities, not just the 'comfortable' ones
- Set aside 1 hour each week at a consistent time to start a new module and work through and/or complete the activity
- Outside of the 1-hour class, set aside an additional minimum of 1 hour per week to practice the activity
- *Reflect* on your incorporation of that activity, the benefits and barriers to your wellness that week, and how that activity impacted your wellness
- Consider recruiting others to do this course with you. While this course is about working on your personal wellness, many of

the activities are great to do with others. Participating with a partner or a group can also help with accountability to stick to your plan!

- **DO NOT** try only the activities that are comfortable or seem interesting. **DO** try activities that push boundaries and explore new ideas!

As an introductory, exploratory course utilizing evidence-based activities, you are encouraged to try new activities and explore your own wellness and wellness needs. This course is not intended to be a long-term wellness plan, but rather, it is meant to help you develop habits that can turn into a more permanent approach to wellness. When you are able to identify activities that meet your wellness needs, we encourage you to dig deeper into those practices and expand beyond the introductory level explored in this course.

Why is this course important to the helping professions?

People who work in the helping professions are, by definition, helping others. They often have personalities that feed off of giving to others and providing care or education for those in need. However, while giving of themselves, helping professionals may not consider their own needs and are vulnerable to stress, frustration, anxiety, and fatigue. Thus, proper self-care is both a responsibility and a necessity in order to be at one's best (Radlauer-Doerfler & VanDenBerg, 2020).

To give some practical, evidence-based examples, here are several examples from research in various helping fields:

Nursing

In 2013, the American Nursing Association (ANA) launched its HealthyNurse Health Risk Appraisal. From the findings of the report, nearly every indicator showed that the health of American nurses is worse than that of the average American. This includes data showing that American nurses are more likely to be overweight, have higher levels of stress, and get less than the recommended hours of sleep (American Nurses Association, n.d.). Further, hazards such as workplace violence and musculoskeletal injuries also contributed to poorer health.

Social Work

Numerous studies have shown evidence that social workers are at risk for higher levels of burnout and stress because of their jobs (Ratcliff, 2024; Schraer, 2015). Larger organizations like the National Association of Social Workers (NASW) have changed their code of ethics (2021) to encourage proactive self-care amongst social workers to improve professional excellence, thereby recognizing the importance of mentally healthy workers.

Teaching

Teachers constantly work with students on a daily basis and are at higher risk for burnout which is often manifested physically or psychologically (Nápoles, 2021). A systematic review showed that teacher burnout was associated with headaches, illness, and voice disorders, among other physical factors (Madigan et al., 2023). Psychologically, one study showed that the proportion of teachers reporting psychological distress was twice as high as compared to a general population sample (Biron et al., 2008).

Personal Training

Personal and athletic trainers are not immune from experiencing burnout, potentially due to irregular hours and long hours (Oglesby et al., 2020). Moreover, because of the nature of the job of a personal trainer in helping people transform their bodies, personal trainers may experience higher levels of dissatisfaction with their own body and would benefit from exercises in self-compassion (Ebbeck & Austin, 2018).

Regardless of the helping profession, there is clear research and evidence that both physical and psychological issues can manifest themselves due to the work being done. To be at our optimal selves, it is vitally important that we take care of ourselves first so that we can maximize our impact on others. Our hope is that not only will you recognize your need for intentional self-care, but that you will actively engage in self-care activities to live your best life.

Reflection

What brought you to explore this course?
What has you interested in exploring wellness?

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20.1: Getting Started - Assessments

Background

"You can't really know where you are going until you know where you have been"

- Maya Angelou

How do we start the exploration of wellness that is the purpose of this course? This first activity looks to set a path forward, by starting with an in-depth evaluation of where you are at now when it comes to wellness.

Princeton U Matter (n.d.) defines wellness as "not merely the absence of illness or distress, [but] a lifelong process of making decisions to live a more balanced and meaningful life" (para. 1). The first step in that process is evaluating your current state, which is similar to many models of improvement including the nursing process. The nursing process follows 5 systematic steps: assess, diagnose, plan, implement, and evaluate (Toney-Butler & Thayer, 2023). Many other helping professions have a similar approach to practice. For example, quality improvement (QI) is something frequently discussed in healthcare. While comparing oneself to healthcare may not be the most therapeutic way to start a course focused on promoting wellness, it can be helpful to borrow a few concepts from QI models. The Model for Improvement used by the Institute for Healthcare Improvement (n.d.) starts by asking three fundamental questions that can be adapted for students in this course.

Definition: The Model for Improvement

The **Model for Improvement** asks three fundamental questions:

1. What are we (am I) trying to accomplish?
2. How will we (I) know that a change is an improvement?
3. What changes can we (I) make that will result in improvement?

One way to answer these questions and complete the assessment stage of the nursing process is to use a variety of inventories or tools to gather data. These assessments can identify different wellness needs that will assist you in creating a plan to better your own wellness.



Figure : Start making changes now. (Photo by Markus Winkler from Pexels)

Activity

This week, you are going to complete a variety of assessments/inventories to gather data about your wellness needs and create individual goals for the course. Taking these assessments should help with the three questions posed in the Model for Improvement. In some ways, this week can be the hardest in the course because it asks participants to dig deeply into their experiences. This takes vulnerability, strength, and courage! Do not be discouraged if this week's activity feels heavy or difficult. Try to recognize that this marks a starting point or baseline for the adventure of this class. The goal is to help you gather data to better inform you of what your needs are and to help you evaluate how you are responding to the different activities each week!

You will complete five assessments this week:

1. Princeton U Matter
2. Social Readjustment Rating Scale OR Students' Stress Rating Scale
3. Hassles & Uplifts
4. Symptoms of Stress
5. Resting Heart Rate

Why are there so many different assessments? Each assessment measures different aspects of wellness which are discussed more in the following sections.

Materials Suggested

- Device with access to Internet (and possibly a printer) to access the assessments to be completed
- Writing utensil and paper or note app to document results
- Optional: SmartWatch for tracking heart rate
    - *Note*: You can either download and print the assessments or take them digitally. Regardless, you need to document your responses for each assessment (if appropriate) and your results to refer back to them throughout the rest of the class.



Figure : Use a laptop, paper, writing instrument, and a SmartWatch. (Photo by KATRIN BOLOVTSOVA from Pexels)

Directions

Please take the time needed to carefully fill out the following five assessments and record your results using this chart. This chart is also available as a PDF download: Assessment Summary

Assessment Summary

A table depicting each assessment with a place for scores and notes and comments.

Tool	Your Score	Notes or Comments
Princeton UMatter: Emotional		
Princeton UMatter: Environmental		
Princeton UMatter: Intellectual		
Princeton UMatter: Occupational		
Princeton UMatter: Physical		
Princeton UMatter: Social		
Princeton UMatter: Spiritual		
Social Readjustment Rating Scale OR Students' Stress Rating Scale		
Hassles & Uplifts: Hassles		
Hassles & Uplifts: Uplifts		
Symptoms of Stress		
Resting Heart Rate		

Princeton U Matter

The *Princeton UMatter Wellness Self-Assessment* prompts the user to consider their current state in 7 different dimensions

including: emotional, environmental, intellectual, occupational, physical, social, and spiritual.

Take the assessment using one of the links below:

- Electronic access to Princeton UMatter Wellness Self-Assessment (recommended for ease of use of results)
- Print version of Princeton UMatter Wellness Self-Assessment

Social Readjustment Rating Scale OR Students' Stress Rating Scale

The Social Readjustment Rating Scale (SRRS) is an updated assessment based off the 1967 Holmes and Rahe Life Stress Inventory. Its goal is to measure the impact of various life events and how susceptible you might be to a stress-induced health breakdown (Wallace et al., 2023). Similarly, the Students' Stress Rating Scale (SSRS) is a 35-item variation on the Holmes and Rahe assessment tailored to college students and stresses that they might be facing (Balamurugan & Kumaran, 2008). These assessments can be valuable in helping you identify significant events that have the possibility of affecting your wellness, as well as giving you an opportunity to think about modifiable vs non-modifiable stressors.

Pick one of the following to complete:

- Electronic access to Social Readjustment Rating Scale (recommended for ease of use of results)
- Print version of Social Readjustment Rating Scale OR Print version of Students' Stress Rating Scale Rating Scale (no electronic version available)

Hassles & Uplifts

The Hassles and Uplifts Scales (HUS) was constructed as a tool to focus on relatively minor events that happen in everyday life. This was a response to, in large part, the significance in psychological testing that the Social Readjustment Rating Scale had taken in measuring major life events (Kanner et al., 1981). While large stressors can and will happen, it is often the daily interactions or choices that impact our mood and our stress levels.

Take the assessment using the link below:

Print version of Hassles and Uplifts Scale

Note: Please read the full directions for completing the assessment to ensure you are completing the assessment accurately. After assigning a score of 0-3 for each item, add the score up for all Hassles, and then add up the score for all Uplifts.

Symptoms of Stress Table

Stress can cause many physical symptoms, some of which may be more obvious than others. The Symptoms of Stress Table can be used to identify what stress is doing to the body. Results can prompt goal setting related to those symptoms (Sairanen et al., 2024). This assessment has elements of the Calgary Symptoms of Stress Inventory (C-SOSI; Carlson & Thomas, 2007), but it is important to note that this assessment is not as comprehensive as that validated tool. The C-SOSI is primarily used by researchers to analyze data on stress symptoms in specific populations, whereas this Symptoms of Stress table is intended as a self-assessment to help identify different ways stress may be showing up in your body.

Take the assessment (found on page 2) using the link below.

Symptoms of Stress Table

To quantify this table, add up the scores as follows for each answer: Almost all day, every day (6 pts.); Once or twice daily (5 pts.); Every night or day (4 pts.); 2-3 times per week (3 pts.); Once a week (2 pts.); Once a month (1 pt.); Never (0 pts.). Record your total score in the assessment summary table.

Resting Heart Rate

Your heart rate can be used as one indicator of health and provides a quantitative piece of data to track. Many things can impact your heart rate, such as fitness level, temperature, and body position. For this course, it is particularly helpful to note that your

emotions can impact your heart rate (American Heart Association, 2025). Once you know what your resting heart rate tends to be, you can use that as a gauge to analyze if stress or emotions may be impacting you physically in any given moment.



Figure : Find your pulse on your wrist. Take your heart rate for 60 seconds. (Photo by BruceBlaus from Wikimedia Commons)

Recommendations for tracking your resting heart rate this week:

- Find a consistent time that you can check your heart rate each day. Ideally, this would be at the start of each day.
  - *Note*: If you wear a fitness tracking device, the device may do this for you.
- Take your heart rate. If you are not familiar with taking your heart rate or could use a refresher, here are some step-by-step instructions from the Mayo Clinic (2024).
- If you notice that you are feeling stressed or are experiencing heightened emotions, take a moment to check your heart rate and note any changes from your resting heart rate.

Assessment Summary

If you have not already done so, please record your assessment scores and any interesting observations or notes you had from taking these assessments: see the Assessment Summary.

Assessing wellness and stress is a complex and challenging process. Today you assessed your wellness from many different perspectives. Look back over each of the assessment tools. You will see that these tools measured wellness and stress from a variety of perspectives including:

- Physiological indicators of stress
- Your perception of what is happening in your life
- Sources of stress and frequency of hassles
- Your level of satisfaction with events in your life
- Type of life events you have experienced

Key Points

- Testing, measuring, and understanding yourself (i.e., assessment) is the first important step in developing a plan for wellness and reduction of stress.
- Stress can trigger physiological changes like an increased pulse. Symptoms of stress can include headache, muscle tension, insomnia, and a host of other warning signs. Listen to what your body is telling you as you continue through this course.
- Perception is key when assessing stress. The same situation can elicit a very different stress response in different individuals due to the individual's perception of the experience. It is okay if you experience something differently than others around

you! Be honest with yourself so you can be most responsive to your needs.
- For a balanced picture of wellness, consider all dimensions of wellness including emotional, environmental, intellectual, occupational, physical, social, and spiritual.
- No single assessment, survey, or tool can tell the whole picture when it comes to assessing your wellness. Consider the results from all of these assessments to gain a better understanding of your personal wellness needs.

Weekly Recommendation/Homework

The real impact of this activity is in **what you will do with the information you learned** about yourself. In this course, you will have the opportunity to explore different evidenced-based practices to develop a plan that is responsive to your wellness needs.

This week, continue to reflect on what you learned from the assessments. Take 5-10 minutes each day to check in with yourself about what you are feeling. Are you experiencing different physical symptoms of stress? Be attentive in listening to your body and assessing your ongoing needs.

Think about the Hassles and Uplifts assessment. Are there things that you can turn into more of uplifts? Are there hassles you can avoid or minimize? Try to be more aware of these throughout your week and repeat the assessment at least one more time to see if your results change with being more intentional about how you view each item.

Before the week is done, it is time to make some goals! Share in your reflection.

Reflection

1. Think back to the three questions from the Models for Improvement (given below) that began this section. Reflect on them in light of your scores on the assessments.
    1. What am I trying to accomplish?
    2. How will I know that a change is an improvement?
    3. What changes can I make that will result in improvement?
2. In light of your reflection, what are 3-5 specific goals that you can work towards to improve your wellness?

These reflection questions are also available as a PDF download: Weekly Recommendation/Homework - Chapter 2

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20.2: Breathwork

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20.3: Yoga

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20.4: Coloring

Background

Have you ever been so absorbed in a task that you lost track of time and everything else seemed to fade away? In those moments, the body and mind are fully engaged in the present, often accompanied by a sense of deep satisfaction and peace (Psychology Today, n.d.). This experience is known as flow state. More casually, this phenomenon is described as being 'in the zone,' as when a person is immersed in an activity that requires complete concentration. Flow state is desirable not only because it enhances productivity, but also because it helps reduce stress and anxiety (Flett et al., 2017). For many, moments of flow can also feel deeply spiritual, providing a sense of connection to something greater than oneself. In Christian practice, this aligns with experiences of being present with God through prayer. Professionals, artists, and athletes are just a few groups who intentionally cultivate flow to optimize their roles, crafts, or performances.

So how does flow state work, and how can you achieve it? The answer lies in neuroscience. When a person experiences the deep mind–body connection of flow, the brain releases *dopamine*, a neurotransmitter associated with pleasure, motivation, and relaxation (Ranes, 2025). This positive chemical response has led researchers to explore interventions that nurture flow for individuals facing high levels of daily stress, like health care workers or those in other helping professions.

One popular intervention that promotes flow state is coloring (Jakobsson Støre & Jakobsson, 2022). Although it may seem simple, coloring is a well-researched activity with proven health benefits. These include a reduction in anxiety and depression in addition to an increase in mindfulness, enjoyment, and creativity (Flett et al., 2017; Flicker et al., 2025; Holt et al., 2019). For health care workers such as nurses, recent research shows a significant decrease in stress symptoms after completing a structured coloring intervention (Daly et al., 2024; Kaplow et al., 2025). Coloring is also an appealing coping strategy because it is affordable, readily available, and easy to practice.

Activity

Today you will be coloring. But not just any coloring of your favorite Disney princess or comic superhero, but a specific type of coloring called *mandala coloring*.

What is a mandala? A mandala is a circular geometric design made of repeating shapes and patterns.

Why choose a mandala design for a coloring activity? Research suggests that coloring a mandala shape provides a clearly defined goal, which supports entry into flow state (Jakobsson Støre & Jakobsson, 2022).

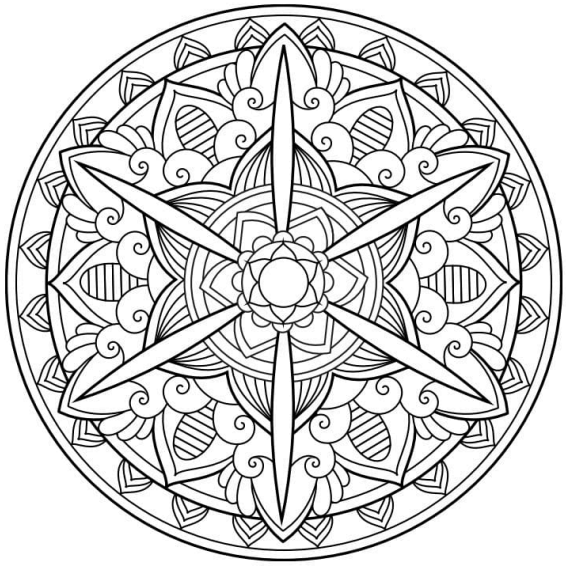


Figure : A mandala taken from the coloring book Magic Mandalas. (Illustration by Peaksel from Wikimedia Commons.)

Materials Suggested

Coloring is an outlet for creativity and emotional expression. As you choose your materials, pay attention to how you are feeling and select colors or patterns that express your current mood. If you wish to shift your mindset, select colors that inspire a positive intention for the day and invite a sense of calm.

1. A printed mandala. You can purchase mandala coloring books at a local discount or dollar store, however, they are also able to be freely printed from online. Some websites with free printable versions include:
   - Crayola
   - Monday Mandala
   - Kelly Dietrich
2. 3-5 colored pencils, crayons, or markers. Remember that repetition of color is part of the beauty of mandala art.
3. Quiet space.
4. Music (optional)

Directions

1. **Set up materials in a quiet space**. Choose an environment with minimal distractions to support deep concentration. This type of calm setting helps promote achievement of flow state.
2. **Select a time frame for your activity**. Most research studies utilize a coloring intervention of 15-20 minutes. This amount of time may be necessary to achieve flow state and attain the physiologic benefits (like reduction of anxiety and stress) that come from coloring.
3. **Begin coloring**. The strategy for coloring a mandala is highly individualized. Suggestions include coloring from center to outer ring, coloring wedge by wedge or one “slice” at a time, or filling similar shapes with the same color and then moving on to the next color. You can watch this quick tutorial of how to color a mandala

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : How to color a mandala. ("Basic tutorial for beginners on how to color a Mandala (Art Lesson 128)" by Mandala Art by Maria Hajj from YouTube.)

4. **Notice your body tension throughout the activity**. Pay attention to your posture and any tightness in your neck or shoulders. If you feel tension, consciously relax those areas and take a few deep breaths. You may find it helpful to set a timer every 4-5 minutes as a reminder to check in and release tension.
5. **Have fun**. There is no "right" way to color a mandala. The process and activity of coloring is the reward.

Alternatives/Variations

These activities may also foster flow state:

- Drawing or sketching
- Painting
- Sculpting
- Puzzles
- Journaling or creative writing
- Dancing
- Yoga

Weekly Recommendations/Homework

Spend 15-20 minutes at least 3-4 times this week coloring a mandala. As you color, pay attention to your thoughts, feelings, and any tension in your body. Choose colors that reflect your current mood or help set a positive intention for the day. You may also play soft music to enhance focus and relaxation. After each session, take a moment to reflect on how the activity influenced you physically, mentally, and spiritually.

Reflection Questions:

1. Describe any changes you noticed in the following areas when coloring this week:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual

2. What benefits did you feel when coloring?

3. What, if any, barriers did you experience when coloring?

4. Do you have any additional thoughts and/or future plans for coloring?

5. What are your current stressors and do you have a wellness goal for this week?

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20.5: Walking in Nature

Background

Have you ever spent some time sitting in nature surrounded by trees and found yourself feeling better? You may have actually been participating in the practice of *forest bathing* without even knowing it. Don't be alarmed - forest bathing has nothing to do with cleaning oneself in a natural stream or pond. Rather, forest bathing (also called shinrin-yoku in Japanese) is a meditative practice characterized by walking in a forest at a non-tiring pace and contemplating the natural environment (Antonelli et al., 2019). It is more than just walking in the woods though. It is the conscious and contemplative practice of using your senses - think sight, smell, feel, and sound - while being immersed in the forest (Global Wellness Institute, n.d.). Peer-reviewed evidence supports that forest bathing is capable of significantly reducing stress levels, especially stress due to studying and working activities (Antonelli et al., 2021). In general, the shorter the forest bathing session is, the smaller the effect of the intervention, but even brief visits to the forest were shown to impact individual well-being (Antonelli et al., 2021). In a separate study, 15 minutes of forest bathing showed positive short-term effects on mental health including reduction in stress and anxiety (Kotera et al., 2020).

The previous module on Breathwork presented how breath is a gift from God. In this module, we can expand the list of gifts from God by directly linking our breath to trees. Think about the perfect partnership that God created between humans and trees. Humans breath out carbon dioxide. Trees use the carbon dioxide and generate oxygen that is in return essential to human life. Humans are designed to work together with nature for the very air we share! Genesis 1:1 states: "In the beginning, God created the heavens and the earth", so this week, let us go enjoy that earth!



Figure : Forest bathing is a meditative practice. (Photo by Alex Moliski from Pexels.)

Activity

This week's activity asks you to take a trip into nature to explore and experience the world around you. Remember that the focus of this practice is not on getting a vigorous workout or hike in, but on becoming more aware of your surroundings and being curious about the world around you. To get a better sense of how to begin forest bathing and what to focus on, check out this beginner's guide from Forestry England.

Materials Suggested

- Comfortable clothing for being outdoors
- Good walking shoes

Directions

Identify a safe place to go for a walk *in a forest*. Ideally this is an actual forest versus an urban park or a cluster of trees in your backyard. Surround yourself by as many trees as possible. This can be done by oneself or with others. For the first fifteen minutes of the walk, direct your attention fully to your surroundings. Avoid conversations and use of audio. Prompt yourself to consider the following questions:

- What do I see?
- What do I hear?
- What do I smell?
- What do I taste?
- What do I feel?

As other thoughts enter your mind, gently push them aside and redirect to focus on nature and your surroundings. It may also be helpful to connect back to the breathwork you experienced earlier in the course and try some of those breathing techniques in the forest as well.

At the end of the set amount of time (aim for 15 minutes minimum), take a moment to reflect on how you feel. Then either continue your walk and engage your senses in nature or transition to a time of conversation with others or use audio (such as music, audiobooks, or podcasts). Note how these different activities each effect you. Consider when each might be useful to implement into your self-care.

Alternatives/Variations

- Grounding/Earthing - standing barefoot and/or making physical contact with the earth's surface
- Visiting a botanical gardens or greenhouse
- Exploring a meadow

Weekly Recommendations/Homework

Aim to spend a total of 2 hours in the forest this week. This can be one long visit/walk or broken down into smaller visits over multiple days. With the visit, be deliberate in considering the how you felt while you were in the forest, and how you felt after.

Reflection Questions:

1. Describe any changes you noticed in the following areas when doing forest bathing this week:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual)

2. What benefits did you feel with forest bathing?

3. What, if any, barriers did you experience doing forest bathing?

4. Do you have any additional thoughts and/or future plans for forest bathing?

5. What are your current stressors and do you have a wellness goal for this week?

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20.6: Reading for Fun

Background

Remembering sitting on the floor in your elementary school classroom and having the teacher read a story to you out loud? How did it feel? Does the image that comes to mind bring a sense of relaxation or comfort?

Reading for pleasure has been associated with many health benefits. One recent study found that recreational reading for college students was associated with reduced psychological distress and improved sleep over the school year (Levine et al., 2020). Critical thinking, a skill important in many college classrooms, was found to increase when students engaged in voluntary reading (Hawkins, 2012) with brain connectivity improving as well when you read a novel (Berns et al., 2013). Psychologically, a different study found that students who emotionally connected with a fictitious story were more empathetic after reading (Bal & Veltkamp, 2013). Another study presented data that reading books was associated with a 20% reduction in mortality when compared to others who did not read books (Bavishi et al., 2016).

Aside from personal health benefits, reading also is a way to expand one's own understanding of the world around them. Proverbs 4:7 (ESV) reads: "The beginning of wisdom is this: Get wisdom, and whatever you get, get insight." Isn't reading a way to get both wisdom and insight? In the helping professions, think of all the different points of views books can offer, and how that can translate to caring for others.

While there is research that provides evidence-based backing for reading for pleasure, there is a gap in evidenced-based literature regarding the potential benefits specific to nurses and other helping professions. Additional research could expand knowledge specific to how reading can help nurses and if different types of reading materials are associated with different benefits!



Figure : Reading for pleasure has many benefits. (Photo by Kaboompics.com from Pexels.)

Activity

This activity will involve you doing some reading on your own - not anything related to your academic studies, but finding something to read that you find enjoyable. For some, this could be a young adult book that you read while growing up. Or it could be a graphic novel or comic book. Or a book of poetry or a play. Or a classic novel that you have wanted to read for years. There are many different possibilities that can take you on a journey of imagination away from the daily grind of your academic studies.

Materials Suggested

- Any book of choice
  - *Note*: If this activity is being done in a class, consider inviting a guest speaker from the Library or English Education department to discuss some book recommendations

Directions

For a classroom setting:

1. Start with a discussion or reflection on how it feels to settle into reading. Share or think about memories of when a book was read out loud to you as a child or when you were able to escape to a different world reading a book.
2. Share brief book recommendations that include a 1-minute summary and why that book is recommended. Aim for a variety of options!
3. After picking a text with a strong chapter for the group to hear, settle into comfortable positions that promote relaxation. **Read the chapter out loud** (or if needed, play an audiobook). Note the book chosen can be from any background! Children's or young adult literature can work just as well as adult fiction.

For an individual:

1. Reflect on how it feels to settle into reading. Think about memories of when a book was read out loud to you as a child or when you were able to escape to a different world reading a book.
2. Spend some time (set a limit) looking up book recommendations to find a book to read this week. Use a book app like GoodReads or Story Graph to look at book options based on your preferences. Or consider a book off of the Great American Read list.
   - *Note*: It can be a physical book or an audiobook of any genre!
3. For at least 30 minutes, settle into the book. Avoid other distractions (turn your phone off) or multi-tasking. Set a timer. When done, reflect on how you feel.

Alternatives/Variations

- Read out loud to others (volunteer at a school or assisted living facility)
- Read the Bible

Weekly Recommendations/Homework

Read something not assigned for a class, for at least 1 hour this week. Consider trying reading at different times to assess how it makes you feel.

- Does reading for 5 minutes in the morning help you start your day more relaxed?
- Does reading a chapter before bed help you sleep better?
- Does listening to an audiobook during a drive make you feel different than listening to the radio or other materials?

Be creative to overcome barriers. If you have a hard time stopping reading at night, consider a book with short chapters to make it easier to set a stop point. Keep your book with you and instead of spending a few minutes scrolling on your phone, open your book during free time.

Reflection Questions

1. Describe any changes you noticed in the following areas when reading for fun this week:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual

2. What benefits did you feel when reading for fun?

3. What, if any, barriers did you experience when reading for fun?

4. Do you have any additional thoughts and/or future plans for reading for fun?

5. What are your current stressors and do you have a wellness goal for this week?

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20.7: Journaling

Background

Did you know that current research suggests that human beings have more than 6,000 thoughts per day? (Tseng & Poppenk, 2020). This statistic demonstrates our brain's amazing ability to engage with a complex world, but it also reveals the busyness and intricacy of our own minds. Have you ever felt like your brain is a Google search bar, with 10-15 open tabs at any given moment? Or maybe you are on autopilot, juggling a never-ending to-do list alongside responsibilities at work, school, and home. When we are bouncing from one thought to another to keep up with the current fast-paced culture, when does the mind have the opportunity to pause, reflect, and truly learn from life's experiences?

One answer to this question is through the wellness activity of journaling. Journaling is the intentional practice of writing down your thoughts and feelings to gain insight into your past, present, and future life experiences. This simple act of self-awareness has powerful, wide-ranging health benefits like lowering blood pressure, boosting immune system response, and reducing symptoms of anxiety and depression (Baikie & Wilhelm, 2005; Krpan et al., 2013; Smyth et al., 2018). Moreover, a 2023 systematic review of workplace interventions to improve well-being among health care workers concluded that gratitude journaling was an effective tool for reducing stress and depressive symptoms as well as increasing feelings of happiness (Cohen et al., 2023). Regular journaling has even been shown to decrease symptoms of burnout and trauma compassion fatigue in nurses (Dimitroff et al., 2017).

So how does the small act of journal writing lead to big changes in physical, mental, and emotional well-being? The short answer is mindfulness. By sitting down and writing your thoughts, your mind remains focused on your present situation. Even if you are writing about past experiences or fears of the future, you are naming, analyzing, and responding to current thoughts or feelings. This practice of intentional reflection is essential for self-growth and well-being.

Activity

Journaling can offer a window into your mental state and a private space to process your thoughts and feelings. It can help you regulate your emotions, track personal growth, and provide clarity in setting goals.



Figure : Writing your thoughts helps you remain focused on your current situation. (Photo by Alina Vilchenko from Pexels.)

Materials Suggested

Because journaling is a form of self-expression, the materials you select should reflect your preferences and personality. Feel free to get as creative as you want and choose supplies with various colors and textures. If a digital journal entry is preferred, then consider logging your entries in a different color or style font.

- Writing utensil
- Paper or notebook
- Computer or tablet (if doing the activity digitally)

Directions

1. **Choose a space that is free from distraction and promotes feelings of relaxation and comfort.** Journaling is an introspective and reflective practice. The ideal setting for this activity allows your mind time and space to explore personal thoughts and feelings without interruption. This could be in a quiet room in your home, sitting in your car, or traveling on public transportation. It could be at a local coffee shop or even a breakroom during a shift at work. One of the best parts of this wellness activity is that it can be done at any time and at any place as long as it works for you.
2. **Choose a time frame for your activity.** Set a goal for the minimum amount of time you want to journal, but allow yourself the flexibility to journal beyond that time limit. Journal writing sessions of 10-20 minutes in length are most common, but health benefits are possible with as little as two minutes of daily journal time (Burton & King, 2008). Journaling time may vary depending on your daily circumstances and wellness needs.
3. **Begin journaling.** Write your thoughts and feelings down on paper or type them on your tablet/computer. You can write down whatever flows naturally from your mind in this moment or choose from one of the following writing prompts suggested by *Psychology Today* (Martin, 2024):
    - What are you worried about right now?
    - What events happened today and how do you feel about them?
    - What are three things that you are grateful for and why?
    - What is a situation that you can't stop thinking about?
    - Discuss a happy memory and reflect on why it makes you happy.
    - Write about something that makes you feel angry, sad, or afraid.
    - Discuss a problem that you want to solve and possible solutions.
4. **Consider using a reflective model.** The Gibbs Model of Reflection (1988) is a helpful tool for journal writing. This six-stage cycle guides the exploration of an individual's experience with emphasis on fostering personal and professional development (Butler, 2024).

Alternatives/Variations

Consider these different forms of writing to express your thoughts and feelings. Review the associated links to gain deeper insight into these variations on journaling.

1. **Reflective writing**
    - Reflective Practice Toolkit, University of Cambridge
    - Reflective Writing, Australian National University
2. **Gratitude journaling**
    - Gratitude Journal: 35 Ideas for Getting Started
3. Learn How to Write Expressively (and heal yourself):

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : Learn how to write expressively. ("Nelda Shorts | James Pennebaker | How to write expressively and heal yourself" by Nelda Studios from YouTube.)

Weekly Recommendations/Homework

Review your daily and weekly schedule to dedicate time for journaling. The goal is to write a daily journal entry. The timing of this activity should be the best fit for your schedule. For some people, this might look like journaling at the same time every day with your morning coffee or before bed. For others, the time for journal writing will vary depending on when your schedule allows for those precious moments of solitude. Whenever you find the time, the most important part of journaling is committing consistent minutes each day to the practice of allowing thoughts and feelings to flow from the mind to paper (or computer/tablet).

Reflection Questions

1. Describe any changes you noticed in the following areas when journaling this week:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual

2. What benefits did you feel when journaling?

3. What, if any, barriers did you experience when journaling?

4. Do you have any additional thoughts and/or future plans for journaling?

5. What are your current stressors and do you have a wellness goal for this week?

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20.8: Sleep

Background

Sleep is an essential part of life. The National Sleep Foundation (2020) recommends that the average adult should sleep 7-9 hours per night. People who get the recommended amount of sleep are more likely to flourish in their day-to-day life (National Sleep Foundation, 2025). Despite knowing how important sleep is, many helping professionals and college students struggle to get adequate sleep. 77.4% of one sample population of hundreds of nurses had a poor quality of sleep, with night shift nurses having more sleep problems than others (Khatony et al., 2020). In a different study, 87% of intensive care unit (ICU) nurses experienced poor sleep quality which affected their professional quality of life (Mansouri et al., 2025). Related to college students, 60% of surveyed students reported experiencing sleep disturbances which affected their physical and psychological health (Lund et al., 2010).

Many factors can impact sleep. One significant factor is the use of electronic devices. A study reported that 97.3% of medical students used a blue light-emitting device at bedtime with a mean duration of screen time being 1 hour and 50 minutes per night. More than half of the students had their sleep interrupted to check messages (Jniene et al., 2019). Healthcare workers are at risk for sleeping disturbances for several reasons including shift work, work-related schedules, stress, and the type of care they provide for other people. Other factors that can impact sleep include one's activity level, alcohol use, caffeine use, stress, and environment.

In the past decade, both the American Nurses Association and the American Academy of Nursing have released position statements on the importance of addressing fatigue, sleep, work, and safety for nurses (Weaver, 2024). Research supports that there is a strong link between sleep disturbances and burnout in nurses (Ren et al., 2025). Nurses who are not getting enough sleep are also at increased risk for many infections like the common cold, pneumonia, bronchitis, sinusitis, and gastrointestinal infections (Hartveit Hosøy et al., 2025). Sleep also impacts the care that healthcare workers can provide others, directly impacting safety for both the nurse and patient as well as overall quality of care. Likewise, poor sleep has many negative impacts on students, including impaired memory, reduced cognitive function, decreased motivation and focus, and increased stress and anxiety (TrueLearn, 2025). Some good news is that while the average college student has a significant need for improved sleep, this population is also more responsive to sleep related interventions (Saruhanjan, et al., 2020).

How does God feel about sleep? In Genesis 2:2 (NLT), we read that "On the seventh day God had finished his work of creation, so he rested from all his work." Even God rested! With all that in mind, this week the focus is on sleep!

Activity

Who doesn't love a good sleep? This week, we are going to assess the length and quality of our sleep using the Pittsburgh Sleep Quality Index (PSQI). This evidence-based assessment helps people measure their sleep quality. From these results, you will identify ways to modify your sleeping patterns. This will mostly be done by setting some sleep-related goals for the week and tracking them. And hopefully, with these modifications, your overall wellness will be improved as well!



Figure : Sleep is essential for your wellbeing. (Photo by Jasmine Pang from Pexels.)

Materials Suggested

- Paper, pencil, or electronic device for documenting
- *Optional*: Sleep aids such as eye masks, ear plugs, noise machines, or sleep tracking devices like a smart watch

Directions

Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (Buysse et al., 1989) is an evidence-based assessment that helps people measure their sleep quality. It contains 19 questions (plus a few more if you sleep with a partner) with a scoring rubric as well.

Take the assessment using one of the links below:

- Electronic access to Pittsburgh Sleep Quality Index (PSQI) (recommended for ease of use of results)
- Print version of Pittsburg Sleep Quality Index PSQI

Note: If you use the print version, you will also need the scoring rubric as well.

For both the digital or print version, a final PSQI score less than or equal to (≤) 5 is associated with good sleep quality. A score greater than (>) 5 is associated with poor sleep quality.

Evidence-Based Sleep Interventions

There are numerous evidence-based interventions that can help with the quality of your sleep. An example of a research study that investigated different inventions tested relaxation, music therapy, and the use of earplugs/eye masks (Ashghab et al., 2024). But there are many more options to consider!

This exercise will help you set a few goals for the week. Consider each of the following interventions and what it could look like for you to try it out this week. If it is something you want to commit to, place a checkmark in the check column. As you go, write specific goals for you and your plans as appropriate, such as "Last coffee for the day is at 12pm" or "Set bed time alert for 11pm."

This chart is also available as a PDF download: Sleep Interventions

Intervention	Check	Comments about specific goal
Physical Environment		
Turn off all lights when going to sleep		
Change lights remaining on in sleeping area to red-light or non-blue light		
Adjust electronic devices off of blue light for night use		
Regulate room temperature		
Insert ear plugs		
Wear an eye mask		
Aromatherapy: Use lavender or damask rose extract		
Sleep with phone away from bed		
Set phone to “sleep mode” each night		
Turn off all non-essential notifications for phone apps		
Activity Considerations		
Set a consistent time to go to bed with a phone alert for this time		
Set a consistent time to wake up		
Avoid napping during the day		
No caffeine for at least 6 hours before bed		

No alcohol for at least 3 hours before bed		
Work out for at least 20 minutes during the day at least 1 hour before bed		
No use of blue light electronics (phone, tablet, computer, TV) at least 1 hour before bed		
Start a routine that excludes electronics or TV for consistent approach to bedtime		
Relaxation Techniques		
Pre-bed muscle relaxation or body scan		
Sleep yoga		
Sleep-focused meditation		
No going to bed feeling stressed, angry, upset, or nervous. Resolve feelings before getting into bed.		
No thinking, planning, or worrying in bed.		
Other		

Resources for Interventions

To assist you in coming up with some sleep interventions or learning more about the different interventions mentioned in the chart, here are some additional resources that may be of assistance (see Gupta et al., 2023 for more specifics about many of these interventions):

Physical Environment:

- Temperature control: Regulate room temperature to personal preference for comfort
- Lighting control: Turn off all lights; use blackout curtains; wear an eye mask
- Sound control: Use ear plugs; use a sound/noise machine
- Different type of sheets
- Use aromatherapy like lavender or damask rose extract

Activity Considerations:

- Try to set a schedule that allows for a consistent time of going to bed and getting out of bed each day
- Avoid daytime napping or reduce the nap to less than 2 hours
- Avoid caffeine for at least 6 hours prior to bedtime (Drake et al., 2013)
- Avoid alcohol at least 3 hours prior to bedtime or consider abstaining altogether (Bryan & Singh, 2025)
- Avoid exercising to the point of sweating within 1 hour of going to bed; Keep track of when and how exercise impacts your sleep
- Avoid use of any blue light (phone, computer, tablets, TV) for at least 1 hour before bed

Relaxation Techniques:

- Avoid going to bed feeling stressed, angry, upset or nervous; try to avoid thinking, planning, or worrying in bed
- Apps/websites that can help you relax including *Calm*, *Balance*, relaxing music playlists on Spotify, Apple Music, or YouTube
- Muscle relaxation
- Body scan meditations

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

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Video : 10 Minute Sleep Meditation. ("10 Minute Sleep Meditation A Guided Talk Down Body Scan" by Great Meditation from YouTube.)

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : 5 Minute Body Scan. ("5 Minute Body Scan Meditation" by Medistate Mind from YouTube.)

- Sleep yoga:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : 8 Minute Evening Yoga. ("8 Minute Evening Yoga - Wind Down & Chill Out Yoga" by Yoga with Kassandra from YouTube.)

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : 5 Minute Yoga for Bedtime. ("5 min Yoga For Bedtime - Yoga Stretch For DEEP SLEEP" by Yoga with Kassandra from YouTube.)

- Sleep meditation or relaxation imagery through guided meditation

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : Sleep Meditation. ("Guided 20 Minute Sleep Meditation" by Great Meditation from YouTube.)

- Spotify (note: account may be required for access):
  - Guided Mediation for Deep Sleep
  - Guided Meditation for Restful Sleep
  - Guided Meditation for Restful Sleep

See some of the previous modules that related to quality sleep:

- Breathwork
- Yoga
- Walk in Nature
- Journaling

Weekly Recommendations/Homework

After considering the different resources for intervention, write three different sleep goals that you can incorporate this week. In addition, you will be tracking and logging your sleep each day using a sleep diary. Fill out the sleep diary as directed each morning and night for one consecutive week.

Print version of a Sleep Diary

Reflection:

1. Describe any changes you noticed in the following areas with focusing on sleep this week:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual

2. What benefits did you feel with focusing on sleep?

3. What, if any, barriers did you experience focusing on sleep?

4. Do you have any additional thoughts and/or future plans for focusing on sleep?

5. What are your current stressors and do you have a wellness goal for this week?

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20.9: Strength Training

Background

For many years, I worked as a labor and delivery nurse. It was a very physically demanding job. I could be on my feet for an entire 12- (or 14- or 16-) hour shift. I assist in heavy lifting to care for patients with limited mobility related to epidurals or surgery. Helping patients deliver might include holding a leg or working in an awkward position to meet the patient's needs. I witnessed and felt the toll that this type of work took on not only my body, but the other nurses around me. Unfortunately, many colleagues suffered from injuries, chronic back pain, and even sometimes the need for spinal surgery.

My experience is not unique. Nursing has been documented as the occupation with the highest prevalence of heavy lifting, which is noted as the most significant risk factor for the development of musculoskeletal injuries, especially to the lower back (Tariq et al., 2023). As such, it is no surprise that nurses have a higher-than-average risk of sustaining musculoskeletal problems related to their work. For a first hand story of a nurse lifting injury, you can read more in the article "The nurse who could lift" (Jones, 2017).

Nurses often engage in the actions of bending, reaching, extended periods of walking and standing, heavy lifting, and moving patients. These activities make nurses especially vulnerable to back injuries, fatigue, slips, trips, and falls (Dressner & Kissinger, 2018). In their report which used data from 2016, 27.7% (5,490 cases) of the days-away-from-work cases involving RNs resulted from injuries to the back and required a median recovery time of 7 days. These injuries occurred at an incidence rate greater than the rate of back injuries for all occupations (Dressner & Kissinger, 2018). Physicians and physical therapists also have been documented to have a prevalence of back issues, though not quite as high as nurses (Tariq et al., 2023).

These startling statistics should be used as a call for nurses to consider modifiable and non-modifiable risk factors for musculoskeletal injuries and preventative steps that can be taken proactively. Physical activity helps nurses reduce stress, build stamina, and inspire healthier lifestyles. While nurses often stay active throughout the day, many do not meet the recommended exercise guidelines (American Nurses Association, n.d.). Strength training is one highly impactful approach to helping prepare the body for the physical demands of nursing (Barrington Orthopedic, 2021). Strength training has numerous benefits that may include bone strengthening, weight management, quality of life improvement, chronic condition management, and even sharpened thinking skills (Mayo Clinic, 2023). Strength training can be done through different methods such as weight lifting or resistance training. Resistance training is defined as "a form of exercise that increases muscular strength and endurance by exercising a muscle or muscle group against external resistance" (Cave, n.d., para. 2). It is associated with improved blood pressure, glycemic index, lipids, and body composition. It also has been associated with enhanced sleep quality and reduced symptoms of depression and anxiety (Paluch et al., 2023). Similarly, weightlifting is a common form of exercise used to improve strength and power (Morris et al., 2022). While this training is often associated with athletes, there are definite benefits to consider for healthcare professionals with physically demanding jobs. Like so many other areas of wellness, research specific to the short- and long- term benefits of weightlifting and resistance training *specific to nurses or those in helping professions* is limited. However, there is plenty of evidence-based support for the health benefits of these activities to the general adult population.

When considering how important the body is as a tool for healthcare professionals, perhaps the Bible can provide further inspiration. 1 Corinthians 6:19-20 (NIV) reads: "Do you not know that your bodies are temples of the Holy Spirit, who is in you, whom you have received from God? You are not your own; you were bought at a price. Therefore, honor God with your bodies." Providing care for others as a healthcare worker seems like an excellent way to honor God with your body. Taking that one step further, providing care for your own body so that you can provide care for others seems like another excellent way to honor God with the gift that is your body. Let those words serve as motivation as you tackle this week's physical activity!

Activity

This week, you are going to move!! The goal is to complete a total body weightlifting circuit routine. If you are completely new to the gym/fitness center, that is okay! Do not stress. Here are some tips for nurses or others in helping professions who are just getting started in the gym (Healthy Nurse, Healthy Nation, 2024). Every fitness center should have personnel that are trained in the use of gym equipment and can help you get started. Don't be afraid to ask! Really, most people are happy to share their knowledge! Or consider asking a classmate, friend, or family member to join you for this week's activity.



Figure : The body is a temple. (Photo by The Lazy Artist Gallery from Pexels.)

Materials Suggested

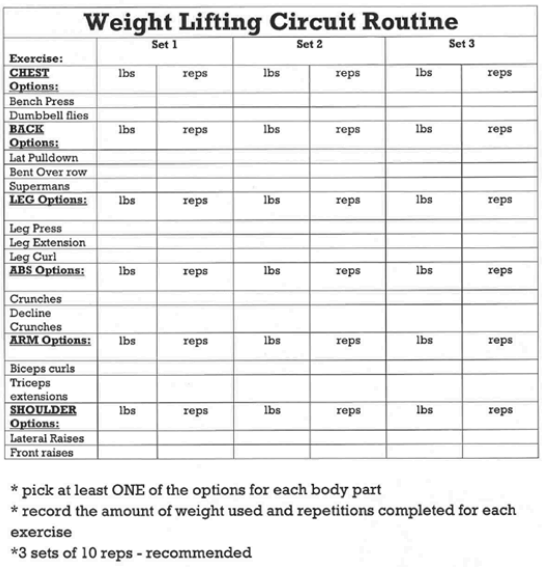
1. Athletic shoes. Supportive footwear matters!
2. Athletic clothing: A loose-fitting T-shirt or tank top and shorts are recommended
3. A fitness center with weight training equipment
   - If you are a student, you are encouraged to explore your school's fitness facility.
   - If you do not have direct access to a fitness center as a student, explore what your community has to offer. Perhaps there is a local recreational center, community center, or fitness center that offers free trial memberships for the week.
   - If you do not have access to a fitness center, you can explore options to workout from home via free online resources. YouTube has a number of alternative options or paid-from-home fitness workouts (examples below). Make sure the workouts include a focus on strength training or muscle building, though, to differentiate from other activities like yoga, walking, biking, or running.

Directions

Please note that if you have any concerns about physical activity, consult your healthcare provider.

1. To start, do a 5 minute warm up which might include one of the following activities:
   - Brisk walking
   - Jog
   - Jumping jacks
   - Elliptical
2. Next, move to weights. You can either use free weights or a machine. If you are not sure how to use either, do not be afraid to ask for help! If you are a beginner, you may also benefit from more information about weight lifting.
3. You should pick at least one option from each of the major muscle groups. Start with a weight level that allows you to feel comfortable lifting that weight at least 10 times with proper form.
   - Each controlled movement is called a repetition (rep, for short).
   - Performing the controlled movement 10 times (or 10 reps) is considered 1 set.
   - After 1 set, you should take a short break (generally, 30-90 seconds depending on your goals).
   - The goal is to complete 3 sets (30 total reps) for each muscle group.
     - Once you have done three sets for all of the major muscle areas, you have completed a circuit.
   - If you are easily able to complete 10 reps for 3 sets, you might consider either increasing to 15 or 20 reps for a set or increasing the weight the next time you do a set.

For this week, you can record your weights and reps on the Weight Lifting Circuit Routine worksheet, available for PDF download: Weight Lifting Circuit Routine worksheet



Weight Lifting Circuit Routine

Exercise:	Set 1		Set 2		Set 3	
CHEST Options:	lbs	reps	lbs	reps	lbs	reps
Bench Press						
Dumbbell flies						
BACK Options:	lbs	reps	lbs	reps	lbs	reps
Lat Pulldown						
Bent Over row						
Supermans						
LEG Options:	lbs	reps	lbs	reps	lbs	reps
Leg Press						
Leg Extension						
Leg Curl						
ABS Options:	lbs	reps	lbs	reps	lbs	reps
Crunches						
Decline Crunches						
ARM Options:	lbs	reps	lbs	reps	lbs	reps
Biceps curls						
Triceps extensions						
SHOULDER Options:	lbs	reps	lbs	reps	lbs	reps
Lateral Raises						
Front raises						

* pick at least ONE of the options for each body part
* record the amount of weight used and repetitions completed for each exercise
*3 sets of 10 reps - recommended

Figure : Weight Lifting Circuit Route. (Used with permission from Dr. Shari Jurgens.)

Tips for a successful strength training experience

- Gently stretch your muscles after completing your work out
- Make sure to drink lots of water and stay hydrated

Alternatives/Variations

If a fitness center is not an option for you, here is an example of a weightlifting workout that you can do at home if you have access to some dumbbells.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : 30 Minute Dumbbell Workout. ("30 Min Full Body Dumbbell Workout for Beginners - Beginner Strength Training at Home with Weight" by HASfit on Youtube.)

If you don't have any equipment, check out these options for home-based resistance training:

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : 30 Minute Dumbbell Workout. ("No Equipment Edition: Home Based Resistance Training" by Edmonton West Primary Care Network on YouTube.)

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Video : Strength Workout for Beginners. (Strength Training for Beginners | Bodyweight Workout *NO EQUIPMENT* by Jenny J Fitness on YouTube.)

Weekly Recommendations/Homework

The goal for this week is to complete 3 circuit workouts. If you did one circuit during class today, congratulations! Look at your calendar and plan for two more sessions, scheduled at least 1 day apart. Track each of your sets with weight and reps and note how you feel during and after each session!

Reflection:

1. Describe any changes you noticed in the following areas with strength training:
Emotional, Environmental, Intellectual, Occupational, Physical, Social, and/or Spiritual

2. What benefits did you feel with strength training?

3. What, if any, barriers did you experience using strength training?

4. Do you have any additional thoughts and/or future plans for strength training?

5. What are your current stressors and do you have a wellness goal for this week?

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20.10: Games

Background

Take a moment to imagine each of the following scenarios:

- Rolling a *Yahtzee* during game night
- Competing as part of a team in a sporting event
- Landing on "Free Parking" during a fierce round of *Monopoly*
- Laughing through a round of charades




Figure : Playing games together can improve physical and psychological health. (Photos by ClickerHappy from Pexels (left), Philip Taylor ptmoney.com from Flikr (right).)

Did any of those scenarios bring to mind a positive memory? Hopefully one or two! All these scenarios have elements of social interaction through playing a game. The saying "fun and games" implies the innate connection between participating in games and finding joy. If you dig a little deeper into that concept, research shows that the health benefits of playing games are plentiful. Some of the benefits may come from the game itself, while other benefits may relate to participating in a social interaction.

Social interaction is important for health. Studies have shown that being socially active is associated with less stress and depression, lower blood pressure, smaller waist circumference and body mass index, and better overall cortisol levels (Barbieri, 2021). Social interaction, also identified as "social and community context", has been identified to be one of the five primary social determinants of health as defined by the Centers for Disease Control and Prevention (CDC, 2024). These health determinants are non-medical factors that are most likely to influence health outcomes in the general population.

Games can be one specific approach to social interaction. In one recent study, data suggested that table-top, role-playing games can result in reduced general anxiety, social anxiety, and improved social skills (Varrette et al., 2022). A different 20-year, population-based study found the risk for dementia was 15% lower in participants who regularly participated in playing board games (Dartigues et al., 2013). A published systematic review incorporated 83 studies about “board games” and outlined health benefits that ranged from decreased heart rate variability and panic attacks to increased gray-matter in the brain and lower depression scores (Nakao, 2019). But board games are not the only game that showed positive effects. Barbieri (2021) reported that individuals who participated in organized sports self-reported that they had improved physical and psychological health.

"Health and games" is not as catchy to say as "fun and games", but the proof of the health benefits are impressive! And remember, people were designed by God as social beings. In Genesis 2:18 (NASB), "the Lord God said, 'It is not good for the man to be alone'.” In Matthew 18:20 (NIV), Jesus states that “where two or three gather in my name, there am I with them." Was Jesus talking about playing board games? No. Did God create Eve specifically to throw around an apple? Probably not! However, humans **were** created to be together and playing games can be just one potentially positive way to do that.

Activity

As you might be able to guess, today you will be playing a game of your choice. Games offer the opportunity for social interaction and the ability to learn life skills that can be applied in other areas of life. Whatever game is chosen, though, have fun!!

Materials Suggested

- A game of your choice
- A person or group of people to play your game with

Directions

Find another person or a group and play a game together! The only requirement is that it *must be with someone else* (no single-player Solitaire or playing a game on your phone!). It is recommended that you play the game in person, but if absolutely necessary there are apps or online games that can allow for live social interaction while playing with others.

The options for games are endless! A few favorites from a recent unofficial survey include:

- Dutch Blitz card game
- Sequence
- Candyland
- Jackbox
- Hilarium
- Kickball
- Tag

Remember that you can also play games that don't have a winner and loser (particularly if you either get too competitive or don't like competition). There are many cooperative games where you work together with others to achieve some task including:

- Pandemic
- Max
- Tower building
- Telephone
- 5-Word Story

Alternatives/Variations

- Gathering together to prepare a meal
- Being part of a team
- Taking a walk with friends

Exercise

Weekly Recommendations/Homework

The activity this week is to play a game. Try to schedule at least two additional social gatherings around a game this week or you can achieve this through one longer game session. If doing more than one session, try a different game and see if that makes any difference on how you feel.

Reflection Questions

1. Describe any changes you noticed in the following areas when gathering for a game:
    - Emotional
    - Environmental
    - Intellectual
    - Occupational
    - Physical
    - Social
    - Spiritual
2. What benefits did you feel while playing a game with others?
3. What, if any, barriers did you experience when playing a game with others?
4. Do you have any additional thoughts and/or future plans for playing a game with others?
5. What are your current stressors and do you have a wellness goal for this week?

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20.11: Choose your Own Adventure

The previous chapters have covered a variety of evidenced-based wellness activities. However, it would be impossible to cover ALL the options for wellness and self-care that are available in the world! The purpose of this chapter is to provide a transition space for you to follow the same structure as the previous activities, but to explore an activity that has not been covered yet. By doing this, you get to experience and learn about another activity of your choosing, but you also begin the evolution of continuing to explore your wellness without exact directions of what is required of you for that week.

How do you know what activity to consider this week? Perhaps there is an activity that you have been curious about or have considered trying. Or maybe there is something that you have never wanted to do, but now you feel ready to step outside of your comfort zone and do something completely different! This week, that choice is yours!

Activity

For each of the previous modules, we have included a foundation of evidence-based practice that shows the wellness benefits for the chosen activity. With modern technology, this might seem pretty easy, but sometimes the "ease" of information can actually make finding evidence-based information harder to discern. Not all evidence is created equal!

Finding good information begins with finding authoritative and credible research, often called ***peer-reviewed research***. Peer-reviewed research is exactly what it sounds like - research that other scholars (or peers) in the field review to ensure that information and data is accurate. Research that goes through this process is considered higher quality and more credible than information that is not peer-reviewed. This does not mean, though, that you should avoid all non-peer-reviewed research when searching for evidence-based information. There are some really good and helpful websites that are not peer-reviewed. However, the majority of information around your activity should be strongly rooted in evidence-based practice.

There are a few ways you can go about finding evidence-based information. If you are a current college student, you most likely have access to research databases through your institution's library. If you have never been shown how to access databases, don't be afraid to ask your librarian for help! Biased opinion here, but I think librarians are pretty nice and a great resource when help is needed!

Some examples of subscription databases for finding wellness-related research could include:

- CINAHL (Cumulative Index to Nursing and Allied Health Literature)
- MEDLINE
- Cochrane Library
- OVID

If you are not a current student, don't worry! PubMed is a freely-available, online database that contains wellness-related content and is published by the United States National Library of Medicine (NLM) and the National Institutes of Health (NIH). A basic search for "wellness" retrieved over 7 million results (as of 2025)! And the majority of it is peer-reviewed which makes it a good source for evidence-based information.

Alternatively, a public library may have access to academic information through some of their database content. Google Scholar could be yet another option, but not everything in the search results is peer-reviewed, so use caution if this is the direction you take.

Once you find a good source of information related to the activity you are considering, you might be ready to engage in the activity or you might find that it leads you to dig deeper into the research. Either way is okay. If you are digging deeper, you might try different databases or look into the references found in your first source.

This activity can be done individually, but if done in a class setting, it can also be a group project. For a group project, it is recommended that every member of the team be responsible for providing at least one peer-reviewed resource.



Figure : Librarians can help you find evidence-based information. (Photo by Kampus Production from Pexels.)

- Computer with access to Internet to:
  - Brainstorm wellness activity ideas
  - Search scholarly databases
  - Gather supporting resources

Once you have found some information supporting a wellness activity, it is time to act. Using the same structure as the other modules, it is recommended that you spend 1 hour learning and trying the activity as an introduction. If this is being done as part of a group project or class, adjust the time to fit the class schedule. For example, you might consider limiting each group to 10 minutes for introduction of the topic and class participation in a mini-activity session.

Since this is a choose your own adventure, the possibilities for alternatives and variations are nearly infinite. In case you are experiencing a bit of a block in trying to pick an activity, here are some possibilities to consider:

- Pet therapy
- Drum circle
- Using a sauna
- Aromatherapy
- Tactile stimulation (e.g., kinetic sand)
- Zen gardening
- Athletic competition
- Volunteering
- Trying a new hobby like crocheting

Weekly Recommendations/Homework

Incorporate the activity into your week for at least 1 additional hour.

Also, consider sharing your activity with the authors of this text. Feel free to contact them with the activity you chose! Maybe it could become a new chapter in the future!

Reflection Questions

1. Describe any changes you noticed in the following areas when doing your activity this week:
    - Emotional
    - Environmental
    - Intellectual
    - Occupational
    - Physical
    - Social
    - Spiritual
2. What benefits did you feel with your activity?
3. What, if any, barriers did you experience with your activity?
4. Do you have any additional thoughts and/or future plans for for your activity?
5. What are your current stressors and do you have a wellness goal for this week?

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20.12: Reassessment

Reassessment

Congratulations! You have made it through a number of activities that focused on giving you opportunities to explore different approaches to research-based wellness. These activities were intended to help you learn about self-care strategies and hopefully more about yourself as well.

One of the most common research study designs is often called pre-test/post-test. In this design, a researcher gives an assessment to a person, provides them with an intervention, and then retests to see if there was any significant change. At the beginning of this text, you did a number of assessments meant to give you a baseline or starting point for how well you were doing around self-care, stress management, and wellness. The various wellness activities over the past weeks were the intervention. And now it is time to retest! After all, what would a wellness course that is grounded in evidence-based research be without doing our own individualized assessments?

Activity

This week, you will repeat the assessments that you completed for the first activity. As a reminder, there were five assessments that you took during the first activitiy and will take again this week:

1. Princeton U Matter
2. Social Readjustment Rating Scale OR Students' Stress Rating Scale
3. Hassles & Uplifts
4. Symptoms of Stress
5. Resting Heart Rate

It should be noted at this point that you should **NOT** go back and look at your initial results until **AFTER** you have taken these assessments again for the second time. Doing so could introduce bias into your responses which could lead to inaccurate results and conclusions. The goal is to assess as you are in your present state.

Materials Suggested

- Device with access to Internet (and possibly a printer) to access the assessments to be completed.
- Writing utensil and paper or note app to document results
- Optional: SmartWatch for tracking heart rate

Note: You can either download and print the assessments or take them digitally. Regardless, you need to document your responses for each assessment (if appropriate) for your reflection

---

Directions

Please take the time needed to carefully fill out the five assessments and record your results using the Assessment Summary. As a reminder, it is also recommended that you **NOT** look at the results of your initial assessments until after you have retaken all of your assessments. The chart is also available as a PDF download: Assessment Summary

Assessment Summary

A table depicting each assessment, a place for scores and notes and comments.

Tool	Your Score	Notes or Comments
Princeton UMatter: Emotional		
Princeton UMatter: Environmental		
Princeton UMatter: Intellectual		
Princeton UMatter: Occupational		
Princeton UMatter: Physical		
Princeton UMatter: Social		
Princeton UMatter: Spiritual		
Social Readjustment Rating Scale OR Students' Stress Rating Scale		
Hassle & Uplift: Hassle		
Hassle & Uplift: Uplift		
Symptoms of Stress		
Resting Heart Rate		

Princeton U Matter

The *Princeton UMatter Wellness Self-Assessment* prompts the user to consider their current state in 7 different dimensions including: emotional, environmental, intellectual, occupational, physical, social, and spiritual.

Take the assessment using one of the links below:

- Electronic access to Princeton UMatter Wellness Self-Assessment (recommended for ease of use of results)
- Print version of Princeton UMatter Wellness Self-Assessment

Social Readjustment Rating Scale OR Students' Stress Rating Scale

The Social Readjustment Rating Scale (SRRS) or Students' Stress Rating Scale (SSRS) measure the impact of various life events on your well-being.

Pick one of the following to complete:

- Electronic access to Social Readjustment Rating Scale (recommended for ease of use of results)
- Print version of Social Readjustment Rating Scale OR Print version of Students' Stress Rating Scale Rating Scale (no electronic version available)

Hassles & Uplifts

The Hassles and Uplifts Scales (HUS) was constructed as a tool to focus on relatively minor events that happen in everyday life.

Take the assessment using the link below:

Print version of Hassles and Uplifts Scale

Note: Please read the full directions for completing the assessment to ensure you are completing the assessment accurately. After assigning a score of 0-3 for each item, add the score up for all Hassles, and then add up the score for all Uplifts.

Symptoms of Stress Table

The Symptoms of Stress Table can be used to identify what stress is doing to the body.

Take the assessment (found on page 2) using the link below.

Symptoms of Stress Table

To quantify this table, add up the scores as follows for each answer: Almost all day, every day (6 pts); Once or twice daily (5 pts.); Every night or day (4 pts.); 2-3 times per week (3 pts.); Once a week (2 pts.); Once a month (1 pt.); Never (0 pts.). Record your total score in the assessment summary table.

Resting Heart Rate

Your heart rate can be used as one indicator of health and provides a quantitative piece of data to track.



Figure : Find your pulse on your wrist. Take your heart rate for 60 seconds. (Photo by BruceBlaus from Wikimedia Commons)

Take your heart rate. If you are not familiar with taking your heart rate or could use a refresher, here are some step-by-step instructions from the Mayo Clinic.

Assessment Summary

If you have not already done so, please record your assessment scores and any interesting observations or notes you had from taking these assessments again: see the Assessment Summary.

Now is the time for you to look back at the results from your initial Assessment Summary. Where possible, consider both your overall score as well as individual item or question comparisons to note the smaller changes that you had.

- What stayed the same between your initial assessments and today's assessments?
- What was different between your initial assessments and today's assessments?

Reflection

Perhaps you have seen some of the improvements you were hoping for, such as a decrease in a physical symptom or better emotional regulation. If so, that is great! However, it is also possible that the scores indicated that you have MORE stress now than when you started. Remember that there are a lot of "unseen" factors that can play a role in assessment and lower scores may not always indicate that things are "worse". For example, if you are taking these assessments around finals week as a college student, some of your scores might be higher, showing the stressors that come with the end of the semester. For other scores, they may be lower due to the removal of certain life stressors or fears. The numbers alone do not tell the whole picture.

It is important to continue to reflect on the why behind the numbers. Use the questions below to reflect on the changes that you noticed between the initial and current assessment.

1. What implications or "take aways" do you notice after comparing the assessment summaries?
    - Why did things stay the same or why did they change?
    - What life circumstances have changed since you took the initial assessment? For the good or for the worse?
    - What changes are more subtle and nuanced reflecting a consistent perspective on your wellness?
2. What changes do you notice in your own understanding of yourself and how you analyze the results?
    - Are you more connected with what you are feeling and the stress-related triggers you experience?

These reflection questions are also available as a PDF download: Reassessment Reflection - Chapter 13

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20.13: Closing and Reflection

"What we call the beginning is often the end
And to make and end is to make a beginning.
The end is where we start from."

T. S. Eliot from Little Gidding

In starting this journey of exploring your wellness, you ended the routine you were doing before and made a new beginning. Now you are at a different end - the end of the structure this text provided - but you have the opportunity to be at a new beginning where you can continue with habits and wellness activities that are intentional and responsive to your needs. As noted at the outset of this text, the real impact is in **what you will do with the information you learned** about yourself. The goal of this closing section is to help you process what you have learned and think about new goals you can set going forward.

Near the beginning of this text, you did an in-depth evaluation of your wellness. You were prompted to consider three questions coming from the Model for Improvement:

1. What am I trying to accomplish?
2. How will I know that a change is an improvement?
3. What changes can I make that will result in improvement?

Do these questions sound familiar? Hopefully! Because they are the key questions of this text. They provide a system and structure that can be used for improvement, not only personally related to wellness, but in many professional and vocational settings as well. They can help with both big and small decisions and are a framework for improvement.

In Weekly Recommendation/Homework 2.1 of this text, you were asked to reflect on the three questions and come up with 3-5 specific goals that you could work towards to improve your wellness. Additionally, most of the wellness activities had a reflection question that also asked for a wellness goal. Go back and find your responses to both the initial reflection prompt and the weekly goals and consider the following questions in light of your earlier responses.

- How did you progress in meeting the overall goals you set?
- Have the changes you made been an improvement based on your initial goals/reflection?
- Why do you think you were able to meet that goal? Or why didn't you meet that goal?
- Consider some of your weekly goals from the reflections. Were you successful in meeting some of these weekly goals?
- How did those weekly goals help you (or did not help you) meet the larger goals?

Lastly, we would gently encourage you to set some new goals that reflect your learning and development.

- What are your future plans for wellness?

Closing

One of the objectives of this text is to help you assess and identify your own wellness needs. At the end of each week's activity, we encouraged you to reflect on the information you learned and notice changes that you were experiencing. How do you feel? Do you feel more in touch with your body, mind, and spirit? Do you feel more equipped to be responsive to your wellness needs? In case it was not clear:

Your reflection matters.

A space for reflection can provide the opportunity to routinely check in and continue moving forward with a growth mindset that both recognizes how far you have already come and what path you want to continue going forward with in the future. Including a time in your daily routine - even 5 minutes - to check-in with your mind, body, and spirit is key to living a life that is balanced.

Wellness is a journey! Exploring wellness activities can and should be a life-long pursuit. Our hope is that this text has given you tools to live this balanced life and that not only will you integrate some of these activities into your own life, but that you will share what you have learned with others. Nothing in this text has to be a secret! By sharing and teaching others, it will help to instill the concepts that you have learned deeper into your core and provide a richer, fuller life experience.

May the Lord bless you on your journey.



Figure 20.13.1: The Lord bless you and keep you; the Lord make His face shine upon you, and be gracious to you; the Lord lift up His countenance upon you, and give you his peace. (Image by Dr. Michael D. Evans from Facebook.)

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GLOSSARY

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Case study #2 – The Land is Sick

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