Fit Happens: Essential Principles of Fitness, Wellness, and Health

Danielle Altman, Rusty Johnson, and Cheryl Owiesny

De Anza College

Medicine



Fit Happens: Essential Principles of Fitness, Wellness, and Health



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Program Page



De Anza College sits in the heart of Silicon Valley, where innovation and opportunity are part of daily life, and also has one of the highest costs of living in the country. For our students, that makes every dollar count, and the price of a textbook can be the difference between staying enrolled or dropping a class. Our Zero Textbook Cost (ZTC) program closes that gap by giving students full access to high-quality, faculty-created course materials at no cost from the first day of class.

De Anza is proud of its diverse student community, and we hold our ZTC materials to the same standard of excellence that defines the college. Faculty across departments write, adapt, and review these resources themselves, keeping them accurate, current, and grounded in the perspectives of the students who use them, with accessibility and inclusive design built in from the start.

This program reflects the time and care our faculty invest in their students. If you have questions, feedback, or come across any issues with a ZTC resource, contact De Anza College's ZTC Grants Coordinator, Shagun Kaur.

Learn more about De Anza ZTC Program [www.deanza.edu/academic-services/oer/]

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Accessibility Statement

Accessibility

De Anza College is dedicated to creating learning materials that are accessible and benefit all students. Our materials follow the Web Content Accessibility Guidelines (WCAG) 2.1 Level AA. Our authors and contracted accessibility specialists checked all resources using this ASCCC OERI checklist, the accessibility tool in LibreTexts, WAVE, JAWS, and other more detailed checks for complex materials such as interactive components.

We selected LibreTexts as our preferred platform because of its commitment to accessibility. In addition to the platform's inherent accessibility, we collaborated with the LibreTexts team to fix any accessibility issues we found.

Our Accessibility Review Process

Accessibility was built into the resource as it was written. This resource went through the following stages of review:

1. **Template check.** The project coordinator and instructional designers checked the first chapter for accessibility as a model to ensure later chapters meet accessibility standards.
2. **Progress checks.** The manuscript was checked at approximately 40%, 60%, and 80% completion to catch and correct accessibility issues in production.
3. **Specialist review.** Once the manuscript was complete, an accessibility expert conducted an accessibility check.
4. **Remediation.** The author and the project manager who conducted the earlier progress checks worked together to remediate the issues identified by the accessibility expert.
5. **Final check.** The resource underwent another full check by the accessibility expert before the book was deemed ready for publication.

This process combines ongoing checks during writing with a final specialist review, so issues are caught early and confirmed fixed before publication.

Report an Accessibility Problem

We are always looking for ways to make our resources more accessible. If you run into a barrier while using this resource, please let us know so we can look into it. When you contact us, it helps to include:

- The name of the resource
- The location of the problem (a web address or page/chapter description)
- A description of the problem you encountered
- The device, browser, and any assistive technology you were using (e.g., Windows 11, Google Chrome, JAWS screen reader)

Contact us: De Anza ZTC team

This statement was last updated August 2026

This resource was project-managed by **Shagun Kaur**, overseeing scope, budget, and schedule; stakeholder coordination via monthly meetings; training and platform support (LibreTexts, troubleshooting, technical support); QA/accessibility check scheduling; and licensing and copyright governance.

A Note on Known Limitations

No accessibility check is perfect. We've made a genuine, sustained effort to catch and fix issues throughout the writing and review process described above, but some barriers may remain, especially in complex or interactive content. We'd rather be upfront about that than claim a standard of perfection we can't guarantee.

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Attribution and OER Revision Statement

AI Use in Course Development – Transparency & Standards

As part of the development process for this textbook and its accompanying course materials, we utilized artificial intelligence (AI) as a supportive educational technology to assist with idea generation, content organization, and early-stage drafting. Our use of AI was guided by principles of transparency, academic integrity, accessibility, and human oversight. At no point was AI used as a substitute for faculty expertise, scholarly judgment, or pedagogical decision-making.

Specifically, we deployed a custom, equity-aware chatbot that was prompt-engineered to align with our educational goals and informed by Open Educational Resources (OER), scholarly materials, and other openly available educational content. The purpose of this tool was to assist with brainstorming, generating potential examples, identifying organizational structures, suggesting learning activities, and helping authors overcome common challenges associated with drafting and revising educational materials.

The AI's role was limited to ideation and preliminary content generation. All AI-generated material underwent extensive review, revision, verification, and editing by the course authors. Faculty members evaluated content for accuracy, clarity, inclusivity, accessibility, relevance, and alignment with course learning outcomes. In many cases, AI-generated text served only as a starting point and was substantially modified, expanded, reorganized, or rewritten during the development process.

We also recognized that AI systems can reflect biases, inaccuracies, omissions, or outdated information. For this reason, no content was accepted without human review and independent verification. All factual claims, educational recommendations, examples, and references were evaluated against current evidence, professional standards, and the authors' subject matter expertise. Responsibility for the content ultimately rests with the human authors, not the technology used during development.

Our use of AI mirrors how many professionals increasingly use emerging technologies in education and the workplace: as tools that can enhance efficiency, creativity, and productivity while still requiring critical thinking, ethical judgment, and expert oversight. By incorporating AI transparently and responsibly, we sought not only to improve the development process but also to model thoughtful technology use for students navigating an increasingly digital and AI-assisted world.

Finally, we believe that innovation must be balanced with a commitment to equity and accessibility. Throughout the development process, all content was reviewed to ensure it met accessibility standards and supported diverse learners. AI-assisted drafting was only one component of a much larger process that included faculty collaboration, scholarly review, accessibility evaluation, and continuous revision. The result is a resource that reflects both the opportunities offered by emerging technologies and the enduring importance of human expertise in teaching and learning.

Copyright & Fair Use Considerations

We aligned with evolving IP policy frameworks, especially insights from the U.S. Copyright Office:

- The Office's Part 3 report on AI model training highlights the importance of fair use analysis and restricts reliance on generative AI when it could replicate copyrighted works—our use was limited to non-protected, openly licensed materials.
- This cautious approach is consistent with guidance. that encourages transformative use, transparency, and limiting output that could inadvertently mirror protected content.

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Dedication

Dear readers:

It is very exciting to share this book, “Fit Happens: Essential Principles of Fitness, Wellness, and Health,” as an Open Educational Resource (OER). Writing this book has been a journey for the authors, and we have all had to challenge ourselves to create something that we hope will be beneficial to so many, but please know it is also truly close to our hearts. We thank all the OER pioneers who came before us and appreciate the many resources that were available to create this book.

This book is dedicated to all our students - past, present, and future - who strive to learn more or even to become their best selves. It is for every student, community member, and student-athlete who wants to live fully for today and for years to come. (And for those who take our yoga, pilates, pickleball, swimming, soccer, futsal, indoor cycling, and other amazing activity classes at De Anza College!)

Your body and mind are your most important tools. Exercise is a prescription for mental health, physical health, strength, mobility, resilience, and longevity. Physical and mental health, fitness, and sport are among the last true arenas where results are earned through real effort. There is no AI shortcut, no instant button, no app that can replace the time, energy, and consistency required to become your best self. True wellness, both in body and mind, demands dedication, practice, and persistence.

Understanding your own health, fitness, and lifestyle choices empowers you to make decisions that enhance every part of your life. Whether your goals are performing at your best, managing a busy schedule, or simply feeling strong and energized every day, the strategies in this book are here to equip you with guidance. Small, consistent actions, rooted in knowledge and intentional effort, are what transform your life. Embrace the challenge!

We are pretty sure your future self will thank you.

In health and happiness,

Danielle, Rusty, and Cheryl

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About the Book

Philosophy and Content

"Fit Happens" is designed as a practical guide for students enrolled in fitness, wellness, and physical activity laboratory courses. The text is grounded in the belief that health and wellness are lifelong pursuits that require knowledge, self-awareness, critical thinking, and active participation. Rather than simply presenting information about exercise and health, the book encourages students to apply course concepts to their own lives through self-assessments, reflection activities, fitness testing, goal setting, and personal wellness planning.

The framework of the text is built around the interconnected concepts of fitness, wellness, and health. While physical fitness is an important component of overall well-being, the text recognizes that health is multidimensional and influenced by physical, psychological, emotional, social, environmental, and behavioral factors. Students are encouraged to view wellness as an active process of making informed choices that support long-term quality of life rather than as a fixed state that can be achieved once and maintained indefinitely. The content emphasizes evidence-based principles that help students understand how lifestyle behaviors influence health outcomes. Topics such as physical activity, exercise programming, cardiorespiratory fitness, muscular fitness, flexibility, nutrition, stress management, sleep, mental health, behavior change, and chronic disease prevention are presented in ways that are both scientifically grounded and personally relevant. Throughout the text, students are asked to connect scientific concepts to their own experiences and health behaviors.

A central philosophy of "Fit Happens" is that lasting health improvements are most likely to occur when students become active participants in their own learning. For this reason, the book incorporates a variety of experiential learning opportunities, including fitness assessments, wellness inventories, activity tracking, goal-setting exercises, and personal reflection. These activities allow students to evaluate their current health behaviors, monitor progress, and develop practical skills that can be applied beyond the classroom.

The content choices reflect a commitment to inclusivity and lifelong physical activity. Rather than focusing solely on athletic performance or competitive sport, the text recognizes that health-enhancing physical activity can take many forms and can be adapted to meet the needs, interests, abilities, and goals of diverse individuals. The ultimate goal is to help students develop the knowledge, confidence, and skills necessary to make informed decisions about their health and wellness throughout their lives.

As an open educational resource, "Fit Happens" is designed to be accessible, adaptable, and student-centered. The text serves not only as a source of information but also as a practical resource that empowers students to take ownership of their health, evaluate wellness-related information critically, and build sustainable habits that support lifelong well-being.

Why Did We Write Fit Happens?

"Fit Happens" was born from a desire to better serve the students of De Anza College. As faculty members in the Department of Physical Education and Athletics, we recognized the need for a resource that reflected both the goals of our curriculum and the unique needs of our students. De Anza College offers a wide variety of physical activity, fitness, wellness, and health-related courses that play an important role in the general education experience and support students pursuing associate and transfer degrees in kinesiology and related fields. We wanted a textbook that would help students connect classroom concepts to their own lives while promoting a deeper understanding of fitness, wellness, and lifelong health.

At De Anza College, we believe in a holistic approach to student success. Academic achievement is important, but so too are the physical, emotional, and social dimensions of well-being. College can be demanding, and students often face significant academic pressures, competing responsibilities, and challenges related to mental health and wellness. For this reason, "Fit Happens" was designed not only to teach the principles of fitness and health but also to encourage students to develop habits and skills that support overall well-being. Throughout the text, we emphasize the interconnected nature of physical activity, mental health, stress management, nutrition, sleep, and lifestyle behaviors, recognizing that each contributes to a healthy and balanced life.

How Did We Write Fit Happens?

The process of creating "Fit Happens" was both rewarding and challenging. In many ways, it reminded us of our own experiences as undergraduate and graduate students spending countless hours researching, writing, revising, and refining academic work. What began as a simple idea quickly became a multi-year project that required us to learn entirely new skills and approaches to textbook development.

As first-time authors in the Open Educational Resources (OER) and Zero Textbook Cost (ZTC) movement, we often found ourselves learning through trial and error. We became the “guinea pigs” as we navigated unfamiliar publishing platforms, explored digital textbook design, and developed a deeper appreciation for accessibility standards and inclusive educational practices. Every chapter required careful consideration of content, organization, readability, and accessibility to ensure that all students could effectively engage with the material. The collaborative nature of the project added both complexity and strength to the process. As three faculty members with different experiences, perspectives, and areas of expertise, we spent many hours discussing content, debating ideas, revising drafts, and striving to create a resource that reflected our shared commitment to student learning. While there were certainly moments of frustration and exhaustion, there were also moments of creativity, discovery, and growth.

One of the most important lessons we learned during this process was the complexity and importance of accessibility. Creating an accessible textbook involves far more than simply providing digital content. Every image requires meaningful alternative text, tables must be structured correctly, headings must follow a logical hierarchy, color choices must be carefully considered, and content must be designed so that it can be effectively navigated and interpreted by a variety of assistive technologies, including screen readers. We quickly discovered that accessibility is not a single task that can be completed at the end of a project; rather, it is an ongoing commitment that must be considered throughout every stage of textbook development.

At De Anza College, we hold ourselves to the highest standards of accessibility because we believe that all students deserve equitable access to educational materials. This commitment challenged us to think differently about how information is presented and how diverse learners engage with content. While the learning curve was often steep, the process deepened our understanding of inclusive education and strengthened our belief that accessibility is not simply a legal requirement; it is a fundamental component of student success and educational equity. As educators, we also viewed this process as an opportunity to model the thoughtful and ethical use of emerging technologies in higher education.

Ultimately, Fit Happens represents more than a textbook. It reflects our belief that high-quality educational resources should be accessible to all students and that fitness, wellness, and health are essential components of a meaningful and successful college experience. We hope that this book not only supports your learning in the classroom but also provides knowledge and tools that will benefit you long after your time at De Anza College.

Terminology Note: Biological Sex and Gender

Throughout this text, the terms **biological sex** and **gender** are used according to their common usage in contemporary health and social science research. **Biological sex** refers to biological characteristics such as chromosomes, reproductive anatomy, and hormone profiles that are typically categorized as male, female, or intersex. **Gender** refers to the social, cultural, psychological, and personal dimensions of identity, roles, and expectations associated with being a man, woman, both, neither, or another gender identity. Although biological sex and gender are related, they are distinct concepts and should not be used interchangeably. Depending on the topic being discussed, researchers in kinesiology may examine biological sex, gender, or both because each can influence physical activity participation, health outcomes, athletic performance, and movement experiences. In exercise physiology and biomechanics research, biological sex is often examined because physiological differences can influence anatomy, metabolism, hormonal responses, and physical performance. In contrast, gender may influence physical activity behaviors, access to sport and exercise opportunities, social expectations, and movement experiences.

Why You Should Adopt This Text

While the cost savings associated with Open Educational Resources are significant, we believe the greatest strength of "Fit Happens" lies in its student-centered design and practical application. The text was written specifically for contemporary college students and emphasizes the knowledge, skills, and behaviors necessary for lifelong health and wellness. Rather than presenting fitness and health concepts as abstract information, "Fit Happens" encourages students to actively engage in self-assessment, reflection, goal setting, and behavior change. The book integrates current evidence-based practices, promotes health literacy, and addresses topics that are increasingly relevant on college campuses, including mental health, stress management, sleep, physical activity, and overall well-being. In addition, its commitment to accessibility, adaptability, and inclusive pedagogy allows

institutions to customize the content to meet the unique needs of their students and programs. Colleges seeking a resource that supports both academic learning and personal development will find "Fit Happens" to be a valuable tool for helping students build the knowledge, confidence, and habits necessary to thrive both inside and outside the classroom.

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About the Authors

About the Authors

Team Images	Team Bios
 Danielle Altman	**Danielle Altman** is the head aquatics coach (men's and women's water polo 2010-2022 and swimming and diving 2010 to the present) and a full-time instructor in the Department of Physical Education and Athletics at De Anza College. Altman also served in the position as Assistant Athletics Director from 2016-2021. She earned her Bachelor of Arts degree from the University of Redlands in 1997, double majoring in International Relations and French. A three-sport athlete, Altman competed in cross country, swimming, and water polo, earning Academic All-American honors in cross country, All-Conference recognition in swimming and water polo, and three-time All-American distinction in water polo. Following her undergraduate studies, Altman initially planned to pursue a career in law. However, her passion for fitness, exercise, and athletics led her to coaching and teaching. She began her coaching career in 1997 as the head coach for the inaugural girls' water polo team at Bear River High School in Grass Valley, California, and also coached both boys' and girls' swim and dive teams. In 1998, Altman was appointed the first women's water polo coach at California State University, San Bernardino. While at CSUSB, she earned a master's degree in Education and Kinesiology and obtained certification as a yoga instructor. She subsequently taught kinesiology courses at both CSU San Bernardino and CSU Fullerton. In 2002, Altman became the head women's water polo coach at the University of California, Santa Barbara, where she guided the program to its highest national ranking in history; fifth in the nation. During her tenure at UCSB, she discovered a deep passion for both teaching and coaching and recognized that the community college environment provided the ideal opportunity to integrate these pursuits. Altman currently resides in Los Gatos, California, with her two children, Xander and Aurora.
 Rusty Johnson	**Rusty Johnson**'s journey has taken him across the country—from North Carolina to California, Nebraska, Alabama, Washington, and Illinois—before settling in the Bay Area to attend Santa Clara University. Growing up in a military family, Rusty moved every few years to a new location in the United States. Throughout each transition, one thing remained constant: being on a soccer team. A former NCAA Division 1 goalkeeper, Johnson competed in the 1999 NCAA National Championship and discovered a lifelong passion for leadership and teaching through sport. After earning his degree in Mechanical Engineering, he returned to Santa Clara as an assistant coach for the men's team, serving for a decade before transitioning to De Anza College as a head coach. He completed a Master of Arts in Kinesiology and Curriculum Development at Fresno Pacific University in 2017 and now serves as a full-time kinesiology instructor and head coach for both the men's and women's soccer programs at De Anza College. Coaching at this level demands so much time and around-the-clock availability that Rusty credits much of his professional success to his assistant coaches and his family's steady support. He lives in Willow Glen, San Jose, with his wife, Meghan, and daughter, Colette.

Team Images	Team Bios
 Cheryl Owiesny	**About the Author** **Cheryl Owiesny** is a Kinesiology and Physical Education instructor at De Anza College in Cupertino, California, where she has dedicated more than 25 years to teaching, coaching, and student success. She holds a Master of Arts in Kinesiology from San José State University, a California teaching credential from Notre Dame de Namur University, and a bachelor's degree in Physical Education with an emphasis in coaching and teaching and a minor in health from California State University, Chico. Cheryl's connection to community colleges began as a student-athlete at Foothill College, where she competed in both soccer and track and field. She later transferred to Chico State, where she continued her soccer career and earned the Female Scholar Athlete Scholarship. Following college, she played semi-professional soccer while pursuing a career in education and coaching. While completing her master's degree, Cheryl worked as a substitute teacher serving students in kindergarten through twelfth grade classrooms. Her passion for education and physical activity ultimately led her to a career in higher education, where she has taught a wide range of kinesiology, fitness, wellness, and physical education courses. In addition to her work in the classroom, Cheryl spent nearly three decades as the head women's soccer coach at De Anza College. Under her leadership, the program earned multiple conference championships, regional playoff appearances, national rankings, academic honors, and All-American selections. Her coaching accomplishments include being named California Community College Soccer Coaches Association Coach of the Year and receiving numerous regional and national coaching honors. In 2016, she was selected as a recipient of the California Community College Coaches Association Coaching Achievement Award, an honor bestowed by a committee of coaches' association leaders in recognition of outstanding contributions to coaching and student-athlete development. In 2024, she was inducted into the California Community College Soccer Coaches Association Hall of Fame. Beyond coaching, Cheryl has served in leadership roles at the state and national levels, advocating for community college athletics, student-athlete success, health and wellness initiatives, and opportunities for women in sport. She has contributed to curriculum development, online education, instructional design, and numerous college and statewide committees. Cheryl also holds advanced coaching credentials, including a United Soccer Coaches Premier Diploma, a United States Soccer Federation "A" License, and a USSF Grassroots Instructor License. As an educator, coach, and lifelong learner, Cheryl believes that physical activity has the power to improve health, enhance quality of life, build confidence, and strengthen communities. Through her teaching and writing, she strives to make evidence-based health and fitness information accessible, practical, and meaningful for students from all backgrounds. Cheryl resides in Saratoga, California, with her husband, Schad, and their daughters, Sydney and Bailey. Her experiences as an educator, coach, parent, and lifelong advocate for health and wellness continue to shape her teaching philosophy and commitment to helping students achieve their personal and academic goals.

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1: INTRODUCTION TO WELLNESS, FITNESS, AND LIFESTYLE MANAGEMENT



Figure 1.1: Practicing yoga can be part of a healthy lifestyle. (Downward Dog; Ginny Rose Stewart via Unsplash)

Introduction to Holistic Wellness

Wellness is a multifaceted concept that goes beyond just physical health to encompass emotional, social, and mental well-being. It involves balancing key areas of life, such as physical fitness, emotional resilience, and social connections, to foster overall health and prevent chronic diseases. This introductory chapter will place an emphasis on making healthy lifestyle choices to positively impact your overall wellness. Mental health, a crucial aspect of wellness, is deeply connected to emotional and social stability, influencing one's ability to cope with stress, work productively, and contribute to society. With over half of Americans experiencing mental health issues in their lifetime, understanding the factors that contribute to wellness and learning how to address barriers can help individuals lead more balanced, fulfilling lives.

Learning Objectives

- Define the ten dimensions of wellness
- Identify health problems in the United States
- Identify the behaviors that promote wellness
- Understand the SMART Goal Setting Process
- Understand the process of behavior change: how change occurs, barriers to change, and how to implement change safely and successfully
- Understand strategies to increase self-efficacy in physical activities
- 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 the incidence and signs of depression

1.1: Introduction to Wellness

1.2: Dimensions of Wellness
1.3: Behavior Change and Goal Setting
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1.1: Introduction to Wellness

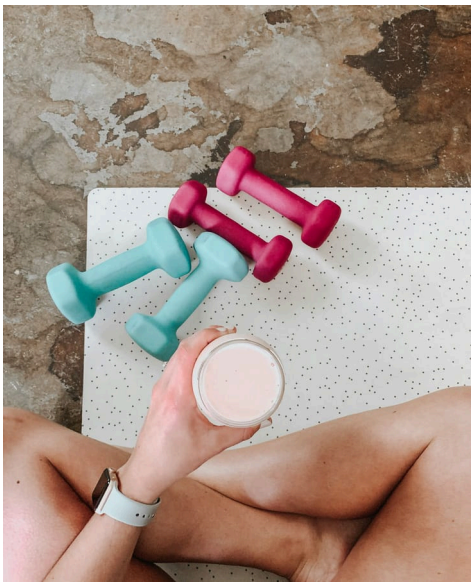


Figure 1.1.1: Exercise and a healthy diet support physical wellness. (Post-Workout; Derick McKinney via Unsplash)

Introduction

Wellness is a holistic concept that encompasses not only physical health but also emotional, mental, and social well-being. In today's world, many chronic diseases are preventable and directly linked to lifestyle choices, making the pursuit of wellness more important than ever. This chapter examines the fundamental aspects of wellness and highlights the significance of adopting healthy habits in achieving a balanced and fulfilling life.

Why Study Wellness?

Wellness is a multifaceted concept that goes beyond just physical health to encompass emotional, social, and mental well-being. It involves balancing key areas of life, such as physical fitness, emotional resilience, and social connections, to foster overall health and prevent chronic diseases. This introductory chapter will emphasize making healthy lifestyle choices to impact your overall wellness. Mental health, a crucial aspect of wellness, is deeply connected to emotional and social stability, influencing one's ability to cope with stress, work productively, and contribute to society. With over half of Americans experiencing mental health issues in their lifetime, understanding the factors that contribute to wellness and learning how to address barriers can help individuals lead more balanced, fulfilling lives.

Wellness is often considered a familiar term, but its true definition extends far beyond the simple absence of disease. This chapter defines the components of holistic wellness and outlines the various factors that contribute to a person's physical and mental health. Like many college students, individuals often set personal goals. While each person's goals may differ, they share a common purpose: the desire to enhance personal well-being. These goals may focus on financial success, improved health, or better relationships, each representing an aspect of holistic wellness.

Question

- When you think of being 'healthy,' do you focus only on diet and exercise, or do you consider your emotions, relationships, and stress levels too?
- Do you think true wellness means balancing all areas of life, not just avoiding illness?

Holistic wellness encompasses all areas of life, emphasizing that true well-being involves more than just physical and mental health. This comprehensive approach includes emotional, social, intellectual, spiritual, and occupational dimensions. Achieving

overall wellness involves living actively and fully. Individuals in this state typically demonstrate confidence, optimism, and a strong sense of self-efficacy. They possess the energy to meet daily challenges and the vision to plan for a healthier, more fulfilling future. The most meaningful and transformative goals are those aligned with achieving the highest levels of personal wellness.

Americans today experience health problems that people who lived 100 years ago did not encounter. What factors 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 (CDC, 2024) [10]

Leading Causes of Death

According to the Mortality in the United States, 2022 by the Centers for Disease Control and Prevention (CDC), the leading causes of death in the United States for 2022 are:

- Heart disease: 702,880
- Cancer: 608,371
- Accidents (unintentional injuries): 227,039
- COVID-19: 186,552
- Stroke (cerebrovascular diseases): 165,393
- Chronic lower respiratory diseases: 147,382
- Alzheimer's disease: 120,122
- Diabetes: 101,209
- Nephritis, nephrotic syndrome, and nephrosis: 57,937
- Chronic liver disease and cirrhosis: 54,803

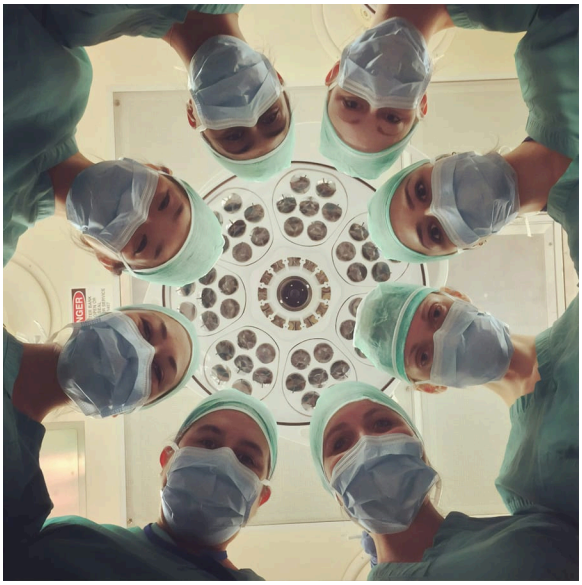


Figure 1.1.2: A healthy lifestyle can prevent the need for medical intervention. (Cancer Surgeons; National Cancer Institute via Unsplash)

Behaviors that Promote Wellness

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

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 one 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 United States invests more in healthcare per person than any other country, yet its health outcomes rank among the lowest

compared to nations with similar levels of education and economic resources. The rise in chronic diseases over the past 50 years, such as cardiovascular disease, diabetes, cancer, and dementia, can largely be traced to the long-term impact of daily lifestyle choices (Medical News Today, 2022). [16]

Question

- Is it difficult for you to make permanent lifestyle changes?
- Are your bad habits hard to break?

Key Points

- Wellness is a holistic concept that includes physical, emotional, mental, and social well-being—not just the absence of disease.
- Chronic diseases are the leading causes of death in the U.S., and many are preventable through healthy lifestyle choices.
- Mental health is a crucial part of overall wellness, affecting stress management, productivity, and social connections.
- Lasting behavior change is challenging but essential, as regular exercise, healthy eating, and stress reduction significantly improve long-term health outcomes.

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1.2: Dimensions of Wellness



Figure 1.2.1: Relaxation supports both physical and mental wellness. (Relaxed Feet; Rune Enstad via Unsplash)

Introduction

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.

Question

- What do you want for yourself, now and in the future?
- By focusing on the different areas of wellness in your life, can you create better wellness for yourself and your family?

10 Dimensions of Wellness

Ten different dimensions of wellness contribute to a person's overall wellness. They include occupational, financial, physical, emotional, intellectual, spiritual, social, environmental, cultural, and most recently, digital wellness (OSU Student Wellness Center, n.d.). [34]

Occupational Wellness

Occupational wellness is very important to overall wellness because of how much time the typical person spends working on their profession. An occupationally well person enjoys the pursuit of a career that 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. It involves working in a safe, supportive environment where your skills and opinions are valued. Job satisfaction isn't just about high pay—it grows when your personal goals align with your employer's, and when you feel your work makes a meaningful impact

Things to look for...

Choose a career you are passionate about, feel a sense of purpose in your daily work, and maintain a healthy work-life balance. You should seek out growth opportunities, such as professional development courses or mentorship, and set goals to advance in your field. Your job satisfies you and aligns with your values, which contributes positively to your overall well-being.



Figure 1.2.2: Occupational wellness includes feeling happy and fulfilled at work. (Working Woman; Brooke Cagle via Unsplash)

Financial Wellness

Financial wellness refers to having a healthy relationship with money, where an individual feels in control of their finances and prepared for both short-term needs and long-term goals. It involves budgeting wisely, saving regularly, managing debt effectively, and making informed financial decisions. A financially well person understands their financial situation, sets achievable goals, and feels confident in their ability to handle unexpected expenses. This sense of financial stability reduces stress and contributes to overall wellness by providing a foundation for security and future planning.

Ways to practice financial wellness...

Track your monthly expenses, stick to a budget, and contribute to both an emergency fund and a retirement account. You should avoid unnecessary debt, pay your bills on time, and plan for big purchases like a car or vacation. This financial planning allows you to feel secure, reduce stress, and focus on other areas of your life with confidence.



Figure 1.2.3: Financial wellness reduces stress and contributes to overall wellness. (US Currency; Blogging Guide via Unsplash)

Physical Wellness

Physical wellness involves taking proactive steps to maintain and improve your body's health through regular exercise, balanced nutrition, adequate sleep, and routine medical check-ups. It means making conscious decisions each day that support your physical functioning, such as staying hydrated, managing stress, and avoiding harmful behaviors like smoking or excessive drinking. A physically well person listens to their body's needs, understands their physical limits, and works to prevent illness or injury. This dimension of wellness not only boosts energy and endurance but also plays a crucial role in supporting emotional and mental health.

Guidelines to Follow...

Follow a consistent routine of going to the gym three times a week, cooking nutritious meals at home, getting 7–8 hours of sleep each night, and scheduling annual health check-ups with your doctor. By maintaining these habits, you support your energy levels, reduce your risk of chronic disease, and enhance your overall quality of life.



Figure 1.2.4: Physical activity and play are important for emotional and mental health. (Kids Playing; Robert Collins via Unsplash)

Emotional wellness can be difficult to deal with, as outside factors are processed on an emotional level in a very personal way. 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.

What can I do...?

After having a stressful day at work, take time to journal your feelings, talk to a trusted friend, and practice deep breathing to manage your emotions healthily. This shows self-awareness, emotional regulation, and a proactive approach to mental well-being.



Figure 1.2.5: Hiding your emotions from others can effect your emotional well being. (Covered Emotion; Sydney Sims via Unsplash)

Intellectual Wellness

Intellectual wellness involves actively engaging in lifelong learning, critical thinking, and creative activities that stimulate the mind. It includes seeking out new ideas, expanding knowledge, and participating in cultural, artistic, or philosophical discussions. Maintaining intellectual wellness helps improve problem-solving skills, broadens perspectives, and fosters personal growth.

Try something new...

Take a cooking class to learn a new cuisine while also reading about the cultural history behind the dishes. This not only enhances your skills and knowledge but also broadens your cultural understanding and keeps your mind actively engaged.

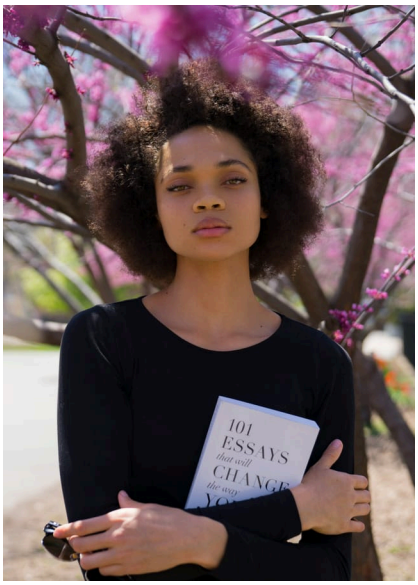


Figure 1.2.6: Reading a book like *101 Essays That Will Change the Way You Think* by Brianna Wiest can support intellectual wellness. (Woman Hugging Book; Thought Catalog via Unsplash)

Spiritual Wellness

Spiritual wellness, as a dimension of overall wellness, refers to the search for meaning, purpose, and connection in life. It involves aligning one's values, beliefs, and actions to create inner harmony and a sense of fulfillment. Spiritual wellness does not necessarily mean religious faith, though it can include religious practices; rather, it encompasses personal growth, mindfulness, and a deep appreciation for life's experiences. This dimension of wellness encourages self-reflection, gratitude, and ethical living, helping individuals navigate challenges with resilience and peace. By fostering spiritual wellness, people can develop a strong moral compass, improve emotional well-being, and build a sense of interconnectedness with others and the world around them.

Put it into practice...

Set aside time each morning to meditate, reflect on their values, and express gratitude. You may not follow a specific religion but find purpose and inner peace through mindfulness and a strong sense of connection to something greater than yourself.



Figure 1.2.7: Meditation can foster a sense of interconnectedness with others and the world around you. (Topless Man; Darius Bashar via Unsplash)

Question

- Do you think your social networking has a positive or negative effect on your social wellness?

Social wellness refers to the ability to build and maintain healthy, supportive relationships with others. It involves effective communication, empathy, mutual respect, and the capacity to create strong social networks that provide encouragement and connection. A socially well person values diversity, practices active listening, and engages in meaningful interactions with family, friends, colleagues, and their community. Social wellness also includes setting boundaries, balancing personal and social time, and being able to both give and receive support. Maintaining strong social connections contributes significantly to emotional stability, mental health, and overall life satisfaction.

Best practices...

Regularly schedule time to catch up with friends, attend community events, or volunteer at a local shelter. Try to maintain open and honest communication in your relationships and offer support to others while also knowing when to seek help yourself. This balance strengthens your sense of belonging and emotional well-being.



Figure 1.2.8: Spending time with friends is an important part of social wellness. (Women Forming Heart Gesture; Melissa Askew via Unsplash)

Environmental Wellness

Environmental wellness involves being aware of and respecting the environment around you, recognizing how your surroundings impact your health and well-being. It includes taking steps to live sustainably, such as recycling, conserving energy and water, and reducing waste. An environmentally well person also seeks to create safe, clean, and supportive spaces, whether at home, work, or in the community, that promote physical and mental health. Understanding your role in the environment and taking responsibility for its care fosters a sense of connection, purpose, and balance with the natural world.

Can I impact my environment...?

You can bike or take public transportation to work to reduce your carbon footprint, use reusable bags and water bottles, and participate in local clean-up events at parks or beaches. You can also make an effort to keep your home environment clean, organized, and free of toxins to support your physical and mental health. These actions show a commitment to living in harmony with the environment and contributing to the well-being of their community.



Figure 1.2.9: This building may support the environmental wellness of its residents. (Live Roof; Zach Rowlandson via Unsplash)

Cultural Wellness

Cultural wellness involves understanding, respecting, and valuing cultural backgrounds as well as the diverse cultures of others. It includes being open-minded and accepting of different beliefs, customs, traditions, and perspectives, while also recognizing how culture influences identity and behavior. A culturally well-informed person actively seeks to learn about other cultures, practices inclusivity, and challenges stereotypes or biases. This dimension of wellness fosters empathy, mutual respect, and a deeper connection with people from various backgrounds, enhancing both personal growth and community harmony.

What's culture to you...?

Attend cultural festivals and events in your community to learn about different traditions, foods, and customs. Make an effort to understand and respect coworkers' diverse backgrounds, celebrate cultural holidays with friends from various cultures, and engage in open conversations about identity and inclusion. By embracing diversity in everyday life, you will foster mutual respect and build meaningful, inclusive relationships.



Figure 1.2.10: Embracing diversity is a key component of cultural wellness. (Large Group; Dibakar Roy via Unsplash)

Digital Wellness

Digital wellness is the practice of using technology in a way that supports one's overall well-being, rather than harming it. It involves being intentional and mindful about screen time, managing distractions, setting healthy boundaries with devices, and maintaining a balance between online and offline life. Digital wellness encourages practices like unplugging regularly, curating digital content, and promoting positive interactions online. By fostering awareness and control over digital habits, individuals can reduce stress, improve focus, enhance relationships, and support their mental and physical health.

How do I reduce...?

Set clear boundaries with technology, such as limiting screen time, taking regular breaks, and prioritizing offline activities. Use digital tools intentionally, engage in positive and meaningful online interactions, and maintain a healthy balance between your virtual and real-life experiences.



Figure 1.2.11: Without healthy boundaries on technology use, we can negatively affect our digital wellness. (ChatGPT Generated Picture via OpenAI)

Sexual Wellness

Sexual wellness is a vital component of overall well-being that extends far beyond physical health. It involves a respectful and informed approach to sexuality, emphasizing consent, communication, emotional connection, and personal values. Sexual wellness overlaps with many of the 10 dimensions of wellness, such as emotional wellness through healthy relationships and self-acceptance, intellectual wellness through informed decision-making, social wellness through respectful connections, and physical wellness through safe sexual practices and preventive care. When nurtured, sexual wellness can enhance confidence, deepen intimacy, and support a balanced, fulfilling life.

Understanding Yourself

Understanding yourself is a foundational part of sexual wellness, especially during the college years when identity formation and self-discovery are central to personal growth. This involves gaining clarity about who you are in terms of your biological sex, gender identity, sexual orientation, and how you relate to others emotionally and physically. These aspects of identity are deeply personal and may evolve, influenced by experiences, relationships, and increased self-awareness.

By exploring these elements openly and thoughtfully, you lay the groundwork for making informed decisions, setting healthy boundaries, and building respectful, fulfilling relationships. Understanding yourself also enhances your ability to advocate for your needs, communicate effectively with partners, and seek out appropriate resources and support. In doing so, you strengthen not just your sexual wellness, but your emotional, social, and psychological well-being as well.

Biological Sex vs Gender Identity

Biological sex and **gender identity** are distinct concepts, both critical to understanding sexual wellness. Biological sex is assigned at birth based on physical characteristics such as genitalia, chromosomes, and hormone levels—typically categorized as male, female, or intersex. However, gender identity refers to an individual's internal sense of self as male, female, both, neither, or somewhere along the gender spectrum. While many people identify with the gender associated with their assigned sex (cisgender), others may identify as transgender, non-binary, or gender queer, among other identities.

Understanding this distinction is vital to promoting sexual wellness, as it fosters inclusivity, respect, and affirmation of diverse experiences. College-aged individuals often explore and affirm their gender identity during a time of increased independence and self-discovery. When a person's gender identity is acknowledged and supported, it positively impacts emotional wellness, self-esteem, and relationship quality. Conversely, misunderstanding or invalidating someone's gender identity can lead to distress, discrimination, and barriers to sexual healthcare. Recognizing and respecting the difference between sex and gender helps create

a more supportive environment for all aspects of wellness (Canadian Institutes of Health Research, 2023). [7]

Sexual Orientation

Sexual orientation is another core aspect of sexual wellness, referring to an individual's enduring pattern of romantic or sexual attraction to others. These attractions may be toward people of the opposite sex (heterosexual), the same sex (homosexual or gay/lesbian), both sexes (bisexual), all genders (pan-sexual), or none (asexual). Orientation exists along a spectrum and can evolve, particularly during the formative years of college when individuals are often discovering and clarifying their identities in new social and emotional environments.



Figure 1.2.12: The rainbow flag is a symbol of pride in the LGBTQ+ community. (Rainbow Flag; Stavrialena Gontzou via Unsplash)

Promoting sexual wellness requires acceptance of diverse sexual orientations without judgment or assumption. Respecting a person's orientation fosters emotional and social wellness by encouraging open communication, reducing stigma, and supporting healthy relationship development. In contrast, experiences of rejection, marginalization, or internalized shame can contribute to mental health challenges such as depression, anxiety, or unsafe sexual behavior. Educational environments that affirm all orientations through inclusive policies and access to supportive resources play a crucial role in helping students achieve holistic well-being (Fiveable, n.d.). [11]

Sexual Development

Sexual development is a lifelong process that includes the biological, psychological, and social changes related to sexuality. It typically begins during puberty when hormonal shifts lead to physical changes and the emergence of sexual thoughts and feelings. During adolescence and early adulthood, particularly the college years, individuals explore their sexual identities, values, boundaries, and preferences. This period often involves learning how to navigate romantic relationships, make informed choices about sexual activity, and understand consent and safe practices.

Healthy sexual development contributes to overall sexual wellness by fostering self-knowledge, confidence, and agency. Students who are well-informed about their bodies, emotions, and desires are more likely to engage in consensual, safe, and satisfying sexual experiences. Conversely, a lack of education or exposure to misinformation can lead to confusion, risk-taking, or shame. Access to accurate, inclusive sexual education and supportive conversations about sexuality empowers young adults to make thoughtful decisions, respect their limits, and build healthy relationships. Supporting sexual development in this way ensures that it aligns with broader wellness goals such as emotional, intellectual, and physical health.

Healthy Relationships

Healthy relationships are grounded in mutual respect, trust, and understanding. At the heart of these relationships is consent, the

ongoing, voluntary, and enthusiastic agreement to engage in any form of intimacy. Consent must be communicated and can be withdrawn at any time. It is not just about saying “yes” or “no,” but about both people feeling safe, heard, and comfortable. In college environments where new relationships often form, understanding and practicing consent is essential to fostering safety and respect in sexual and romantic interactions.

Communication plays a critical role in building and maintaining healthy relationships. Open, honest conversations about expectations, boundaries, desires, and concerns help prevent misunderstandings and build trust between partners. Effective communication also includes active listening, where each person genuinely considers the other’s perspective without judgment. In intimate relationships, discussing topics such as contraception, STI testing, and emotional needs creates a space where both individuals feel valued and respected. When communication is prioritized, conflicts can be resolved more constructively, and both partners can feel empowered to express themselves authentically.



Figure 1.2.13: Healthy relationships thrive on community and emotional connection. (Woman Riding on Man's Back; Chermiti Mohamed via Unsplash)

Another key component of healthy relationships is emotional connection. This refers to the sense of closeness, support, and vulnerability that partners share. Emotional intimacy develops over time through shared experiences, empathy, and consistent care. It allows individuals to feel accepted for who they are and creates a foundation for deeper trust and commitment. In sexually active relationships, emotional connection can enhance physical intimacy by reinforcing safety, affection, and mutual satisfaction. Without this emotional bond, relationships may feel one-sided or transactional, which can hinder overall well-being and satisfaction.

Together, consent, communication, and emotional connection form the core of sexual and relational wellness. They help individuals navigate the complexities of intimacy while maintaining self-respect and caring for others. By prioritizing these elements, college students can build stronger, more meaningful connections that support both their personal growth and their overall health (University of South Florida, n.d.). [37]

Protecting Your Health

Sexually transmitted infections (STIs) are a significant public health concern, particularly among college-aged individuals who are navigating new relationships and increased independence. Preventing STIs is essential for maintaining overall sexual health and well-being. This chapter explores effective strategies for STI prevention, including barrier methods, vaccinations, regular testing, and emerging medical interventions.

Barrier Methods

Consistent and correct use of barrier methods is a cornerstone of STI prevention. External (male) and internal (female) condoms, when used properly, significantly reduce the risk of transmission of HIV and other STIs. Dental dams are also effective for

reducing the risk of STI transmission during oral sex. These methods act as physical barriers, preventing the exchange of bodily fluids that can carry infectious agents.

Vaccinations

Vaccination is a powerful tool in preventing certain viral STIs. The Human Papillomavirus (HPV) vaccine protects against the strains of HPV most commonly associated with cervical cancer and genital warts. It is recommended for individuals starting from ages 11–12, but catch-up vaccination is advised up to age 26. Similarly, the Hepatitis B vaccine is recommended for all unvaccinated adults at risk for infection through sexual exposure.

Screening

Regular STI screening is crucial, especially for sexually active individuals with multiple partners. Early detection through testing allows for prompt treatment, reducing the risk of complications and preventing the spread to others. Many STIs can be asymptomatic; therefore, routine testing is essential even in the absence of symptoms. Healthcare providers can offer guidance on appropriate testing intervals based on individual risk factors.

Emerging Preventative Measures

Advancements in medical science have introduced new preventative options. Pre-exposure prophylaxis (PrEP) is a daily medication that significantly reduces the risk of HIV infection in high-risk populations. Post-exposure prophylaxis (PEP), when taken within 72 hours after potential exposure, can also prevent HIV infection. Additionally, recent studies have explored the use of doxycycline as post-exposure prophylaxis (DoxyPEP) for bacterial STIs like chlamydia and syphilis, showing promising results in specific populations.

Communication and Mutual Responsibility

Open and honest communication with sexual partners about STI status, testing history, and prevention strategies is vital. Mutual responsibility in practicing safe sex, getting tested, and seeking treatment fosters trust and reduces the risk of transmission. Educational programs and counseling services can support individuals in developing effective communication skills and making informed decisions about their sexual health.

By integrating these strategies into daily practices, college students can take proactive steps toward preventing STIs and promoting a culture of health and respect in their communities (CDC, 2024). [9]

Navigating Social and Cultural Influences

Sexual wellness does not develop in isolation—it is shaped significantly by the cultural, social, and familial environments in which individuals live. Cultural norms, including religious beliefs, traditional gender roles, and societal expectations around sexuality, can influence how people perceive their own sexual identity, behaviors, and relationships. For example, some cultures emphasize abstinence before marriage or discourage open discussions about sexual health, which can lead to shame, misinformation, or limited access to sexual health resources. On the other hand, cultures that promote comprehensive sex education and open dialogue may encourage healthier attitudes and behaviors related to consent, contraception, and respect in relationships.

Peer pressure is another major factor, especially in college environments where young adults may feel compelled to conform to the sexual behaviors or attitudes of their peers. This pressure can manifest in various ways, from engaging in unwanted sexual activity to avoiding testing or safe sex practices due to fear of judgment. When peers model healthy communication, respect for boundaries, and informed decision-making, they can positively influence others. However, when peer norms encourage risky behavior or silence around consent, they can undermine individual sexual wellness and confidence.



Figure 1.2.14: Peer pressure can encourage risky behavior, especially in college environments. (Partying by Jacob Bentzinger via Unsplash)

Navigating these social and cultural influences requires self-awareness and a strong sense of personal values. It's important for students to critically examine the messages they receive from family, friends, media, and institutions, and decide which align with their beliefs and well-being. Colleges and communities can support this process by offering inclusive education, safe spaces for discussion, and access to confidential sexual health services. By recognizing and understanding the broader forces at play, individuals can make empowered choices that support their sexual health and respect the diversity of experiences around them.

Resources and Support

Support for sexual wellness is more accessible than ever, particularly for college students who can take advantage of a variety of campus, online, and professional resources. Campus health services are often the first stop for students seeking help with sexual health concerns. These clinics typically offer confidential STI testing and treatment, contraceptive counseling, HPV and other vaccinations, and access to sexual health education. Many also provide mental health services that can help students navigate relationship concerns, identity exploration, or trauma recovery.

Beyond campus, numerous online tools and platforms offer information and support. Reputable websites like the CDC and Planned Parenthood provide medically accurate, inclusive, and age-appropriate content on topics ranging from consent and contraception to sexual orientation and gender identity. Some platforms even offer tele-health appointments, STI testing kits by mail, or anonymous Q&A services, giving students private and convenient access to care and education.

In some cases, it may be important to seek professional help from medical providers, therapists, or sexual health educators. Professionals can provide more specialized care, such as treatment for sexual dysfunction, counseling for sexual trauma, or ongoing management of chronic conditions like HIV. Whether through individual therapy, group support, or clinical care, these services ensure students are not navigating their sexual wellness alone. Together, these resources empower individuals to make informed choices, build healthy relationships, and care for their physical and emotional well-being.

More to Explore

Online Tools and Resources

- Planned Parenthood: Offers comprehensive information on sexual and reproductive health, including STI testing, birth control options, and educational materials.
- Scarleteen: Provides inclusive, sex-positive education for teens and young adults, covering topics like consent, relationships, and sexual health.
- American Sexual Health Association (ASHA): Delivers reliable, science-based information on sexual health, including resources on STIs and preventive practices.
- Bedsider: A birth control support network offering information on contraceptive methods and a clinic finder tool.

- Wisp: Provides online sexual and reproductive health services, including treatment and contraception options that are affordable and accessible.

Professional Help and Support

- Center for Healthy Sex: Offers therapy and educational resources for individuals and couples dealing with sexual health issues, including sexual dysfunction and addiction.
- The Trevor Project: Provides crisis intervention and suicide prevention services to LGBTQ+ youth, including support related to sexual health and identity.
- Love Matters: An online platform offering information on relationships, sex, and love, tailored to various cultural contexts.

Key Points

- Wellness is multidimensional, encompassing more than just physical and mental health—it includes emotional, intellectual, spiritual, occupational, financial, social, environmental, and cultural well-being.
- Each dimension is interconnected, meaning growth or imbalance in one area can impact the others and overall personal wellness.
- Achieving overall wellness involves intentional actions like setting goals, managing emotions, maintaining healthy relationships, engaging in meaningful work, and respecting diverse cultures and environments.
- Self-awareness is essential—recognizing your strengths, limitations, values, and needs across all nine areas helps support a more balanced, fulfilling life.
- Sexual wellness is multidimensional, involving informed choices, healthy relationships, and self-understanding across emotional, physical, and social areas.
- Prevention matters—using protection, getting vaccinated, and regular STI testing are essential for maintaining sexual health.
- Support is available through campus clinics, online tools, and professional services to help students make safe, confident decisions.

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1.3: Behavior Change and Goal Setting



Figure 1.3.1: (Change; Ross Findon via Unsplash)

Introduction

Behavior change is a gradual and ongoing process that requires intentional effort, self-awareness, and motivation. Rather than happening all at once, change typically occurs in phases, with individuals progressing at their own pace. Understanding this process can help in developing strategies that support lasting improvements in health and wellness. Using tools like S.M.A.R.T. goal setting, which emphasizes creating specific, measurable, achievable, results-focused, and time-bound goals, can make behavior change more manageable and increase the likelihood of long-term success.

How Changes in Behavior Occur

Changing personal behavior, especially long-standing habits, can be challenging and complex. Whether it's adopting healthier eating patterns, becoming more active, quitting smoking, or improving mental wellness, lasting change requires more than just willpower. **The Transtheoretical Model (TTM)**, also known as the Stages of Change Model, provides a structured framework to help understand how people move through the process of change. It recognizes that behavior change is not a single event but a gradual journey that unfolds in stages. By identifying where someone is in this journey and applying the right strategies for that stage, individuals can increase their motivation, overcome barriers, and build lasting habits that align with their values and goals.

The Transtheoretical Model

The Transtheoretical Model (TTM), 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 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 (Prochaska & Velicer, 1997).[32]

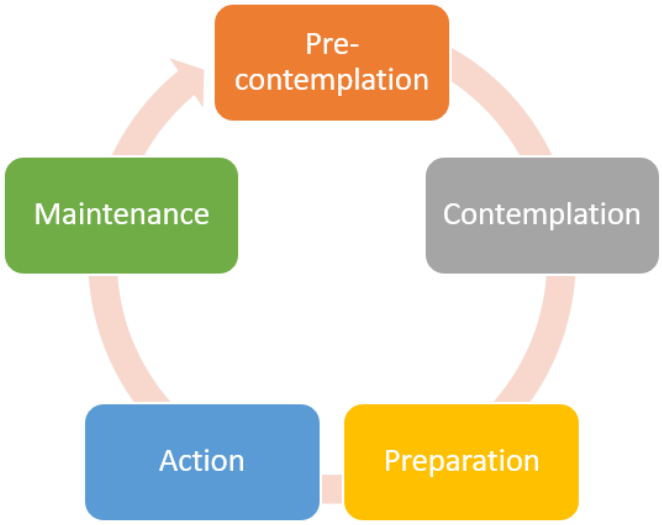


Figure 1.3.2: (CC BY-SA 4.0 via Wikimedia Commons)

Six Stages of Behavior Change

The TTM posits that individuals move through six stages of change: pre-contemplation, contemplation, preparation, action, maintenance, and termination. Termination was not part of the original model and is less often used in the 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.

Stage 1: Pre-Contemplation

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 intend 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 behavior change, and they believe that 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.

Question

- How can I find the motivation for change?
- Have you ever tried to change a 'bad' habit and thought, "Why is this so hard?"



Figure 1.3.3: Friend groups can provide support in all stages of behavior change. (Friends by ChatGPT via OpenAI)

Ten Processes of Change

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 others. These processes result in strategies that help people make and maintain change (University of Rhode Island Cancer Prevention Research Center, n.d.). [36]

Consciousness Raising

Consciousness Raising is a behavior change strategy focused on increasing a person's awareness and understanding of a specific health issue or behavior. The goal is to help individuals recognize the importance of a healthy behavior, understand the risks of unhealthy choices, and learn how change can benefit their well-being. This awareness often acts as the first step toward motivation and action.

Through information, education, and personal reflection, individuals become more informed about their current behavior and its consequences. Consciousness raising is especially effective in the early stages of behavior change, like the pre-contemplation and contemplation stages of the Transtheoretical Model.

Common Examples

- **Smoking Cessation Campaigns**: Graphic warning labels on cigarette packs or ads that show the long-term effects of smoking (e.g., lung cancer, stroke) help increase awareness of smoking's dangers.

- **Nutrition Education**: A school might teach students how to read food labels, explaining the impact of sugar and saturated fats on heart health. This awareness can prompt healthier eating choices.
- **Mental Health Awareness Events**: Hosting a seminar on stress and anxiety, where people learn how chronic stress affects the body and are introduced to coping tools like mindfulness, raises awareness of the importance of mental self-care.
- **Documentaries on Fitness or Diet**: A person watching a documentary on the effects of a sedentary lifestyle might realize their own risk for chronic illness and begin walking daily as a result.

Dramatic Relief

Dramatic Relief is a behavior change process that involves experiencing and expressing strong emotional reactions, either positive or negative, related to a health behavior. This emotional arousal helps people connect personally with the consequences of their actions, often triggering a deeper motivation to change. It transforms abstract risks into emotionally felt realities.

Dramatic relief often comes from stories, media, or personal experiences that evoke feelings such as fear, sadness, hope, or inspiration. It's especially powerful in the contemplation stage of change, where people begin to feel the emotional weight of their behavior and may start to envision change as both necessary and meaningful.

Common Examples

- **Anti-Drunk Driving Campaigns**: Commercials that show the tragic aftermath of a drunk driving accident can cause viewers to feel grief or fear, prompting them to think twice about driving under the influence.
- **Testimonies from Survivors**: A person sharing their story of surviving a heart attack due to poor diet and lack of exercise can evoke fear and urgency in others who relate to that lifestyle.
- **Hopeful Stories of Recovery**: Hearing how someone overcame addiction and rebuilt their life can inspire others struggling with similar issues, generating hope and a desire for change.
- **Before-and-After Visuals**: Seeing visual transformations (e.g., weight loss success, improved mental health after therapy) can stir admiration and motivate personal action.

Self-Reevaluation

Self-Reevaluation is the process of reflecting on one's values, identity, and self-image to recognize how adopting a healthy behavior aligns with the person they want to become. It involves asking, "Who am I now?" and "Who do I want to be?" This internal shift can foster motivation for change by linking behavior to personal significance and long-term objectives.

During self-reevaluation, individuals examine how their current behaviors fit with their ideal self-image and consider how making a change could support their personal values, goals, or future identity. This process is especially useful in the contemplation and preparation stages of behavior change, when people begin mentally committing to a healthier lifestyle.

Common Examples

- **Imagining a Future Self**: A person who wants to quit smoking might picture themselves as a healthy, energetic grandparent able to play with their grandchildren—someone who values vitality and family.
- **Journal Reflection Activity**: Writing about how regular exercise could improve self-confidence and self-esteem helps someone realize fitness is part of who they want to be.
- **Therapy or Coaching Sessions**: Guided conversations that help people explore how their behaviors match or contradict their values—e.g., someone who values sustainability realizing their excessive fast food consumption clashes with that identity.
- **Vision Boards**: Creating a board filled with images and words that represent the healthy, empowered self can make the benefits of change feel more personal and real.

Environmental Reevaluation

Environmental Reevaluation is the process of recognizing how one's unhealthy behavior impacts the people around them and the broader environment. This involves a shift in perspective, from a social or empathetic standpoint, to consider how personal choices impact family, friends, community, or even the planet. It helps individuals understand that their behavior isn't isolated and can motivate change out of concern for others.

Through environmental reevaluation, people become more aware of the social, emotional, or environmental consequences of their actions. This awareness can create a sense of responsibility and spark the desire to change, not just for personal benefit, but for the well-being of others. It's especially effective in the contemplation stage of behavior change.

Common Examples

- **Secondhand Smoke Awareness**: A smoker learns how their habit increases health risks for their children or spouse through secondhand smoke, leading to motivation to quit.
- **Parental Influence**: A parent realizes their sedentary lifestyle and poor eating habits are being modeled by their kids, encouraging them to adopt healthier behaviors for their family's future.
- **Littering and Pollution**: Someone who frequently uses disposable plastics sees the environmental impact of waste and decides to switch to reusable containers and bags.
- **Community Impact**: A person consuming excessive alcohol realizes how their behavior contributes to neighborhood disturbances or family stress and starts seeking help to reduce harm.

Social Liberation

Social Liberation refers to the external changes in society and the environment that support and encourage healthy behavior. It highlights how cultural shifts, policies, or community resources can make it easier for individuals to adopt and maintain healthier lifestyles. The idea is that when people see their environment supporting positive behavior change, it becomes more attainable and socially acceptable.

Social liberation involves recognizing and utilizing opportunities around us, like supportive laws, inclusive programs, and shifting norms, that empower people to make healthier choices. This process often reinforces that change is not only possible but also encouraged and respected in society. It's helpful at any stage of behavior change, but particularly during action and maintenance.

Common Examples

- **Smoke-Free Public Spaces**: The creation of smoke-free restaurants, parks, and workplaces signals that society supports quitting smoking and prioritizes public health.
- **LGBTQ+ Inclusive Gyms or Health Programs**: A fitness center offering gender-neutral locker rooms or LGBTQ+-friendly health coaching shows societal support for inclusive wellness.
- **Plant-Based Options in Schools and Restaurants**: The availability of vegetarian or vegan meals in public institutions supports healthier, more sustainable eating habits.
- **Free Mental Health Services**: Community initiatives that offer free or low-cost therapy increase access and signal that taking care of mental health is a valued norm.
- **Workplace Wellness Programs**: Employers providing standing desks, on-site fitness classes, or mental health days promote a culture where healthy behavior is supported.

Self-Liberation

Self-Liberation is the process of making a firm, personal commitment to change a behavior, fueled by the belief that change is not only necessary but possible. It reflects a shift from thinking about change to actually deciding to act, choosing to take control of one's own behavior through willpower and belief in success.

This process involves building confidence, setting intentions, and declaring a decision to change, often with a clear plan or goal in mind. Self-liberation is rooted in self-efficacy, or the belief in one's ability to succeed. It becomes especially important in the

preparation and action stages of behavior change.

Common Examples

- **Making a Public Commitment**: Someone announces on social media that they're beginning a 30-day challenge to quit sugar or alcohol, using accountability to reinforce their commitment.
- **Signing a Behavioral Contract**: A person writes and signs a formal agreement with themselves (or a coach) to exercise 4 times a week for the next month.
- **Joining a Program**: Enrolling in a smoking cessation group or weight loss support group signifies a deliberate step toward change.
- **Setting SMART Goals**: Someone prepares for behavior change by creating Specific, Measurable, Achievable, Relevant, and Time-bound goals, like "I will walk 30 minutes a day, 5 days a week."
- **Daily Affirmations**: Using affirmations such as "I am in control of my health" helps reinforce belief in personal ability to change.

Helping Relationships

Helping Relationships are supportive connections with people who encourage, motivate, and assist someone in making a healthy behavior change. These relationships offer emotional, informational, and sometimes practical support, helping to reduce feelings of isolation and build accountability during the change process.

This process focuses on seeking out and maintaining relationships that reinforce the desire and commitment to change. Support can come from friends, family, professionals, or peers, and is especially vital during the preparation, action, and maintenance stages of change. Helping relationships increase the likelihood of success by providing encouragement, reducing stress, and offering constructive feedback.

Common Examples

- **Accountability Partners**: Two friends decide to go to the gym together three times a week, holding each other accountable and offering encouragement.
- **Support Groups**: Joining a group like Alcoholics Anonymous or Weight Watchers provides a structured space to share experiences and gain motivation from others facing similar challenges.
- **Therapy or Coaching**: A person works with a counselor or health coach to process setbacks and develop effective strategies for maintaining behavior change.
- **Family Involvement**: A spouse joins their partner in eating healthier meals or quitting smoking to offer moral and practical support.
- **Online Communities**: Participating in a health-focused online forum or social media group where members share progress, setbacks, and tips for success.

Counter-Conditioning

Counter-Conditioning is the process of replacing unhealthy behaviors or thoughts with healthier alternatives. Rather than simply trying to stop a bad habit, the focus is on substitution—deliberately choosing a positive behavior that serves the same purpose or meets the same need as the old, unhealthy one.

This strategy helps individuals deal with triggers or cravings by offering a healthier response. It requires identifying the situations that lead to unhealthy behaviors and preparing new, constructive habits to use instead. Counter-conditioning is especially effective in the action and maintenance stages of change, when someone is actively trying to sustain progress.

Common Examples

- **Stress Eating** → Walking: Instead of reaching for snacks during stressful moments, a person goes for a 10-minute walk to reduce anxiety.

- **Smoking** → Deep Breathing: A person trying to quit smoking uses deep breathing exercises or chews gum whenever they feel the urge to light a cigarette.
- **Late-Night Screen Time** → Reading: Someone trying to reduce screen time before bed replaces their phone habit with reading a paperback book.
- **Angry Outbursts** → Journaling: A person trying to manage anger starts journaling or practicing mindfulness whenever they feel a surge of emotion coming on.
- **Negative Self-Talk** → Affirmations: When someone catches themselves thinking, "I can't do this," they counter it with, "I'm making progress every day."

Reinforcement Management

Reinforcement Management involves increasing the likelihood of healthy behavior by providing rewards for positive actions and removing rewards for unhealthy behaviors. This process uses motivation and consequences—both internal and external—to shape behavior over time.

People are more likely to repeat behaviors that result in positive outcomes. Reinforcement management focuses on creating a system where healthy behaviors are encouraged through praise, incentives, or personal satisfaction, while unhealthy behaviors are made less appealing by reducing their payoff or introducing consequences. This process is especially effective in the action and maintenance stages of change.

Common Examples

- **Rewarding Exercise**: After a week of regular workouts, a person treats themselves to a massage, a new workout outfit, or a fun activity.
- **Reducing Junk Food Temptation**: Someone stops buying sugary snacks for the house, making it harder to indulge and removing the immediate reward of convenience.
- **Tracking Progress with Milestones**: A person sets up a reward system for every 5 pounds lost or 30 days alcohol-free, like a movie night or a new book.
- **Verbal Encouragement**: Friends or family members give praise and encouragement when a person sticks to their meal plan or avoids a cigarette.
- **Behavioral Consequences**: Someone tells a friend to hold them accountable—e.g., if they skip a workout, they have to donate to a cause they don't support.

Stimulus Control

Stimulus Control involves changing your physical and social environment to support healthy behaviors and reduce temptations that lead to unhealthy ones. It's about using reminders, cues, and environmental design to make the desired behavior easier and the undesired behavior harder.

By intentionally modifying your surroundings, you create triggers for positive behavior and remove cues that promote negative behavior. This strategy helps reduce reliance on willpower by making the healthy choice the path of least resistance. Stimulus control is particularly effective in the action and maintenance stages of change.

Common Examples

- **Healthy Food Placement**: Keeping fruit on the kitchen counter and storing junk food out of sight (or not buying it at all) encourages better eating habits.
- **Exercise Cues**: Laying out workout clothes the night before as a visual reminder to exercise in the morning.
- **Limiting Screen Time**: Deleting social media apps from your phone or turning off notifications to reduce digital distractions.
- **Sleep Hygiene**: Creating a bedtime routine with dim lighting, a white noise machine, and removing electronics from the bedroom to support better sleep.

- **Avoiding Triggers**: A person recovering from alcohol use may avoid bars or social gatherings where drinking is common and instead plan activities in alcohol-free settings.



Figure 1.3.4: A healthy meal includes fresh vegetables and fruits. (Meal Prep; Heather Ford via Unsplash)

Limitations of the TTM

One major limitation of the TTM is that it often fails to account for the broader social context in which behavior change occurs. Specifically, it tends to overlook key factors such as socioeconomic status, income, education, housing stability, and access to resources—all of which significantly influence a person's ability to make and sustain healthy changes.

Students often face unique life challenges that can directly impact their readiness and ability to change behaviors. Many students juggle school with jobs, caregiving responsibilities, financial stress, or lack of reliable transportation and healthcare. These circumstances can limit access to healthy food, safe exercise environments, or even time for self-care.

Common Examples

- A student working two part-time jobs to afford tuition may want to eat healthier or exercise more but lacks the time or money to cook balanced meals or join a gym.
- A student living in a food desert may know the benefits of eating more vegetables (consciousness raising) but still be unable to make the change due to limited availability or affordability.
- Mental health challenges or unstable housing may make it difficult to maintain motivation or stay in the action/maintenance stage of change.

Another key limitation of the TTM is the lack of clear, standardized criteria for determining a person's stage of change. The boundaries between stages like contemplation, preparation, and action can be blurry and subjective, making it difficult to accurately assess where someone is in their behavior change journey. While various questionnaires exist to help place individuals into a stage, these tools are not always scientifically validated or consistent across different populations.

For students, behavior change tools and strategies must be adaptable, culturally responsive, and tailored to individual experiences. Relying on unclear or unvalidated assessments can hinder effective support and lead to disengagement. More flexible models that respect the complexity of students' lives—and include their input—can help ensure that health and wellness interventions are both relevant and empowering.

Common Examples

- Support may be mistimed or mismatched—for example, giving action-oriented strategies to a student who is still ambivalent about change.
- Students may be labeled incorrectly, leading to feelings of frustration or failure if progress doesn't align with expectations.
- Interventions may fail to resonate, especially if they don't consider cultural, educational, or developmental differences in how students interpret and approach change.

A significant limitation of the TTM is that it does not define how long a person should remain in each stage of change, nor does it provide clear guidance on how much time is needed to move from one stage to the next. This lack of time-specific direction makes it difficult to track progress, set realistic expectations, or know when an intervention should be adjusted.

Students often face unpredictable schedules, shifting priorities, and limited time, making consistency in health or behavior change especially difficult. For students, flexibility and personalization in behavior change support are crucial. The TTM's lack of defined timelines means that students—and those supporting them—should avoid rigid expectations and instead focus on progress, not perfection. Recognizing that each student moves at their own pace allows for more compassionate, realistic, and effective wellness support.

Common Examples

- Students may feel pressure to change too quickly or assume they are "failing" if they haven't moved to the next stage fast enough.
- Educators or health advisors may misinterpret a student's pace, expecting results before the student is ready, or overlooking the progress made in maintaining readiness.
- It's harder to build supportive programming when no benchmarks exist for how long to focus on building motivation or implementing action steps.

One last major critique of the TTM is that it assumes individuals make thoughtful, rational, and logical decisions when choosing to change a behavior. The model outlines a step-by-step progression, implying that people weigh pros and cons, assess their readiness, and then take deliberate action. However, in reality, human behavior is often influenced by emotions, habits, stress, social pressures, and unpredictable life events, not just logic.

Students frequently face high stress, time constraints, and competing priorities like work, caregiving, and academic responsibilities. These factors can lead to decisions based more on emotional survival than strategic planning. The TTM doesn't always account for the messiness of real life, which can cause students to feel ashamed, unmotivated, or misunderstood if they don't follow a "logical" path to change.

For students, it's important to acknowledge that behavior change is often driven by more than rational thought. Emotional support, mental health resources, and compassionate, trauma-informed approaches are essential to help students succeed. Effective interventions should meet students where they are, not where the model expects them to be.

Common Examples

- A student might skip healthy meals or workouts not because they lack willpower or understanding, but because they're exhausted after working a double shift.
- Emotional reactions like anxiety, overwhelm, or low self-esteem may cause a student to abandon change efforts, even if they "know better."
- Decision-making can be impulsive or reactive due to mental health struggles, trauma, or lack of supportive environments, not because a student failed to make a plan.

The first step in creating and maintaining a regimen for lifelong participation in physical activity is to identify desired outcomes. Perhaps the desired outcome is to embrace a healthy lifestyle, enhance mental well-being, and improve self-esteem. Research indicates that exercise may produce numerous positive outcomes; however, the challenge lies in overcoming perceptual and

environmental barriers to consistently following an exercise plan. Often, an individual will revert to old habits of inactivity (despite their desired outcomes) if clear goals are not set regarding physical activity participation.

S.M.A.R.T. Goal Setting



Figure 1.3.5: Setting goals is important for successful changes in behavior. (Gray Textile; Ronnie Overgoor via Unsplash)

Setting clear, realistic goals is a key part of making lasting behavior changes—whether you're aiming to improve your health, succeed in school, or develop better habits. The **S.M.A.R.T. goal**-setting framework is a powerful tool that helps turn vague intentions into concrete, actionable steps. By focusing on goals that are Specific, Measurable, Achievable, Results-focused, and Time-bound, students and individuals alike can stay motivated, track progress, and increase their chances of success. This structured approach transforms big dreams into manageable plans, making it easier to stay focused and committed along the way (Substance Abuse and Mental Health Services Administration, n.d.). [35]

Specific:

Specific goals are characterized by clearly defining what is to be accomplished. A specific goal answers questions such as what the individual wants to achieve, why it is important, and how it will be done. It removes ambiguity and provides a clear direction. For example, rather than stating, "I want to get in shape," a more specific goal would be, "The individual will walk for 30 minutes, five days a week, to improve cardiovascular health." Being specific helps maintain focus, makes progress easier to track, and boosts motivation by providing a clear objective to work toward.

Measurable:

Creating a measurable goal gives the ability to track progress and determine when the goal has been achieved. A measurable goal includes clear criteria or indicators that can be quantified or assessed. This helps provide evidence of progress and keeps individuals motivated as they can see how far they've come. For example, instead of saying, "Exercise more," a measurable goal would be, "Exercise for 30 minutes, three times a week." This allows for tracking each workout and knowing when the target has been met. Measurable goals often answer questions like how much, how many, or how will I know when it's accomplished? By including measurable elements, individuals are better equipped to stay accountable and adjust their efforts if needed.

Achievable:

Setting an achievable goal means that the goal is realistic and attainable based on the individual's current abilities, resources, and circumstances. An achievable goal should stretch a person slightly to encourage growth, but it should not be so difficult that it feels impossible or discouraging. This element considers whether the individual has the time, knowledge, skills, and support necessary to reach the goal. For example, setting a goal to run a marathon next month may not be achievable for someone new to

running, but committing to jog three times a week is more realistic. Achievable goals help build confidence, prevent frustration, and create a solid foundation for long-term success by ensuring that the individual can realistically follow through with the plan.

Results-Focused:

Coming up with a results-focused goal means the goal should emphasize the desired outcome rather than the activities or tasks involved. It should clearly define what success looks like and focus on the result that the individual wants to achieve. This helps ensure that efforts are aligned with a meaningful objective, not just busy work. A results-focused goal answers the question, What is the intended outcome? For instance, instead of saying “Go to the gym three times a week,” a results-focused goal would be, “Improve cardiovascular endurance by regularly completing 30-minute cardio workouts.” While the activity (going to the gym) is important, the real focus is on what that activity is meant to accomplish. By keeping goals centered on results, individuals are more likely to stay motivated and make adjustments to their actions as needed to reach the desired outcome.

Time-Bound:

Creating a time-bound goal means that the goal has a clear deadline or timeframe for completion. This creates a sense of urgency and helps prioritize the goal among other responsibilities. A time-bound goal answers the questions: When will the goal be achieved? And what can be accomplished within a set period? Without a deadline, goals can be delayed indefinitely, making it harder to stay focused and motivated.

For example, instead of saying “Start eating healthier,” a time-bound version would be, “In the next four weeks, replace fast food meals with home-cooked dinners at least five nights a week.” This provides a specific window for tracking progress and encourages consistent action. Having a defined timeline also allows for setting short-term milestones, evaluating progress along the way, and adjusting strategies if necessary. Overall, time-bound goals help turn intentions into actionable plans with clear checkpoints for success.

Video 1.3.1 S.M.A.R.T. Goals - Quick Overview

Length of Video: 3 minutes 57 seconds

This video provides an overview of the S.M.A.R.T. goal-setting process and the key considerations to keep in mind when creating your goals. This video explains how to use the S.M.A.R.T. goals framework to set and achieve meaningful goals more effectively. Many people struggle not from a lack of effort, but from poorly structured goals.

The video emphasizes that goal-setting is an ongoing process, not a one-time event. Goals may need to change as life changes, so regular evaluation and flexibility are key to staying motivated and on track.

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

Key Points

- Behavior change is gradual and happens in stages, requiring motivation, awareness, and effort over time.
- Progress involves strategy, including cognitive and behavioral tools to move through each stage and prevent relapse.
- Overcoming barriers like unclear goals or environmental challenges is essential for lasting change.
- S.M.A.R.T. goals improve success by making goals clear, realistic, trackable, and time-bound.

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1.4: Overcoming Barriers to Change



Figure 1.4.1: Overcoming barriers in your own behavior can help you accomplish difficult things. (Woman Wearing Academic Gown; Chichi Onyekanne via Unsplash)

Introduction

Adopting and maintaining a regular physical activity routine can be challenging, especially when faced with common psychological and lifestyle barriers. For many individuals, particularly college students juggling academics, work, and social commitments, making lasting health behavior changes may feel overwhelming. This section introduces the psychological and behavioral factors that influence one's ability to engage in consistent physical activity. By exploring concepts such as self-efficacy, goal setting, and strategies for overcoming setbacks, readers will gain a foundational understanding of how to build and sustain healthy habits that support long-term wellness.

Considering the numerous barriers to physical activity reviewed previously, healthy behavior changes and adoption of a habitual physical activity regimen into an individual's lifestyle may seem like a daunting task. College students may feel particularly challenged in implementing a regular physical activity plan into their schedule, given the need to balance school, work, and social lives. Thus, an individual must weigh their current "readiness" to make a behavior change to effectively plan and implement desired behavioral changes into their daily routine.

Dr. James M. Olson, a psychology professor at the University of Western Ontario, London, has identified several psychological barriers that commonly prevent people from acting, 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 (Olson, 1992). [30]

Barriers to Admission of the Problem

Admitting there is a problem is often the most difficult and critical first step in behavior change. This stage, known as the "admission of the problem," serves as the foundation for any meaningful lifestyle modification, yet many individuals struggle to reach it. Several psychological mechanisms can prevent people from acknowledging that their current behaviors may be harming their health.

One common barrier is **denial**, the refusal to accept that a problem exists. This may stem from fear, discomfort, or a desire to avoid the responsibility of change. Individuals may also trivialize their risk, convincing themselves that the consequences of their behavior are minimal or unlikely to happen to them. This sense of invulnerability, the belief that "it won't happen to me," can lead

people to ignore warning signs or delay taking action.

Another factor is **faulty conceptualization**, where individuals misinterpret or rationalize symptoms and behaviors. For example, someone might attribute constant fatigue to being "just busy" rather than recognizing it as a sign of poor health. Additionally, debilitating emotions such as fear, guilt, or anxiety can arise when people consider confronting a problem. Instead of motivating change, these emotions may overwhelm the individual, leading them to avoid addressing the issue altogether.

Ultimately, recognizing and admitting a problem requires a level of self-awareness and emotional courage. Without this step, individuals are unlikely to pursue or stick with strategies for change, making it one of the most significant psychological barriers in the journey toward wellness.

Ask yourself...

- What specific things made it hard for me to stick to my plan?
- Did I avoid admitting there was a real problem?
- Did I believe something about the change that wasn't true or realistic?
- How did these thoughts or beliefs affect my motivation or actions?

Barriers to Initial Attempts to Change

The initial attempt to change is a critical phase in the behavior change process, and for many people, it becomes a major barrier when those first efforts result in failure or frustration. At this stage, individuals typically recognize that a problem exists and are motivated to take action, but they often lack the tools, knowledge, or confidence to follow through successfully.

A key obstacle during this phase is low self-efficacy—the belief that one is not capable of making or sustaining change. Even when someone is motivated, if they don't believe in their ability to succeed, they are more likely to give up at the first sign of difficulty. This lack of confidence can be reinforced by past failures or unrealistic expectations for quick results.

Additionally, people often face a lack of knowledge or resources, which can make the path forward unclear or overwhelming. For instance, someone who wants to start exercising regularly may not know how to design a workout plan, where to begin, or how to stay motivated. Without proper guidance or structure, these good intentions can quickly lose momentum.

Dysfunctional attitudes can also play a role. These include all-or-nothing thinking ("If I can't go to the gym every day, it's not worth it"), perfectionism, or negative self-talk. Such attitudes can make minor setbacks feel like total failures, which discourages continued effort.

Ultimately, initial failed attempts can shake a person's confidence and lead to discouragement or abandonment of their goals altogether. Recognizing that relapse or struggle is a normal part of the change process, and equipping individuals with realistic strategies, support systems, and small, manageable steps can help overcome this barrier and build resilience for long-term change.

Barriers to Long-Term Change

Barriers to long-term change are some of the most persistent challenges individuals face after making initial progress toward a healthier lifestyle. While the early stages of change are often marked by enthusiasm and motivation, maintaining new behaviors over time requires sustained effort, adaptability, and emotional resilience. Several psychological and environmental factors can make it difficult to preserve these changes.

One of the most common barriers is **cognitive** and **motivational drift**. Over time, people may lose sight of their original reasons for changing or grow tired of the effort required to maintain their new habits. The initial excitement fades, and without consistent reinforcement or visible progress, motivation can wane. This drift is especially likely when the benefits of the change are gradual or not immediately obvious—for example, when healthy eating or exercise doesn't lead to quick weight loss or energy boosts.

Another significant factor is the lack of perceived improvement. If individuals don't see or feel the expected results, they may believe their efforts aren't working, leading to frustration and a return to old habits. This perception can be especially damaging if expectations were unrealistic to begin with. Long-term change requires patience and a recognition that small, incremental gains

are still progress.

Social support plays a critical role in sustaining change. Without encouragement from friends, family, or peers, individuals may feel isolated or unsupported in their efforts. In some cases, social environments can even discourage progress, such as when peers downplay the importance of healthy behaviors or when routines involving unhealthy habits are shared with others.

Finally, relapse or lapses—temporary returns to old behaviors—can feel discouraging and trigger negative emotions like guilt or shame. Some people may interpret a lapse as a complete failure rather than a normal part of the process, which can lead to giving up entirely. It's important to understand that setbacks are common and can serve as valuable learning experiences.

Successfully overcoming these long-term barriers involves strategies like revisiting personal goals and motivations, seeking consistent social and emotional support, tracking progress, and cultivating self-compassion. Recognizing that long-term change is a journey, with ups and downs, can help individuals build the resilience needed to maintain healthy behaviors over time.

More to Explore

To read more about these barriers to change, including strategies for overcoming these barriers, read Dr. Olson's entire article titled Psychological Barriers to Behavior 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 takes time and requires 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 (American Psychological Association, n.d.). [3]

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 it 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 well-being inherent in the highest level of your wellness are more than worth the effort required to change.

More To Explore

For more information about making permanent lifestyle changes, go to the American Psychological Association website to read Lifestyle Changes That Last.

Increasing Self-Efficacy and Goal-Setting



Figure 1.4.3: Joining a support group or working with a buddy can provide support in your wellness training. (People Riding Boat on Body of Water; Matteo Vistocco via Unsplash)

Strategies which may assist an individual in overcoming physical activity barriers– thus, facilitating successful progression

through the TTM stages of change – include increasing self-efficacy for physical activity, and engaging in effective goal setting.

Self-efficacy refers to an individual's beliefs that they will be successful in performing a specific behavior, whereas self-confidence refers to a more global sense of personal worth. Studies indicate that increased self-efficacy may positively impact an individual's motivation to participate in a particular behavior, the performance achievements gained from participation in said behavior, and overall well-being (Bandura, 1994). [5] Notably, self-efficacy can be developed for a variety of human behaviors. However, for the current Chapter, physical activity self-efficacy will be exclusively reviewed. It is important to note that improvements in physical activity self-efficacy may reduce an individual's negative perceptions of exercise, a commonly cited barrier to physical activity (CDC, 2024). [8]

Factors that may enhance an individual's self-efficacy for physical activity:

- Experiencing positive physiological states (i.e., mood)
- Receiving verbal encouragement for physically active behavior
- Observing others successfully performing physically active tasks (i.e., role model)
- Mastering physical activity skills on an individual level (Moore & Tschannen-Moran, 2010). [17]

Physical activity self-efficacy can be strengthened in three areas, which correlate with personal, environmental, and behavioral factors.

1. **Personal (Mood):** Noticing and acknowledging positive physiological states (i.e., feelings of calmness and enjoyment) during physical activity may increase self-efficacy for future physical activity participation.
2. **Environmental (Surrounding oneself by a healthy environment)**: Speaking positively about physical activity participation (verbal encouragement) and observing and being mindful of the physical activity behaviors of those individuals in one's social group (watching role-models in exercise and sport) may positively impact an individual's self-efficacy for future physical activity participation.
3. **Behavioral (Engaging in exercise – "doing"!)**: Engaging in consistent, successful efforts related to physical activity (mastery experiences) may increase physical activity-related self-efficacy. Participation in habitual physical activity requires a clear vision for oneself, effective goal-setting, and self-monitoring of progress.

A review of how to best create a vision, set appropriate goals, plan for adversity, and self-monitor is the final step in this chapter's overview of the benefits of physical activity, perceived barriers, and healthy behavior change sections. Research indicates that the following methods may be effective in planning, monitoring, and adhering to a personal health and fitness program (Lock & Latham, 2002). [13]

1. **Create a compelling vision**: Before beginning a behavior change journey, individuals should take time to envision a "healthier self." It is important to identify the driving forces behind the desire for change. Why is this transformation important? How will improved health enhance one's quality of life and positively impact those around them? By clarifying which behaviors they aspire to engage in consistently, individuals can define what it means to become their "best self."
2. **Design behavioral goals for the exercise plan**: Individuals should establish S.M.A.R.T. goals—goals that are Specific, Measurable, Achievable, Realistic, and Time-bound. These goals, whether short-term or long-term, provide a structured approach to building and maintaining a consistent health regimen.
3. **Plan for setbacks**: It is essential to recognize that setbacks are a natural part of any behavior change process. Individuals should mentally prepare for these challenges and develop a proactive "game plan" to address them. By identifying strategies for responding to adversity, one can build resilience and stay committed to long-term success.
4. **Track and measure progress**: Monitoring progress through journaling or self-assessment helps individuals make necessary adjustments to their behavior change plan. Regular "goal check-ins" allow for the evaluation of both accomplishments and areas needing improvement. As short-term goals are achieved, individuals may find their long-term goals evolving or expanding, leading to new aspirations and continued personal growth.

Reflection Activity

- How may you increase your self-efficacy for physical activity? Please provide a detailed answer.
- Do you acknowledge positive physiological cues during or after exercise? (i.e., calm breathing or relaxed state)
- Do you surround yourself with individuals who voice their support for your exercise endeavors?

Key Points

- Behavior change happens in stages: Individuals face psychological barriers when admitting a problem, trying to change, and maintaining new habits.
- Planning and support are essential: Lasting lifestyle changes require small, realistic goals, social support, and a long-term mindset.
- Self-efficacy drives success: Belief in one's ability to be active can be strengthened through encouragement, role models, and positive exercise experiences.
- Clear goals and self-monitoring improve outcomes: Setting S.M.A.R.T. goals, planning for setbacks, and tracking progress help maintain motivation and long-term behavior change.

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1.5: Emotional and Mental Health



Figure 1.5.1: (Black Heart Cutout; Kelly Sikkema via Unsplash)

Introduction

Mental health is a vital component of overall well-being, influencing how individuals think, feel, and behave as they navigate daily life. It affects our relationships, work, decision-making, and ability to cope with stress. In recent years, the importance of mental health has gained recognition alongside physical health, highlighting the need for a more holistic view of wellness. This section explores the definition and significance of mental health, the relationship between mental health and Maslow's Hierarchy of Needs, the role of positive psychology and happiness, and practical strategies for maintaining mental wellness. It also examines common challenges that impact mental health, emphasizing the importance of awareness, support, and proactive self-care in fostering long-term mental and emotional resilience.

What is Mental Health?

Mental health is a state of well-being in which an individual realizes their abilities, can cope with the normal stresses of life, can work productively, and can contribute to their 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 (World Health Organization, 2022). [38]

Mental Health's Connection to Wellness

Positive mental health is more than just the absence of mental illness; it is a dynamic state of well-being in which individuals recognize their potential, cope effectively with the normal stresses of life, work productively, and contribute meaningfully to their communities. It encompasses emotional, psychological, and social wellness, all of which influence how people think, feel, and behave.

Individuals with positive mental health are better equipped to manage challenges, build strong relationships, and maintain a sense of balance and purpose in their lives. They are more resilient, able to recover from setbacks, and are often more engaged and satisfied in their daily activities. Positive mental health also supports physical health by reducing the risk of chronic diseases and improving immune function. Cultivating positive mental health involves practices such as staying connected to others, engaging in regular physical activity, managing stress through mindfulness or relaxation techniques, and maintaining a sense of gratitude and meaning in life.

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 – Maslow's Hierarchy of Needs

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 for you to strive to reach your human potential? Is it important to feel safe 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**. The purpose of the Hierarchy of Needs was to explain that there are levels of human needs, and we need to focus on each level 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, it was observed that most people fulfilled their basic needs in the order of the hierarchy, but there are some exceptions. The order of needs, as categorized by Maslow from bottom to top, is: 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 in which they generally progress as lower needs are reasonably well met (Maslow, 1943). [14]



Figure 1.5.2: Maslow's Hierarchy of Needs; with physiological needs at the bottom, moving up to safety needs, social needs, self-esteem needs, and the top of the pyramid being self-actualization. These sections are divided on the left side of the triangle into deficiency needs and growth needs, with all sections falling under deficiency needs and self-actualization under growth needs. These sections are divided on the right side of the triangle into basic, psychological, and self-fulfillment needs. For these groupings, safety and physiological needs fall under basic needs, social needs and self-esteem needs fall under psychological needs, and self-actualization falls under self-fulfillment needs. (CC BY-SA 4.0 via Wikimedia Commons)

Level 1: Physiological Needs

Physiological needs are the most basic and essential level in Maslow's Hierarchy of Needs, forming the foundation of human motivation. These needs are tied directly to the body's ability to survive, and when unmet, they take priority over all other concerns. People must satisfy these fundamental requirements before they can focus on higher-level needs like safety, belonging, or self-esteem.

Examples

- **Air:** Without oxygen, the brain and body cannot function. Access to clean, breathable air is a non-negotiable human requirement.
- **Water:** Hydration is crucial for regulating body temperature, transporting nutrients, and removing waste. A lack of clean water can lead to serious health consequences.
- **Food:** Proper nutrition provides energy and supports every bodily system. Inadequate food intake can lead to illness, fatigue, and cognitive decline.
- **Clothing:** Protecting the body from extreme weather conditions and maintaining basic hygiene are both essential for survival and dignity.
- **Shelter:** A safe, stable place to sleep and live protects against the elements and provides a sense of security.

Level 2: Safety Needs

After physiological needs are met, safety becomes the next priority in Maslow's Hierarchy of Needs. This level centers on a person's desire for stability, order, and protection from harm, both physically and emotionally. While survival is the most immediate concern, people cannot fully focus on personal growth or relationships if they do not feel safe and secure in their environment.

For students, safety needs are often a hidden but critical factor influencing success. Many students may be dealing with unstable housing, food insecurity, unsafe living conditions, or jobs that don't provide consistent income. Others may struggle with mental health challenges or lack access to affordable healthcare. If these needs are unmet, students may find it difficult to concentrate in class, complete assignments, or participate in campus life.

Examples

- **Personal and Family Safety:** This involves protection from violence, abuse, accidents, or dangerous environments. A stable living situation and safe neighborhoods contribute significantly to this sense of security.
- **Financial Security:** A reliable income, access to employment, and the ability to meet financial obligations (like rent, tuition, or healthcare costs) all help reduce stress and anxiety. Uncertainty about money can lead to chronic worry and distract from academic or personal goals.
- **Health and Well-Being:** Physical and mental health are vital to feeling safe. Access to medical care, insurance, clean environments, and mental health support are essential components of this level.

Level 3: Social Needs

Once physiological and safety needs are fulfilled, social needs emerge as a powerful motivator in Maslow's Hierarchy of Needs. At this level, individuals seek meaningful relationships, emotional connection, and a sense of belonging. These needs reflect the human desire to feel accepted, valued, and connected to others, whether through friendships, romantic relationships, family bonds, or community involvement.

For students, social needs play a critical role in both personal well-being and academic success. Many students may be balancing school with work or caregiving responsibilities, which can lead to feelings of isolation or disconnection. Others may be the first in their family to attend college or may come from diverse cultural backgrounds, making it harder to find peers who understand their experiences.

If social needs are unmet, students may struggle with loneliness, anxiety, or low motivation, which can negatively affect class attendance, participation, and persistence. Conversely, when students feel connected to classmates, instructors, clubs, or campus groups, they are more likely to be engaged, confident, and successful. Colleges can support social needs by fostering inclusive environments, offering mentorship programs, promoting student organizations, and creating safe spaces for authentic connection. Meeting this need helps students build a supportive network that encourages personal growth, emotional resilience, and a stronger sense of identity.

Examples

- **Friendship:** Having people to share experiences with, trust, and rely on emotionally.
- **Intimacy and Love:** Romantic and emotional relationships that foster closeness, affection, and validation.
- **Belonging to Groups:** Feeling accepted as part of a group—whether it's a family, social circle, class, team, or campus community.

Level 4: Self-Esteem

After fulfilling the need for love and belonging, individuals strive to meet their esteem needs—the fourth level in Maslow's Hierarchy of Needs. This level reflects the human desire for self-respect, recognition, and a sense of personal accomplishment. When people feel competent, valued, and capable, they are more likely to pursue challenges, take pride in their achievements, and maintain motivation.

Esteem falls into two categories:

- **Self-Esteem**: This includes confidence in one's abilities, independence, self-worth, and a sense of control over life.
- Esteem from Others: This involves feeling respected, acknowledged, and valued by peers, mentors, colleagues, and society.

For students, esteem needs are especially important, and often under pressure. Many students are navigating multiple roles (e.g., worker, parent, student) and may question their academic abilities or feel "less than" compared to peers in traditional four-year colleges. Some may have returned to school after setbacks or face cultural or language barriers that affect confidence. Helping students build self-esteem can dramatically improve their academic and personal success.

Examples

- Celebrating milestones, no matter how small (e.g., passing a test, completing a semester)
- Providing constructive feedback that focuses on growth rather than just performance
- Encouraging leadership opportunities, campus involvement, and peer mentorship
- Creating inclusive environments where every student's background and contributions are valued

Meeting esteem needs helps students develop a stronger belief in themselves and their goals—paving the way for the final level in Maslow's hierarchy: self-actualization.

Level 5: Self-Actualization

At the top of Maslow's Hierarchy of Needs is At the top of Maslow's Hierarchy of Needs is **self-actualization**—the realization of one's full potential and the desire to become the best version of oneself. Once all the foundational needs (physiological, safety, social, and esteem) are met, individuals are free to focus on personal growth, purpose, and self-fulfillment. This level is highly individual and varies greatly from person to person, depending on their values, goals, and passions—the realization of one's full potential and the desire to become the best version of oneself. Once all the foundational needs (physiological, safety, social, and esteem) are met, individuals are free to focus on personal growth, purpose, and self-fulfillment. This level is highly individual and varies greatly from person to person, depending on their values, goals, and passions.

Self-actualization is not about perfection, but about progress and personal fulfillment. It is often described as a lifelong journey rather than a final destination. In essence, self-actualization represents the highest form of motivation—one driven not by necessity, but by purpose, passion, and the belief that one's life has meaning.

Examples

- Discovering passions and strengths through new opportunities and experiences
- Defining personal success—not just by grades or degrees, but by personal growth and the ability to give back
- Building confidence that they can shape their future, overcome challenges, and contribute meaningfully to the world

Maslow's Hierarchy: An Example

A clear example of Maslow's Hierarchy exists in the blockbuster movie, *Cast Away*, starring Tom Hanks. In *Cast Away*, Tom Hanks portrays Chuck Noland, a FedEx systems analyst who becomes stranded on a deserted island after a plane crash. The film powerfully illustrates Maslow's Hierarchy of Needs as Chuck is forced to rebuild his life from the ground up, moving through each level of the hierarchy in raw, survival-based conditions.



Figure 1.5.3: A call for help on Pikelot Beach. (Public Domain; US Coast Guard via Wikimedia Commons)

Physiological Needs

Immediately after the crash, Chuck's first concern is survival—finding clean water, food, and shelter. He learns to catch fish, harvest coconuts, and make fire, highlighting the primal focus on basic needs. Without meeting these, nothing else matters.

Safety Needs

Once his immediate survival is secured, Chuck begins creating a more stable living environment. He builds a shelter to protect himself from the elements, starts a fire for warmth, and creates tools. He also navigates the island's dangers and works to avoid injury or illness, illustrating the deep human need for security and stability.

Love and Belonging Needs

As isolation sets in, Chuck struggles emotionally. He creates "Wilson," a volleyball with a face drawn in blood, to serve as a companion. This relationship, though imaginary, reflects his desperate need for connection, companionship, and emotional intimacy—key elements of this level in Maslow's model.

Esteem Needs

Over time, Chuck becomes more confident in his ability to survive. He takes pride in his self-reliance, creativity, and resilience—mastering fire-building, navigation, and resourcefulness. These achievements feed his self-esteem, reinforcing a sense of competence and control.

Self-Actualization

Chuck's eventual escape from the island and return to society represent more than survival—they reflect his personal growth and transformation. He's not the same man who boarded the plane. His journey has reshaped his identity, values, and purpose. Though he loses much (including his former life and fiancée), he gains clarity about what truly matters, reflecting the pursuit of self-actualization—living authentically and finding meaning beyond material success.

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 on bringing positivity into your life? What do Denmark, Iceland, Switzerland, Finland, and the 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 reduces the chance of all-cause mortality (Steptoe, 2019). [33] The science of happiness is just one area of what is called **positive psychology**. 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 person's optimal functioning and helps them to flourish (Ackerman, 2022). [1]

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 (Hansenne, 2021). [12] To increase happiness in your life, focus on bringing positivity into your life, which will lead to happiness. Just focusing on wanting to be happy will likely harm your well-being.

More to Explore

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 the Netherlands are routinely shown to be the happiest countries in the world.

Focus on Your Mental Health

Maintaining positive mental health is essential for overall well-being and quality of life. It involves more than just avoiding mental illness—it requires active effort to support emotional, psychological, and social health. The following strategies provide practical ways to strengthen mental health, build resilience, and foster a greater sense of balance and fulfillment in daily life.

Getting help if needed

Seeking help from a licensed therapist, counselor, or mental health professional can provide valuable support and guidance when dealing with emotional challenges, mental illness, or overwhelming stress. Professional help offers a safe space to explore thoughts and feelings, learn coping strategies, and receive treatment tailored to individual needs.

Connecting with others

Strong social connections are essential for emotional support and resilience. Building and maintaining relationships with family, friends, or community members helps reduce feelings of loneliness and isolation, fosters a sense of belonging, and improves overall well-being.

Staying positive

Maintaining a positive mindset doesn't mean ignoring life's difficulties, but rather focusing on what you can control, practicing optimism, and looking for growth opportunities even in hard times. Positive thinking can help reduce stress, increase motivation, and improve overall outlook on life.

Getting physically active

Regular physical activity has been shown to boost mood, reduce symptoms of depression and anxiety, and improve sleep and energy levels. Exercise releases endorphins—natural chemicals in the brain that promote feelings of happiness and relaxation.

Helping others

Acts of kindness, volunteering, or simply being there for someone in need can improve your own sense of purpose and

satisfaction. Helping others creates a positive feedback loop that enhances self-worth and strengthens social bonds.

Getting enough sleep

Sleep is essential for mental and physical health. Poor sleep affects mood, concentration, and decision-making, and can worsen mental health issues. Aiming for 7–9 hours of quality sleep per night supports emotional regulation and cognitive functioning.

Developing coping skills

Learning and using healthy ways to manage stress, frustration, and adversity—such as deep breathing, journaling, time management, or seeking social support—can protect mental health and build emotional resilience.

Developing a sense of meaning and purpose in life

Having goals, values, and a sense of direction helps give life purpose and motivation. Whether through career, spirituality, relationships, or personal passions, feeling that life has meaning contributes to long-term well-being and satisfaction.

Relaxation techniques

Practices like meditation, progressive muscle relaxation, and deep breathing can reduce stress, lower blood pressure, and promote a sense of calm. These techniques train the mind to focus and let go of negative or racing thoughts.

Practicing mindfulness

Mindfulness involves paying full attention to the present moment without judgment. It helps individuals become more aware of their thoughts, feelings, and surroundings, reducing stress and promoting emotional balance.

Practicing gratitude

Regularly reflecting on and appreciating the positive aspects of life—whether big or small—can shift focus away from negative thinking. Keeping a gratitude journal or simply acknowledging what you're thankful for each day can enhance mood and overall mental health.

Challenges to our Mental Health

While striving for positive mental health and personal growth is important, it's equally crucial to recognize that challenges and setbacks are a natural part of life. Mental health can be influenced by a variety of internal and external factors, many of which are beyond an individual's control. Understanding these contributing factors—such as genetics, life experiences, chronic illness, substance use, and social isolation—can help us better identify potential risks, reduce stigma, and promote early intervention. The following section explores common causes of mental health challenges and emphasizes the importance of awareness and support in maintaining emotional well-being.

Biological Factors

Mental health can be influenced by genetic predispositions and chemical imbalances in the brain. Just as physical traits like eye color or height can be inherited, so too can a vulnerability to mental health conditions such as depression, anxiety, or bipolar disorder. Additionally, disruptions in neurotransmitter activity—chemicals in the brain that regulate mood and behavior—can play a significant role in the development of mental illnesses.

Life Experiences

Traumatic experiences, especially those occurring in childhood, can have long-lasting effects on mental health. Abuse—whether emotional, physical, or sexual—as well as neglect, violence, or the loss of a loved one, can disrupt a person's sense of safety and

self-worth. These events may lead to conditions such as post-traumatic stress disorder (PTSD), depression, or anxiety, and can impact a person's ability to trust others or regulate emotions.

Family History

Having a family member with a mental health condition can increase the likelihood of developing one as well. This may be due to genetic factors, shared environmental influences, or learned behaviors. While a family history does not guarantee the onset of mental illness, it may increase risk and highlight the importance of early support and intervention.

Experiences From Ongoing Medical Conditions

Living with chronic illnesses can affect mental health by creating ongoing physical discomfort, lifestyle limitations, or emotional strain. Conditions like cancer, diabetes, or autoimmune disorders often come with stress, fear, and uncertainty, which can contribute to feelings of helplessness, frustration, or depression. Additionally, the side effects of treatment or the burden of managing a long-term illness can take a significant toll on emotional well-being.

Alcohol or Drug Use

Substance use can alter brain chemistry, impair judgment, and increase the risk of developing mental health conditions. While some people turn to alcohol or drugs to cope with stress or emotional pain, these substances often worsen underlying issues and can lead to addiction. Substance use can also exacerbate symptoms of mental illness or interfere with the effectiveness of treatment.

Loneliness or Isolation

Human beings are social creatures, and meaningful connection is vital for emotional health. Prolonged loneliness or social isolation can lead to sadness, low self-esteem, and even clinical depression. It can also impact cognitive functioning and increase the risk of anxiety. People who feel disconnected from others may struggle to find purpose, making it harder to cope with everyday challenges.

These contributing factors highlight the complexity of mental health and the importance of a supportive, informed approach to prevention and care. Recognizing these influences can help individuals seek the help they need and foster compassion and understanding in others.

Key Points

- Mental health is vital to overall well-being, impacting thoughts, emotions, relationships, and daily functioning.
- Positive mental health builds resilience, helping individuals cope with stress, maintain relationships, and reach their full potential.
- Maslow's Hierarchy highlights essential needs, showing that basic physical, emotional, and social needs must be met for personal growth.
- Positive psychology promotes well-being, focusing on strengths like gratitude, purpose, and optimism to support mental health.
- Mental health can be challenged by various factors, including genetics, trauma, chronic illness, substance use, and social isolation.

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1.6: Mental Health Disorder and Treatment



Figure 1.6.1: Mental health issues include grief, anxiety, phobia, post-traumatic stress, stress, shame, depression, and panic. (Mental Health on the Brain; The People Speak!, CC BY-NC 2.0 via Flickr)

Introduction

Mental health is a fundamental component of overall well-being, shaping how individuals think, feel, and act in their daily lives. It influences our ability to manage stress, build relationships, make decisions, and fulfill responsibilities. Despite its importance, mental illness is incredibly common, affecting millions of people each year across all age groups and backgrounds. This chapter explores the nature and prevalence of mental health disorders, including mood, anxiety, psychotic, and eating disorders, while highlighting the warning signs that may indicate someone is struggling. It also examines both healthy and unhealthy coping strategies, the role of defense mechanisms, and the wide range of treatment options available, from psychotherapy to medication. Through increased awareness, education, and support, we can reduce stigma, promote early intervention, and foster a more compassionate approach to mental health for ourselves and others.

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 not just affect 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 2020, there were an estimated 52.9 million adults aged 18 or older in the United States with AMI. This number represented 21.0% of all U.S. adults. The prevalence of AMI was higher among females (25.8%) than among 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 those 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%) (NIMH, n.d.). [22]

Warning Signs of Mental Illness

Not sure if you or someone you know is living with mental health problems? Recognizing the signs of mental health issues is important for early intervention and support. While symptoms can vary from person to person, there are common indicators that someone may be struggling.

Persistent feelings of sadness, irritability, or emotional overwhelm are often early warning signs. Individuals may begin withdrawing from social interactions and losing interest in activities they once enjoyed. Changes in eating and sleeping habits, such as overeating, loss of appetite, insomnia, or excessive sleeping, can also signal emotional distress. Fatigue, low energy, and a lack of motivation to complete everyday tasks are additional red flags. Cognitive difficulties, like trouble concentrating, making decisions, or remembering information, may arise as well. Feelings of hopelessness, worthlessness, or a lack of purpose can be deeply concerning, especially when combined with increased use of substances like alcohol or drugs as a coping mechanism. In some cases, people may report unexplained physical symptoms, such as headaches or stomachaches, which are often linked to underlying mental health conditions. Sudden and extreme mood changes or expressions of self-harm and suicidal thoughts should always be taken seriously and addressed immediately. Being aware of these signs can help foster understanding and encourage individuals to seek the help they need.

Warning Signs of Mental Illness

Not sure if you or someone you know is living with mental health problems? Recognizing early warning signs can help individuals seek support or professional help before problems get worse. Common indicators include:

- Changes in eating or sleeping patterns (too much or too little)
- Withdrawal from friends, family, or usual activities
- Low or no energy; persistent fatigue
- Feelings of numbness or lack of purpose
- Unexplained physical pain, such as headaches or muscle aches
- Feelings of helplessness or hopelessness
- Increased use of alcohol, tobacco, or drugs
- Frequent confusion, irritability, or excessive worry
- Conflict with family or friends
- Extreme mood swings that disrupt relationships
- Intrusive thoughts or memories that are difficult to control
- Hallucinations or delusional beliefs
- Thoughts of self-harm or harm to others
- Difficulty performing daily responsibilities, such as attending work, school, or caring for family

Coping Mechanisms and Defense Mechanisms

When confronted with something challenging to our mental health or stress, many people respond with **coping mechanisms**

(Algorani & Gupta, 2021) [2] or **defense mechanisms** (Bailey & Pico, 2021). [4] 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.

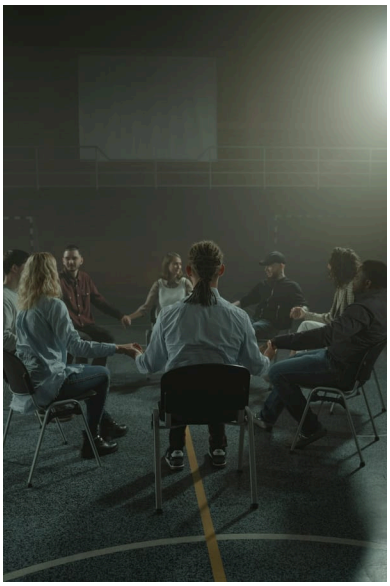


Figure 1.6.2: Engaging in group therapy can be a useful coping mechanism. (Group Therapy; Tima Miroshnichenko via Pexels)

As described in Table1.6.1, 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 employ maladaptive coping mechanisms, which could lead to poor mental health, such as using drugs or alcohol to avoid a problem.

Table 1.6.1 *Coping Mechanisms*

Coping Mechanism Category	Example
Problem-Focused	Active coping, problem-solving, planning, restraint coping, and suppression of competing activities.
Emotion-Focused	Positive re-framing, acceptance, and humor
Meaning-Focused	Focus on beliefs and values to support well-being
Social-Focused	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



Figure 1.6.3: Physical activity such as trail running is an excellent coping skill. (Trail Runner; Brian Metzler via Unsplash)

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.



Figure 1.6.4: Children engage in coping and defense mechanisms when they grow attached to their parents. (Little Feet; Daiga Ellaby via Unsplash)

Defense mechanisms include avoidance, repression, regression, displacement, sublimation, reaction formation, projections, and rationalization, as shown in the following table with examples and descriptions of each mechanism.

Table 1.6.2 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 excuses to avoid attending social gatherings.
Repression	Unknowingly placing an unpleasant memory or thought in the conscious mind	Not remembering a traumatic event such as being sexually abused as a child
Regression	Reverting 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 or another sport with contact.
Reaction Formation	Overacting oppositely to one's true feelings	Someone who feels strong resentment toward a coworker acts overly friendly and complimentary toward them instead.
Projection	Attributing one's own unacceptable feelings and thoughts to others and not yourself	Accusing your boyfriend or girlfriend of cheating on you because you have thoughts about cheating on them.
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.

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

Mood disorders primarily affect a person's emotional state and can lead to prolonged periods of extreme sadness, happiness, or fluctuations between the two.

- **Depression**: Characterized by persistent feelings of sadness, hopelessness, and a lack of interest in daily activities. It can also involve changes in appetite, sleep disturbances, fatigue, and difficulty concentrating. In severe cases, it may lead to suicidal thoughts or behaviors.
- **Bipolar Disorders**: Involves shifts between depressive episodes and manic or hypomanic episodes. Manic episodes may include elevated mood, increased energy, impulsive behavior, and decreased need for sleep, while depressive episodes resemble symptoms of major depression.
- **Seasonal Affective Disorder (SAD)**: A type of depression that follows a seasonal pattern, usually occurring in the fall and winter months when there is less sunlight. Symptoms often improve with the return of spring and can include low energy, irritability, and social withdrawal.

Anxiety Disorders

Anxiety disorders involve excessive fear, worry, or nervousness that interferes with daily functioning.

- **General Anxiety Disorder (GAD)**: Involves persistent and excessive worry about various aspects of life, such as health, work, or social interactions. Individuals often experience restlessness, fatigue, difficulty concentrating, and muscle tension.
- **Specific Phobias and Agoraphobia**: Specific phobias are intense, irrational fears of particular objects or situations (e.g., heights, spiders). Agoraphobia is the fear of situations where escape may be difficult, such as crowded places or open spaces, often leading to avoidance behavior.
- **Post-Traumatic Stress Disorder (PTSD)**: Can develop after experiencing or witnessing a traumatic event. Symptoms include flashbacks, nightmares, severe anxiety, and emotional numbness.
- **Panic Disorder**: Characterized by sudden, repeated panic attacks—intense episodes of fear that may include chest pain, heart palpitations, dizziness, and a fear of losing control or dying.
- **Social Anxiety Disorder**: Involves intense fear of social or performance situations where one might be judged, embarrassed, or rejected. This can lead to avoidance of social interactions and impair daily life.

Psychotic Disorders

A psychotic disorder involves distorted thinking and perception, including hallucinations and delusions.

- **Schizophrenia**: A chronic and severe mental health condition that affects how a person thinks, feels, and behaves. Symptoms may include hallucinations (seeing or hearing things that aren't there), delusions (false beliefs), disorganized speech or behavior, and impaired cognitive ability. It often requires long-term treatment and support.

Eating Disorders

Eating disorders involve unhealthy relationships with food and body image, often leading to serious physical and psychological harm.

- **Anorexia Nervosa**: Marked by an intense fear of gaining weight and a distorted body image, leading to severe restriction of food intake and extreme weight loss. Individuals may also engage in excessive exercise or other behaviors to lose weight.
- **Bulimia Nervosa**: Involves cycles of binge eating followed by purging behaviors such as vomiting, use of laxatives, or excessive exercise. People with bulimia often feel out of control during binges and experience shame or guilt afterward.
- **Binge Eating Disorder**: Characterized by regularly eating large quantities of food in a short period, often accompanied by feelings of distress or lack of control. Unlike bulimia, binge eating is not followed by purging, which can lead to obesity and other health complications.

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.



Figure 1.6.5: Clinical depression is more than just having a bad day. (Covering Face; Danie Franco via Unsplash)

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

- 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 self-harm

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 mild depression. The severity and frequency of symptoms and how long they last will vary depending on the individual and their particular illness. Symptoms may also vary depending on the stage of the illness (NIMH, n.d.). [19]

Bipolar Disorder

Bipolar disorder is a mood disorder characterized by intense mood swings. Sometimes a person may feel extremely “up,” elated, irritable, or energized. This is called a manic episode. Other times, a person may feel “down,” sad, indifferent, or hopeless. This is called a depressive episode. They may have both manic and depressive symptoms together. This is called a mixed episode. Bipolar disorder is a lifelong condition, but it can be managed with a combination of medication, therapy, lifestyle changes, and support. Early diagnosis and consistent treatment are crucial for improving the quality of life and reducing the risk of severe mood swings.

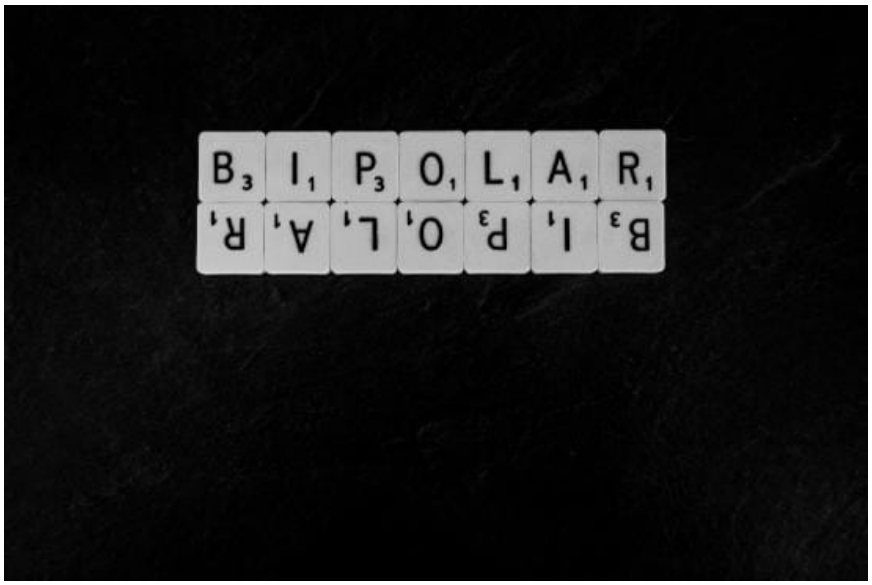


Figure 1.6.6: People with bipolar disorder swing between feeling "up" and "down". (Bipolar; Nick Fewings via Unsplash)

Symptoms of Bipolar

The primary symptoms involve episodes of mania and depression, which can vary in intensity and duration. During a manic episode, individuals may experience elevated or irritable mood, increased energy, racing thoughts, decreased need for sleep, impulsive behavior, and inflated self-esteem. They might talk excessively, engage in risky activities (like reckless spending or unsafe sex), or feel overly optimistic and invincible. In more severe cases, mania can lead to psychosis, including delusions or hallucinations. On the other end of the spectrum, depressive episodes involve prolonged periods of sadness, hopelessness, or a loss of interest in activities once enjoyed. Individuals may experience fatigue, changes in appetite or sleep patterns, difficulty concentrating, and feelings of worthlessness or guilt. In severe cases, thoughts of death or suicide can occur. These mood swings can significantly impact a person's daily life, relationships, and ability to function. The timing and frequency of episodes can differ from person to person, and some may also experience mixed episodes, where symptoms of mania and depression occur simultaneously.

Manic Episode

- During a manic episode, an individual may feel extremely elevated, energetic, or unusually irritable. Symptoms typically last for at least one week and may be severe enough to interfere with work, relationships, or even require hospitalization.
- Elevated mood: Feeling excessively happy, euphoric, or "on top of the world."
- Increased energy and activity: Engaging in multiple tasks at once or being overly active without feeling tired.
- Decreased need for sleep: Feeling rested after only a few hours of sleep or staying awake for long periods.
- Racing thoughts: Jumping quickly from one idea to another, making it difficult to follow conversations.
- Pressured speech: Talking rapidly and incessantly, often difficult to interrupt.
- Impulsivity or poor judgment: Engaging in risky behaviors such as excessive spending, reckless driving, unprotected sex, or substance use.
- Grandiosity: Inflated self-esteem or unrealistic beliefs in one's abilities or importance (e.g., believing they have special powers).
- Distractibility: Inability to concentrate or stay focused due to constant shifts in attention.

Hypomanic Episode

Hypomania includes similar symptoms to mania but is less severe and does not typically cause major disruptions in daily life. The individual may seem energetic, overly confident, or more productive than usual, but without the extreme impairment seen in full mania.

Depressive Episode

- A depressive episode in bipolar disorder mirrors the symptoms of major depression and lasts for at least two weeks. It represents a significant drop in mood and energy, often affecting a person's ability to function.
- Persistent sadness or emptiness: Feeling hopeless, worthless, or deeply discouraged.
- Loss of interest: No longer enjoying activities once found pleasurable, including hobbies, socializing, or sex.
- Fatigue or lack of energy: Feeling physically drained, sluggish, or unable to complete simple tasks.
- Changes in appetite or weight: Significant weight loss or gain not related to dieting.
- Sleep disturbances: Insomnia or excessive sleeping (hypersomnia).
- Difficulty concentrating: Trouble thinking clearly, making decisions, or remembering things.
- Feelings of guilt or worthlessness: Self-blame or harsh self-criticism, even over minor issues.
- Thoughts of death or suicide: Suicidal ideation or attempts may occur in severe cases (NIMH, 2025). [29]

Seasonal Affective Disorder (SAD)

Seasonal affective disorder is a type of depression that occurs at a specific time of year, most commonly during the fall and winter months when daylight hours are shorter. It is believed to be linked to changes in natural light exposure, which can disrupt the body's internal clock (circadian rhythm), and affect levels of serotonin and melatonin—chemicals that influence mood and sleep.



Figure 1.6.7: Reduced exposure to sunlight may contribute to Seasonal Affective Disorder. (Woman Behind a Glass Window; Kelly Ritta via Pexels)

Symptoms of Seasonal Affective Disorder

SAD symptoms are similar to those of major depression but follow a seasonal pattern. They may include:

- Persistent sadness or depressed mood
- Loss of interest in activities once enjoyed
- Low energy or fatigue, even after adequate rest
- Oversleeping (hypersomnia)
- Increased appetite, particularly cravings for carbohydrates
- Weight gain
- Difficulty concentrating or making decisions
- Feelings of hopelessness or worthlessness
- Social withdrawal or increased isolation ("hibernating")

The exact cause of SAD isn't fully understood, but it is thought to involve:

- Reduced sunlight exposure, which can affect serotonin levels and the sleep-wake cycle
- Disruption of circadian rhythms, leading to mood changes
- Lower melatonin production affects sleep and mood regulation

People who live farther from the equator, where daylight hours vary more drastically between seasons, are at higher risk. A personal or family history of depression or SAD can also increase risk (NIMH, 2023). [27]

Generalized Anxiety Disorder

Generalized anxiety disorder (GAD) 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.



Figure 1.6.8: Generalized anxiety disorder goes beyond anxiety to include fatigue and other symptoms. (Anxiety; Suzy Hazelwood via Pexels)

Symptoms of General Anxiety Disorder

- 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 (NIMH, n.d.). [18]

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 a feeling of impending doom. 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.



Figure 1.6.9: Panic disorder can have negative effects across a person's life. (Woman Sitting on the Floor; Pavel Danilyuk via Pexels)

Symptoms of Panic Disorder

- Heart palpitations, a pounding heartbeat, or an accelerated heart rate
- Sweating
- Trembling or shaking
- Sensations of shortness of breath, smothering, or choking
- Feelings of impending doom
- Feelings of being out of control (NIMH, 2022) [23]

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 agoraphobic, or suffers from **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.

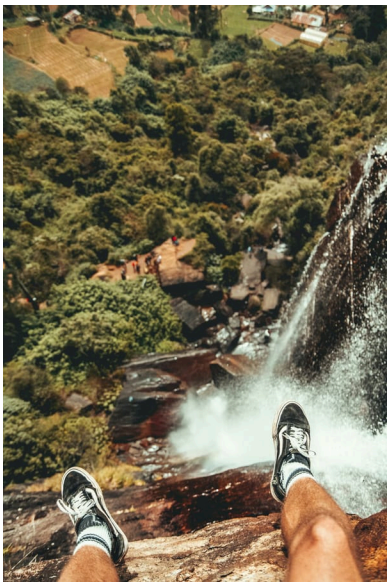


Figure 1.6.10: Someone with acrophobia would be very uncomfortable at this height. (Acrophobia; Eddy Billard via Unsplash)



Figure 1.6.11: Arachnophobia is an intense fear of spiders. (Arachnophobia; Julian Schultz via Unsplash)



Figure 1.6.12: A person who is agoraphobic may have difficulty leaving their homes. (Agoraphobia; cottonbro studio via Pexels)

Symptoms of Specific Phobias

- 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 (NIMH, n.d.). [21]

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.



Figure 1.6.13: Being extremely camera shy may be a symptom of social anxiety disorder. (Hand; Deeana Arts via Pexels)

Symptoms of Social Anxiety Disorder

- 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 (NIMH, 2022). [25]

Post-Traumatic Stress Disorder (PTSD)

Post-traumatic stress disorder is an anxiety disorder that develops in some people who have experienced a shocking, scary, or dangerous event. The “fight or flight” reaction is a natural process meant to keep a person from harm when in traumatic experiences. 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.



Figure 1.6.14: People who have experienced traumatic events, such as military veterans, may develop post-traumatic stress disorder (PTSD). (Soldiers; Art Guzman via Pexels)

Symptoms of Post-Traumatic Stress Disorder

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 (NIMH, 2023) [26]

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).



Figure 1.6.15: This haunting image attempts to depict the distress experienced by someone who has schizophrenia. (Schizophrenia; Camila Quintero Franco via Unsplash)

Symptoms of Schizophrenia

- 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 (NIMH, 2022) [24]

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 the risk of suicide. Most people, could be at least 90%, who have died by suicide have suffered from mental disorders (Brådvik, 2018). [6] 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.



Figure 1.6.16: You can save a life by knowing suicide warning signs and how to get help. (Pair of Hands; Akhil Nath via Unsplash)

Warning Signs & Risk Factors

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 good bye 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 (NIMH, 2024) [28]

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:**
    1. Call the toll-free SAMHSA 988 Suicide and Crisis Lifeline, 24 hours a day, 7 days a week. The service is available to everyone.
    2. You can also connect 24/7 to a crisis counselor by texting the Crisis Text Line. Text HOME to 741741.
    3. The deaf and hard of hearing can contact the Lifeline via TTY at 1-800-799-4889.
    4. 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 that the number of suicide deaths goes down when someone follows up with the at-risk person.

Mental Health: Risks, Causes, and Treatments

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

- **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 changes, 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 because 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, psychotherapists, psychiatrists, social workers, or family members (Mayo Clinic, n.d.). [15]

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 their needs. A typical "side effect" of psychotherapy is temporary discomfort involved with thinking about confronting feared situations.

Cognitive Behavioral Therapy (CBT)

Cognitive Behavioral Therapy (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 are 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

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 a 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 (NIMH, n.d.). [20]

Key Points

- Mental illness is common, affecting over 50% of Americans in their lifetime, with 1 in 5 adults and children experiencing it annually.
- Mental health disorders are categorized into mood, anxiety, psychotic, and eating disorders, each affecting thoughts, emotions, and behaviors differently.
- Depression, bipolar disorder, and seasonal affective disorder are mood disorders that significantly impact energy, motivation, and daily function.
- Anxiety disorders—including GAD, PTSD, panic disorder, and phobias—are marked by excessive fear, worry, and physical symptoms like restlessness or heart palpitations.
- Psychotic disorders like schizophrenia involve hallucinations, delusions, and impaired thinking, often requiring long-term support and treatment.
- Eating disorders, such as anorexia, bulimia, and binge eating disorder, involve unhealthy eating behaviors and serious emotional distress.

- Warning signs of mental health issues include withdrawal, changes in sleep or appetite, fatigue, hopelessness, and thoughts of self-harm or suicide.
- Coping and defense mechanisms help manage stress—healthy strategies include exercise, meditation, and social support, while unhealthy ones include substance use and avoidance.
- Treatment options include psychotherapy (especially CBT), medications, stress management, and strong social support systems.
- Suicide is preventable—recognizing warning signs, providing support, and connecting individuals to professional help can save lives.

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1.7: Comprehension Check

Summary

Wellness encompasses more than just physical health—it includes ten interconnected dimensions: physical, emotional, intellectual, spiritual, social, occupational, financial, environmental, cultural, and digital. Achieving holistic wellness requires adopting healthy behaviors, setting SMART goals, and understanding the stages of behavior change through models like the Transtheoretical Model.

Mental health is equally vital, influencing thoughts, emotions, and actions, and is impacted by biological, psychological, and social factors. Common mental health issues include mood and anxiety disorders, psychotic conditions like schizophrenia, and eating disorders.

Recognizing early warning signs and fostering self-efficacy can support long-term lifestyle change and well-being. Strategies such as positive coping mechanisms, support networks, and professional treatment, like psychotherapy and medication, are key to maintaining mental wellness. Ultimately, focusing on purpose, positivity, and proactive self-care helps individuals reach their full potential.

Test Your Understanding

1. What are the ten dimensions of wellness, and why is it important to address all of them rather than just physical health?
2. Describe the Transtheoretical Model of Behavior Change and explain what occurs during the “Preparation” and “Maintenance” stages.
3. Provide an example of a SMART physical activity goal and explain how it meets all five criteria (Specific, Measurable, Achievable, Results-focused, Time-bound).
4. What are three common warning signs of mental illness, and why is it important to recognize them early?
5. According to Maslow’s Hierarchy of Needs, why must physiological and safety needs be met before an individual can reach self-actualization?

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Chapter 1 Glossary

- **Acrophobia**: An intense fear of heights that triggers anxiety or panic in high places, often treated with therapy or relaxation techniques.
- **Agoraphobia**: An anxiety disorder characterized by an intense fear of situations where escape may be difficult or help unavailable, often leading to avoidance of crowded places, public transportation, or open spaces.
- **Arachnophobia**: An intense fear of spiders and other arachnids, causing significant anxiety or avoidance behavior when encountering them.
- **Avoidance**: A defense mechanism where individuals unconsciously evade situations, thoughts, or emotions that cause anxiety or distress, providing temporary relief but often hindering long-term resolution.
- **Biological Sex**: The physical and genetic characteristics a person is assigned at birth, typically categorized as male or female.
- **Bipolar Disorder**: A mental health condition characterized by extreme mood swings that include emotional highs (mania or hypomania) and lows (depression), often affecting energy, activity levels, and daily functioning.
- **Cognitive Behavioral Therapy (CBT)**: A structured, short-term form of psychotherapy that focuses on identifying and changing negative thought patterns and behaviors to improve emotional regulation and develop healthier coping strategies.
- **Cognitive Drift**: The gradual decline in focus, motivation, or commitment to a goal or behavior over time, often leading individuals to revert to old habits or lose sight of their original intentions.
- **Consciousness Raising**: The process of increasing awareness and understanding of a behavior or issue to help individuals recognize its impact and motivate change.
- **Coping Mechanisms**: Strategies or behaviors individuals use to manage stress, emotions, or challenging situations, which can be healthy (e.g., problem-solving, relaxation techniques) or unhealthy (e.g., avoidance, substance use).
- **Counter Conditioning**: The process of replacing unhealthy behaviors or thoughts with healthier alternatives. It involves choosing positive responses to triggers or situations that previously led to negative habits.
- **Cultural Wellness**: The ability to respect, understand, and engage with different cultural values, beliefs, and traditions, fostering inclusivity, mutual respect, and a sense of belonging in diverse environments.
- **Defense Mechanisms**: A subconscious psychological strategy used by individuals to protect themselves from anxiety, stress, or uncomfortable emotions, often by distorting or avoiding reality.
- **Denial**: A psychological defense mechanism in which a person refuses to acknowledge or accept the reality of a situation, problem, or feeling, often to avoid discomfort, anxiety, or emotional pain.
- **Depression**: A mental health disorder characterized by persistent feelings of sadness, hopelessness, and loss of interest or pleasure in activities, often accompanied by physical symptoms such as fatigue, changes in appetite, and difficulty concentrating.
- **Digital Wellness**: Maintaining a healthy relationship with technology and digital media. It involves using devices, apps, and online platforms in a way that supports your mental, physical, and emotional well-being—rather than disrupting it.
- **Displacement**: A defense mechanism where emotions, like anger, are unconsciously redirected from their original source to a safer, less threatening target.
- **Dramatic Relief**: The process of experiencing and expressing strong emotions—like fear, sadness, or hope—in response to learning about a behavior's impact.
- **Dysfunctional Attitudes**: Negative, rigid, and often unrealistic thought patterns that can distort perception, hinder emotional well-being, and interfere with healthy behavior and decision-making.
- **Emotional Wellness**: The ability to understand, manage, and express emotions effectively, while maintaining resilience, coping with challenges, and fostering positive relationships.
- **Environmental Wellness**: Maintaining a healthy and sustainable relationship with the natural and built environment, including taking actions to protect and preserve the planet while creating safe, supportive, and clean surroundings.
- **Environmental Reevaluation**: The process of recognizing how one's behavior affects others and the environment. It involves understanding the social and environmental consequences of actions, which can motivate change out of concern for others or the greater good.
- **Faulty Conceptualization**: The inaccurate or mistaken interpretation of a situation, symptom, or problem, often leading individuals to downplay or misattribute serious issues—such as viewing early signs of illness as harmless—thereby delaying appropriate action or change.
- **Financial Wellness**: The ability to effectively manage your financial resources, meet current and future financial obligations, and feel secure and confident about your financial stability.
- **Gender Identity**: A person's deeply held internal sense of their own gender, which may be male, female, a blend of both, neither, or something else entirely. It is how individuals perceive themselves and what they call themselves, which may or

may not align with the sex assigned to them at birth.

- **Generalized Anxiety Disorder (GAD)**: A mental health condition characterized by excessive, persistent worry and fear about various aspects of daily life, often accompanied by symptoms like restlessness, fatigue, difficulty concentrating, irritability, muscle tension, and sleep disturbances.
- **Helping Relationships**: Supportive connections with others that encourage and assist in behavior change. These relationships provide emotional support, accountability, and motivation, often through friends, family, mentors, or support groups.
- **Intellectual Wellness**: Actively engaging in lifelong learning, critical thinking, creativity, and the pursuit of knowledge to expand skills, challenge the mind, and foster personal growth.
- **Maslow's Hierarchy of Needs**: A five-tier model of human needs, ranging from basic survival (physiological and safety) to social, esteem, and self-actualization.
- **Medication**: Prescribed drugs used to manage symptoms of mental health conditions, such as depression, anxiety, bipolar disorder, or schizophrenia, by balancing brain chemistry and improving emotional and cognitive functioning.
- **Mental Health**: A person's emotional, psychological, and social well-being, influencing how they think, feel, behave, handle stress, relate to others, and make decisions.
- **Mental Illness**: A wide range of mental health conditions that affect a person's thinking, mood, behavior, or overall functioning, often causing significant distress or impairment in daily life.
- **Motivational Drift**: The gradual loss of motivation or drive to maintain a behavior or goal, often occurring when initial excitement fades, progress plateaus, or the behavior becomes routine without ongoing reinforcement.
- **Occupational Wellness**: Finding personal satisfaction and fulfillment in work, balancing responsibilities, and aligning career goals with values, while maintaining a healthy work-life balance.
- **Panic Disorder**: A mental health condition characterized by recurring, unexpected panic attacks—intense episodes of fear or discomfort—often accompanied by physical symptoms such as rapid heartbeat, sweating, shortness of breath, and a fear of losing control or impending doom.
- **Physical Wellness**: Maintaining a healthy body through regular exercise, proper nutrition, adequate sleep, and proactive management of health to enhance overall physical functioning and quality of life.
- **Positive Psychology**: The scientific study of strengths, virtues, and factors that enable individuals and communities to thrive, focusing on enhancing well-being, happiness, and fulfillment rather than solely addressing problems or disorders.
- **Post-Traumatic Stress Disorder (PTSD)**: A mental health condition triggered by experiencing or witnessing a traumatic event, characterized by symptoms such as intrusive memories, flashbacks, avoidance of reminders, negative changes in mood or cognition, and heightened arousal or reactivity.
- **Projection**: A defense mechanism where individuals attribute their own unacceptable thoughts, feelings, or traits to others.
- **Psychotherapy**: A therapeutic process in which a trained mental health professional uses evidence-based techniques to help individuals explore thoughts, feelings, and behaviors, address mental health concerns, and develop healthier coping strategies.
- **Rationalization**: A defense mechanism where individuals justify unacceptable behaviors or feelings with logical or socially acceptable explanations to avoid guilt or discomfort.
- **Reaction Formation**: A defense mechanism where individuals unconsciously act in a way opposite to their true feelings to hide or suppress unacceptable emotions or desires.
- **Regression**: A defense mechanism where individuals revert to earlier developmental behaviors to cope with stress or anxiety.
- **Reinforcement Management**: Using rewards to encourage healthy behaviors and reducing the rewards or benefits of unhealthy behaviors. It helps strengthen positive habits through motivation and accountability.
- **Repression**: A defense mechanism where distressing thoughts or memories are unconsciously pushed out of awareness to reduce anxiety.
- **Schizophrenia**: A chronic mental health disorder characterized by disruptions in thought processes, perceptions, emotional responsiveness, and social functioning, often including symptoms such as hallucinations, delusions, disorganized thinking, and impaired cognitive abilities.
- **Seasonal Affective Disorder (SAD)**: A type of depression that occurs at a specific time of year, typically during fall and winter, when there is less natural sunlight, and is characterized by symptoms such as low energy, sadness, changes in sleep and appetite, and difficulty concentrating.
- **Self-actualization**: The process of realizing and fulfilling one's potential, talents, and abilities to achieve personal growth, purpose, and the highest level of self-fulfillment.
- **Self-efficacy**: An individual's belief in their ability to successfully perform tasks, achieve goals, and manage challenges in specific situations.
- **Self-esteem**: An individual's overall sense of self-worth or personal value, encompassing confidence in one's abilities and respect for oneself.
- **Self-liberation**: The process of committing to behavior change based on the belief that change is possible. It involves making a firm decision to act, often supported by goal setting, self-belief, and personal accountability.

- **Self-Reevaluation**: The process of reflecting on how a behavior aligns with one's values, identity, and goals. It helps individuals see how changing a behavior supports the person they want to become, increasing motivation for change.
- **Sexually Transmitted Infections (STIs)**: Infections that are primarily spread through sexual contact, including vaginal, anal, or oral sex. They are caused by bacteria, viruses, or parasites and can affect anyone who is sexually active.
- **S.M.A.R.T. Goal**: A clearly defined objective that is Specific, Measurable, Achievable, Relevant, and Time-bound, designed to enhance focus and increase the likelihood of success.
- **Social Anxiety Disorder**: A mental health condition characterized by an intense fear of social or performance situations, where individuals worry about being judged, embarrassed, or humiliated, often leading to avoidance and significant distress.
- **Social Liberation**: The process of recognizing and using social or environmental supports that encourage healthy behavior change. It involves becoming aware of societal shifts, policies, or resources that make positive change easier and more accepted.
- **Social Wellness**: The ability to build and maintain healthy, supportive relationships, effectively communicate, and contribute to a connected and positive community.
- **Spiritual Wellness**: A sense of purpose, meaning, and connection to something greater than oneself, often involving values, beliefs, or practices that promote inner peace and harmony.
- **Stimulus Control**: The process of modifying your environment to support healthy behaviors and reduce triggers for unhealthy ones. It involves adding cues that promote positive habits and removing those that encourage negative ones.
- **Stress-Management**: The use of techniques and strategies to control, reduce, or cope with stress, enhancing overall well-being and resilience in challenging situations.
- **Sublimation**: A defense mechanism where unacceptable impulses are transformed into socially acceptable behaviors or activities.
- **Suicide**: The act of intentionally ending one's own life, often resulting from overwhelming emotional pain, mental health struggles, or a sense of hopelessness.
- **The Transtheoretical Model (TTM)**: Explains behavior change through six stages: pre-contemplation, contemplation, preparation, action, maintenance, and termination.
- **Wellness**: Wellness is a balanced approach to physical, mental, emotional, and social well-being, achieved through intentional choices like staying active, eating well, and managing stress.

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2: PRINCIPLES OF PHYSICAL FITNESS



Figure 2.1: Physical activity, such as kayaking, is crucial for good health. (Women Kayaker; Kalen Emsley via Unsplash)

Introduction

In various forms, exercise has been integral to human life for thousands of years, deeply rooted in our history and evolution. Early humans were naturally physically active as part of daily survival, hunting, gathering, and migrating. Over time, the physical movement became more structured and deliberate, with ancient civilizations such as the Greeks and Romans formalizing athletic competitions, like the Olympic Games, and developing training methods for soldiers and athletes. By the 20th century, exercise shifted focus from survival and combat to health, recreation, and fitness, influenced by societal changes and advances in science and medicine. Today, exercise is vital in promoting health, improving quality of life, and preventing diseases.

This chapter lays the groundwork for understanding the essential elements of exercise science, covering the origins and definitions of physical activity, the physiological principles of adaptation, and key safety measures for a successful fitness journey. It explores various types of exercises, training methods, and the science behind physical performance. While regular physical activity is crucial for improving bodily functions and preventing chronic diseases, rising inactivity rates, particularly in the U.S., are alarming. The chapter also highlights the core components of fitness, endurance, strength, and flexibility, and explains principles such as overload and specificity, while cautioning against the risks of overtraining and detraining.

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

2.1: The Value of Physical Activity – Past and Present

2.2: What Is Physical Activity and Exercise?

2.3: Principles of Adaptation of Stress

2.4: Creating a Successful Fitness Plan

2.5: Physical Activity Guidelines for Adults
2.6: Exercise Safety
2.7: Comprehension Check
2.8: Glossary
2.9: References

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2.1: The Value of Physical Activity – Past and Present



Figure 2.1.1: Men dressed for the traditional Native American sport of lacrosse. (Public Domain; George Caitlin via Wikimedia)

Introduction

Physical fitness is more than just a marker of health—it's a cornerstone of overall wellness and quality of life. Engaging in regular physical activity can elevate mood, sharpen mental focus, increase energy levels, support healthy body composition, and reduce the risk of chronic illnesses such as heart disease, type 2 diabetes, and some forms of cancer. These benefits extend beyond physical health, influencing emotional resilience, stress management, and even social well-being. This chapter explores the historical and cultural significance of physical activity, defines key fitness principles, and presents evidence-based recommendations for developing a safe and effective exercise plan tailored to individual lifestyles and goals.

The Original Health Hack: Moving Your Body

The idea that exercise is essential to health is not new. Long before treadmills and gym memberships became commonplace, physical activity was an integral part of daily survival. Our Paleolithic ancestors were naturally fit, not by choice, but by necessity. Their "workouts" involved chasing prey, foraging for food, building shelter, and migrating across rugged terrain. In that world, physical inactivity wasn't an option—it meant starvation or death.

As civilizations evolved and agriculture took root, the demands of daily life shifted. Technological advancements have made food more accessible and life less physically demanding. Still, some early thinkers recognized the importance of staying active. Around the 4th century BCE, Herodicus, a Greek physician, advocated for vigorous exercise as a form of medicine, launching what would later be known as “gymnastic medicine.” Hippocrates, his contemporary and the father of modern medicine, famously wrote, “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.”

Centuries later, the value of movement continued to echo through history. In the 12th century, Rabbi Moses ben Maimon (Maimonides), a Jewish philosopher and physician, observed that no matter how well one eats or lives, without regular exercise, health deteriorates. By the 17th century, theologian Robert Burton attributed both physical and emotional illnesses—including depression, then known as “melancholy”—to inactivity. For Burton, exercise was not only a remedy but a moral imperative, vital to both body and soul.

Cultural Roots of Movement and Sport

Physical activity has never been just about health—it's also deeply woven into culture and tradition. In Mesoamerica, the Mayans organized one of the first recorded team sports: the Ball Game. Played with intense physicality and spiritual symbolism, this game involved passing a ball through a high-mounted stone hoop using only specific body parts. In some rituals, the stakes were incredibly high; the captain of the losing team might be offered as a human sacrifice, an honor believed to ensure prosperity and cosmic balance.

On the North American continent, Indigenous tribes played physically demanding stickball games—precursors to modern lacrosse. Figure 2.1.1 of three Native American Indians illustrates what lacrosse looked like in its earliest times. Far more than sport, these games were interwoven with spirituality, diplomacy, and tribal identity. French settlers later named the game lacrosse, but to the Native peoples, it was a sacred event often played to resolve conflicts, heal communities, and prepare warriors for battle.

These examples remind us that physical activity has long been a tool for connection between people, between body and spirit, and between individuals and their environments.



Figure 2.1.2: "Son of a farmsteader at Roanoke Farms, North Carolina" (April 1938). (Public Domain; John Vachon via Library of Congress)

From Ancient Practices to Modern Science

Though technology and lifestyle have changed dramatically since the days of Herodicus or the early Mayans, the core message remains the same: movement matters. Today, countless studies confirm what these ancient cultures already understood—regular physical activity supports longevity, protects against disease, and improves every aspect of life. It sharpens the mind, strengthens the heart, builds resilience, and fosters emotional well-being.

Culturally, sports and physical play continue to shape youth development, community identity, and global traditions. Biologically, the benefits are backed by data: exercise improves circulation, increases oxygen delivery to tissues, enhances brain function, boosts mood-regulating hormones, and helps maintain a healthy musculoskeletal system.
Whether through ancestral games, philosophical texts, or modern exercise science, one truth echoes throughout history: an active body is a healthy body.



Figure 2.1.3: This image of two trucks working in a vast agricultural field reflects the evolving nature of physical activity in rural labor. Modern farming relies heavily on powerful machinery, which has transformed how physical effort is used in agriculture. Where once farming demanded intense manual labor—plowing, harvesting, and lifting—today's farmers often depend on machinery to complete tasks efficiently over large areas. While this shift increases productivity, it also reduces the amount of natural, daily physical activity associated with traditional farm life. (Two Red and gray trucks on brown field; Rob Mulder via Unsplash)

The transformation of farming through technology has significantly altered the physical demands placed on farmers. Historically, agriculture was labor-intensive, requiring extensive manual effort. Figure 2.1.2 captures an African American farmer preparing a field for planting, using a disc harrow pulled by two mules, a reflection of the labor-intensive agricultural practices of the era and the resilience of rural communities in the American South. The farmer is seated, guiding the plow through the fields. A process demanding considerable physical exertion.

In contrast, Figure 2.1.3 contemporary farming leverages advanced machinery and automation. Modern equipment, such as autonomous tractors and precision agriculture tools, has streamlined tasks like planting and harvesting, reducing the need for manual labor. This shift has reduced physical strain on farmers, enabling more efficient, less physically demanding agricultural practices.

While these technological advancements have improved productivity and reduced physical labor, they have also introduced new challenges, such as the need for technical skills to operate complex machinery. Nonetheless, the evolution from manual to mechanized farming underscores the profound impact of technology on the physical aspects of agricultural work. In the same way, technology has impacted farming by reducing manual labor; this has also happened in many other professions that used to require more physical labor from workers.

Question

Technology and changing lifestyles have significantly reduced the amount of physical activity required in daily life, both at work and at home. Take some time to explore this shift by talking with your parents, grandparents, or other older family members.

- What kinds of physical activity were naturally built into their routines—at home, school, or work?
- How did they stay active for fun or fitness?
- What role did technology (or the lack of it) play in how much they moved throughout the day?
- Based on your conversation, what small steps could you take to be more active in your current routine?

Physical Activity in the United States: Trends, Challenges, and Equity

Despite centuries of evidence supporting the value of movement, physical activity participation in the modern United States falls dramatically short of national guidelines. Understanding these trends requires a public health perspective—one that combines

behavioral science, epidemiology, and policy to address both individual choices and systemic barriers.

Physical Activity Epidemiology is the study of how physical activity behaviors are distributed across populations and the factors—social, economic, cultural, and environmental—that influence those behaviors (Dishman et al, 2004). [6] This field helps us understand who is active, who isn't, and why.
To track these patterns, several large-scale national surveys provide ongoing data:

- National Health Interview Survey (NHIS)
- National Health and Nutrition Examination Survey (NHANES)
- Behavioral Risk Factor Surveillance System (BRFSS)

The results are sobering. These surveillance tools show that over 80% of U.S. adults do not meet physical activity guidelines (Pleis, et al, 2009). [19] At the same time, the prevalence of overweight and obesity has risen to alarming levels. According to recent data from the National Health and Nutrition Examination Survey (NHANES), the prevalence of obesity among U.S. adults from August 2021 to August 2023 was 40.3%, with no significant differences between men and women. However, adults aged 40–59 experienced higher obesity rates compared to those aged 20–39 and those 60 and older. Educational attainment appeared to play a role, as individuals with a bachelor's degree or higher had a lower prevalence of obesity than those with less education. Severe obesity, defined as a higher body mass index (BMI) threshold, affected 9.4% of adults and was consistently more prevalent in women than men across all age groups. While the overall age-adjusted obesity rate has remained relatively stable since 2013–2014, the prevalence of severe obesity has increased from 7.7% to 9.7%. Obesity is recognized as a chronic condition that significantly elevates the risk of developing hypertension, type 2 diabetes, coronary heart disease, stroke, and certain types of cancer (Emmerich et al, 2024). [7]

The Healthy People 2020 Initiative

In response, public health leaders have developed nationwide initiatives to reverse these trends. Healthy People 2020, a federal program led by the Office of Disease Prevention and Health Promotion, outlines specific goals to improve health, fitness, and quality of life through daily physical activity (US Department of Health and Human Services, 2020). [21]

This initiative takes a multi-level approach:

- Promoting infrastructure development, such as sidewalks, bike lanes, and safe parks.
- Encouraging policy reform at the local and state levels to support active lifestyles.
- Partnering with schools, workplaces, and community organizations to promote inclusion.

A key goal of Healthy People 2020 is to eliminate health disparities in physical activity participation. Too often, the opportunity to be active is not equally distributed. Populations that experience significant barriers include:

- Socioeconomically disadvantaged individuals may lack access to affordable gyms, safe neighborhoods, or time for leisure.
- People of color and minority groups are more likely to live in environments with limited recreational infrastructure.
- Older adults, who may face physical limitations, a lack of transportation, or social isolation
- Female adolescents often experience declines in activity due to social norms, lack of encouragement, or reduced access to sports.
- LGBTQ+ individuals, who may not feel safe or welcomed in traditional fitness spaces (National Center for Health Statistics, 2011). [16]

These disparities are not simply the result of personal choice. They are rooted in structural inequities—urban planning, socioeconomic status, discrimination, and policy gaps—that limit access to health-supporting environments (Kramer, 2019). [11]
As such, the promotion of physical activity must also be a movement toward equity.
The message is clear: to improve national health, we must not only encourage individuals to move more, but we must also ensure they have the opportunity to do so.

Question

- How could schools, workplaces, or city governments promote more inclusive access to physical activity for all people?

Physical activity has been essential to human survival, health, and culture for thousands of years, from ancient hunter-gatherers to Mayan ball games and early medical philosophies. While the nature of daily movement has changed dramatically with industrialization and modern technology, the need for physical activity remains just as vital today.

Despite overwhelming evidence of its benefits—better mood, sharper focus, longer life, and lower disease risk—most Americans still don't meet the minimum recommended activity levels. Social, cultural, and economic factors shape these patterns, and understanding them is key to building a more active and equitable society.

Key Points

- Physical activity and exercise are fundamental to overall wellness, promoting physical, emotional, and social health.
- Throughout history, cultures have recognized the value of movement, not just for survival, but for healing, spirituality, and social connection.
- Early physicians such as Herodicus, Hippocrates, and Maimonides viewed exercise as essential to health, long before modern science confirmed these benefits.
- Ancient team games like the Mayan Ball Game and Indigenous lacrosse were more than sports—they carried cultural, spiritual, and diplomatic significance.
- Modern research affirms that regular physical activity improves cardiovascular, muscular, and mental health and reduces the risk of chronic diseases.
- More than 80% of U.S. adults do not meet national physical activity guidelines, contributing to high rates of obesity and chronic disease.
- Healthy People 2020 is a federal initiative aimed at increasing physical activity, improving community infrastructure, and reducing health disparities.
- Barriers to physical activity are especially prevalent among socioeconomically disadvantaged individuals, racial and ethnic minorities, older adults, female adolescents, and LGBTQ+ populations.

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2.2: What Is Physical Activity and Exercise?



Figure 2.2.1: Throughout the lifespan, physical activity improves health and wellness. (Man Rowing; Centre for Ageing Better via Unsplash)

Introduction

Almost any kind of physical activity promotes health. Individuals are encouraged to be more active throughout the day, regardless of whether they are able to fit in a formal workout. Short periods of intense exercise do not compensate for hours of inactivity. It is recommended to get up and move around every hour when studying, working on the computer, or watching television.

What is Physical Activity and Exercise?

Physical Activity refers to any bodily movement produced by skeletal muscles that requires energy. This includes everyday activities such as walking the dog, cleaning, gardening, or playing with children. Health benefits include improved blood pressure, blood-lipid profile, and heart health. Physical activity does not have to be done all at 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.

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 or maintain physical fitness. **Physical fitness** is a set of physical attributes that allows the body to respond or adapt to the demands and stress of physical effort and to perform moderate to vigorous levels of physical activity without becoming overly tired. The more we ask of our bodies, the stronger and fitter they become. As a positive side effect, exercise has a significant impact on overall health. Fitness improvements include the heart's ability to pump blood, increased muscle size, and improved flexibility.

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. A **sedentary** lifestyle is common among Americans. Too many Americans are physically inactive. According to the Centers for Disease Control (CDC), only 24.2% of adults aged 18 and over met the 2018 Physical Activity Guidelines for Americans for both aerobic and muscle-strengthening activities. Hispanic men (23.5%) were less likely to meet both physical activity guidelines than non-Hispanic White (30.5%), non-Hispanic Asian (30.2%), and non-Hispanic Black (29.7%) men (Figure 3). Non-Hispanic White women (24.3%) were more likely to meet both guidelines than Hispanic (18.0%), non-Hispanic Asian (16.7%), and non-Hispanic Black (16.5%) women. The percentage of adults meeting the guidelines was higher among men than women overall and for each category of age, race, Hispanic origin, and family income. For both men and women, adults living in households with family income at 200% of the federal poverty level or more had higher percentages

meeting both physical activity guidelines compared with adults who had lower family income (Elgaddal et al, 2022). [8]

While physical activity is vital for overall health and offers a wide range of health benefits, exercise is necessary to significantly improve physical fitness. Understanding this distinction between physical activity, which improves health and wellness, and exercise, which improves fitness, is essential for interpreting and applying physical activity guidelines effectively.

Increasing Physical Activity to Improve Health and Wellness

According to the U.S. Surgeon General's Office, engaging in regular physical activity is one of the most important things that people of all ages can do to improve their health (National Prevention Council, 2011). [17] Regular physical activity supports overall wellness and helps prevent many chronic diseases. National health organizations, including the U.S. Department of Health and Human Services, the American College of Sports Medicine, and the American Heart Association, have made specific exercise recommendations for promoting health. Their reports emphasize the importance of regular physical activity and that any amount of physical activity is better than none.

Physical activity plays a key role in preventing high blood pressure, heart disease, stroke, type 2 diabetes, colon cancer, and osteoporosis. It also improves mental health by reducing feelings of depression and anxiety. These benefits apply to people of all ages, backgrounds, and abilities.

Key Physical Activity Guidelines for Adults

- **Basic health benefits**: Adults should aim for at least 150 minutes of moderate-intensity aerobic activity (like brisk walking) or 75 minutes of vigorous-intensity aerobic activity (like jogging) per week, or a combination of both. It's best to spread activity throughout the week in 30-minute sessions.
- **Greater health benefits**: Increasing aerobic activity to 300 minutes per week (or 150 minutes of vigorous activity) provides even more extensive health benefits. Research shows that people who are more physically active tend to live longer and have a lower risk of serious illness. For example, one long-term study found a 16-year survival rate of 84% for those doing vigorous exercise, compared to only 65% in those doing no physical activity.
- **Muscle strengthening**: Adults should also engage in muscle-strengthening activities like weight training or calisthenics at least two days a week, targeting all major muscle groups. These activities help maintain muscle mass and prevent falls in older adults.
- **Avoid inactivity**: Limiting time spent sitting, especially in front of screens, is important. Inactivity is linked to poor metabolic health, weight gain, and a higher risk of chronic disease (US Department of Health and Human Services, 2018). [20]

Understanding Physical Activity

Moderate-intensity physical activities include brisk walking, cycling, swimming, dancing, and yard work. These activities typically burn around 150 calories in 15–60 minutes and noticeably increase heart rate. Vigorous-intensity activities, like jogging, cause faster breathing and a more substantial increase in heart rate. The same health benefits can be achieved through either longer sessions of moderate activity or shorter sessions of vigorous activity. Selecting enjoyable activities, such as dancing, increases the likelihood of maintaining regular physical activity.

Physical activity doesn't need to happen all at once. It can be broken into 10-minute sessions throughout the day. For instance, biking to class, walking to the store, or completing household chores can all contribute to a person's daily activity total. If sedentary adults increased their activity to just 30 minutes a day, it would significantly boost both individual health and public health outcomes.

Physical Activity and Weight Management

Because nearly two-thirds of Americans are overweight, the U.S. Department of Health and Human Services has recommendations focused on weight management. This is for those who need to prevent weight gain, lose weight, or maintain weight loss. Therefore, 150 minutes per week of physical activity may not be enough. They recommend up to 90 minutes of physical activity per day. While exercise alone may not lead to significant long-term weight loss, it provides important health benefits regardless of weight change.

Exercising to Improve Physical Fitness

Moderate activity can improve overall health, particularly for inactive individuals. But to improve physical fitness, more vigorous and structured exercise is often needed. Simply put, “moderate physical activity alone is not enough.” Fitness requires higher-intensity movement that challenges the body.

The American College of Sports Medicine provides guidelines for creating structured exercise programs that support strength, endurance, and long-term fitness goals. With consistent effort and the right approach, individuals can improve their physical fitness, increase their energy levels, and reduce their risk of disease—all while enhancing their overall quality of life.

How Much Physical Activity Is Enough?

Experts agree that physical activity offers significant health benefits, but there is some debate over how much is needed. Some believe that simply increasing daily movement, such as walking more or being active around the house, can provide most of the health benefits. Others argue that structured, more intense activity is necessary to improve the body’s capacity for exercise and enhance physical fitness. In reality, both perspectives have value. What’s clear is that regular physical activity, regardless of intensity, promotes better health and helps prevent chronic diseases. While becoming more active offers many benefits, physically fit individuals tend to experience even greater rewards, including improved energy levels, better body control, and enhanced quality of life. Fitness empowers individuals to move more freely and enjoy everyday activities with greater ease.

Even for those not interested in sports, physical activity supports the stamina and strength needed for daily tasks and leisure activities, such as playing with children, gardening, or walking through a museum. Fit individuals tend to lead more active, independent lives compared to their sedentary peers.

Setting Realistic Goals

How much activity is needed? Most health professionals agree that some activity is better than none, and more is better, provided it is done safely. To determine the appropriate activity level, individuals should consider their current physical activity, health status, and personal goals. A common starting point is at least 30 minutes of moderate-intensity activity, such as brisk walking, five days a week. For those focused on weight management, beginning with this 30-minute goal and gradually increasing to 60–90 minutes of daily activity is recommended. For additional benefits, individuals may also choose to participate in a structured exercise program designed to build physical fitness.

Ultimately, any increase in physical activity can enhance an individual’s health and well-being, both in the present and over the long term. Making movement a regular part of one’s lifestyle and choosing enjoyable, sustainable activities support long-term consistency. As the book continues, readers will be provided with additional information on setting realistic goals.

Question

- If the benefits of physical activity are well-documented and accessible through everyday tasks, why do you think so many young adults, including college students, struggle to meet basic activity guidelines, and what changes (personal or societal) could realistically reverse this trend?
- Consider how academic pressures, screen time, mental health, and access to safe or convenient exercise spaces might influence physical activity levels. Are there small lifestyle shifts or campus-wide initiatives that could make a difference?

Components of Health-Related Fitness

A minimal level of fitness is required to carry out daily activities without becoming physically overwhelmed. To perform these activities without fatigue, individuals must maintain health in five key areas: cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition. These five areas are known as the components of health-related fitness. Developing each component enhances quality of life, reduces the risk of chronic disease, and optimizes overall health and well-being. Each of the five components will be examined in greater detail in later sections, but a brief overview is provided below. As previously stated, these areas are significant in that they influence a person's quality of life and overall health and wellness.

Cardiorespiratory endurance

Definition: **Cardiorespiratory endurance** is the ability to carry out prolonged, large-muscle, dynamic movements at a moderate to high level of intensity. This refers to the heart's ability to pump blood and the lungs' capacity to take in oxygen, as well as the ability of the heart, lungs, and blood vessels to deliver oxygen to working muscles during sustained physical activity.

- Examples: Running, swimming, cycling.
- Why it matters: Improves heart and lung function, supports stamina, and reduces the risk of cardiovascular disease.

Muscular strength

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

- Examples: Lifting weights, push-ups.
- Why it matters: Supports posture, joint health, and functional movement, and helps prevent injury.

Muscular endurance

Definition: **Muscular endurance** is the ability to exert a force over time or repetitions.

- Examples: Planks, bodyweight squats, rowing.
- Why it matters: Enhances daily activity performance and overall physical stamina.

Flexibility

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

- Examples: Stretching, yoga, dynamic warm-ups.
- Why it matters: Aids in movement efficiency, better athletic performance, reduces injury risk, and helps maintain mobility with age.

Body Composition

Body composition is the relative amount of fat mass to fat-free mass (muscle, bone, and water).

- Assessment tools: BMI, skinfold calipers, bioelectrical impedance.
- Why it matters: A healthy body composition supports metabolic health and reduces the risk of chronic diseases (Mt. Hood Community College, n.d.). [15]

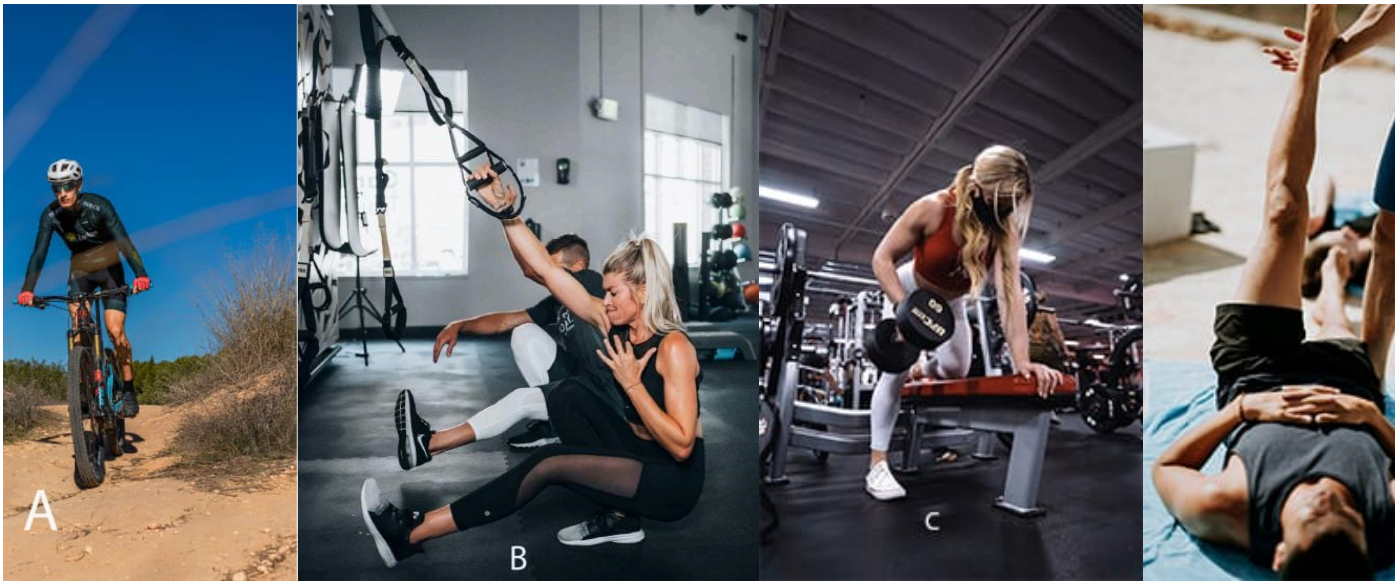


Figure 2.2.2: These images represent the components of exercise including cardiorespiratory endurance, muscle strength and endurance, and flexibility. (Male mountain biker; Tuvalum via Unsplash; Woman doing TRX lunges; Graham Mansfield via Unsplash; Prone row exercise; Brandon Morales via Unsplash; Stretching; Annie Spratt via Unsplash).

Skill-Related Components of Fitness

In addition to the five health-related components of fitness, cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition, six skill-related components also contribute to developing optimal fitness, particularly in activities that demand speed, precision, and coordination. While these components are crucial for athletic performance, they also enhance daily movement efficiency and help prevent injuries for individuals of all fitness levels. The six skill-related components are:

Speed

- Definition: The ability to perform a movement in a short time.
- Example: Sprinting 100 meters or quickly changing position on the court.
- Why it matters: Critical in both individual and team sports for performance and competitive advantage.

Agility

- Definition: The ability to change the position of the body quickly and accurately
- Example: Dodging an opponent in sports like soccer or basketball.
- Why it matters: Key for fast-paced, reactive movements in many sports.

Coordination

- Definition: The ability to perform motor tasks accurately and smoothly using the body movements and senses
- Example: Hand-eye coordination when hitting a baseball.
- Why it matters: Improves skill execution in sports and everyday tasks.

Balance

- Definition: The ability to maintain equilibrium while moving or while stationary
- Example: Holding a yoga pose or staying upright on a beam.
- Why it matters: Important for injury prevention, coordination, and performance in activities like gymnastics, skating, or daily

movement.

Power

- Definition: The ability to exert force rapidly, based on a combination of strength and speed
- Example: A vertical jump in volleyball or a sprint start.
- Why it matters: Crucial for explosive movements and peak athletic performance.

Reaction time

- Definition: The ability to respond and react quickly
- Example: Catching a ball after it's been thrown unexpectedly.
- Why it matters: Essential for quick decision-making in fast-paced environments (Mt. Hood Community College, n.d.). [15]

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 help develop 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. Skill-related fitness tends to be sport-specific and is best developed through practice.



Figure 2.2.3: These images capture several key skill-related components of fitness in action. Volleyball players (Image A) jumping to spike or block the ball demonstrate power, the ability to generate force rapidly. A woman balancing (Image B) on a Bosu ball highlights the role of balance in controlling body position during movement. A sprinter (Image C) launching from the starting blocks showcases reaction time, speed, and power, essential for explosive performance. Finally, a climber (Image D) navigating a rock face illustrates coordination, as she synchronizes movements for smooth, efficient progress. Together, these components—power, balance, speed, reaction time, and coordination, enhance athletic performance and support physical competence in daily life. (A group of women playing volleyball; Kim West via Unsplash; Balance training; Andrea Boncata via Unsplash; Athlete on starting line in daytime; Nicolas Hoizey via Unsplash; Photo of women climbing; x) via Unsplash).

Figure 2.2.3 highlights the importance of skill-related components of fitness, which enhance physical performance in both sport and everyday movement. Although not pictured here, agility, the ability to change direction quickly and accurately, is another critical skill component often seen in sports like soccer, basketball, and tennis. Together, these attributes improve athletic ability and functional movement. In contrast, the health-related components of fitness, cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition, contribute more directly to overall health, disease prevention, and quality of life. A complete fitness program should address both skill- and health-related components to support lifelong physical well-being.

Key Points

- Physical activity is any movement by skeletal muscles that requires energy and promotes health. Every day tasks like yard work, cleaning, dog walking, or taking stairs count as physical activity.
- Activity can be accumulated throughout the day and doesn't need to happen all at once.
- Minimal-energy activities (like typing or gaming) are not enough to improve health.
- To gain health benefits, adults should aim for at least 150 minutes of moderate or 75 minutes of vigorous activity per week.
- For more extensive health benefits, adults should increase their aerobic physical activity to 300 minutes a week of moderate-intensity activity, or 150 minutes a week of vigorous-intensity activity, or an equivalent combination of both moderate and vigorous-intensity activities

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2.3: Principles of Adaptation of Stress



Figure 2.3.1: (Man doing a fitness circuit; Gabin Vallet via Unsplash)

Introduction

The human body adapts well when exposed to stress. The greater the demands made on it, the more it adjusts to meet those demands. The term **stress**, within the context of exercise, is defined as an exertion above normal functioning. **Adaptation** refers to the physiological changes that occur with exercise training, and over time, these immediate, short-term adjustments lead to long-term improvements in fitness and performance. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. The goal of physical training is to produce long-term changes and improvements in the body's functioning and fitness. **Physical training**, the performance of diverse activities that cause the body to adapt and improve its fitness level, is essential for overall health.

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. To design an effective exercise program, individuals must first understand the basic principles of physical training, which include the following:

- Specificity
- Progressive overload
- Reversibility
- Individual differences

Specificity

Simply put, developing a particular fitness component requires performing exercises specifically designed for that component. This concept is known as the principle of **specificity**. In cardiorespiratory fitness, the goal of exercise is to stimulate the cardiorespiratory system. Activities such as swimming, biking, dancing, cross-country skiing, and aerobic classes can achieve this objective by building lung capacity and improving cellular and heart function. The principle of specificity also applies to skill-related fitness components and different parts of the body.

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 this is what they will 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 bodies

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, for example, 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, it is essential to train with specificity, focusing on the type of training that aligns with the desired adaptations.

Progressive Overload and the FITT-VP Principle

The principle of **progressive overload** describes the need to gradually increase the demands placed on the body to stimulate improvement. If an exercise remains the same over time, the body adapts and progress plateaus. To encourage continual adaptation, the body must be challenged with an increased workload. Progressive overload, a key principle in exercise training. To help apply progressive overload in a structured and measurable way, fitness professionals use the FITT-VP framework, which stands for Frequency, Intensity, Time, Type, Volume, and Progression. By systematically adjusting these components, individuals can create effective exercise programs that promote consistent improvement while minimizing the risk of injury.

Progressive Overload

Consider the old saying, “No pain, no gain.” Does exercise have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. The body adapts to the demands of exercise by improving its functioning. When the amount of exercise (also called overload or stress) is increased progressively, fitness continues to improve. 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 progressive overload (Libretexts, n.d.). [13]

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. Adaptation occurs when the body becomes more efficient at a specific activity, often resulting in reduced energy expenditure for the same task. While this is a sign of improved fitness, it also means the stimulus is no longer sufficient to drive further change. To avoid plateaus, training variables should be modified periodically to continue challenging the body. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

FITT-VP Principle

The **FITT-VP principle** is a guideline used to design effective exercise programs. It ensures that workouts are structured and optimized for individual goals, fitness levels, and progression. The amount of overload needed to maintain or improve a particular level of fitness for a particular fitness component is determined through six key dimensions:

- **Frequency**- How often
- **Intensity**- how hard or how fast
- **Time**- how long (duration)
- **Type**- mode of activity
- **Volume**- how much (frequency x intensity x time)
- **Progression**- how a program advances over time (Fahey et al, 2025) [9]

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

Frequency relates to how often exercises are performed over a period of time. Developing fitness requires regular exercise. In most cases, the number of walking or jogging sessions would be determined for a week. For most people, a frequency of three to five days per week for cardiorespiratory endurance exercise and two or more days per week for resistance and flexibility training is appropriate for a general fitness plan.

Intensity

Fitness benefits occur when a person exercises harder than his or her normal level of activity. **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? Intensity can be assessed through methods like METs, heart rate, or perceived exertion. 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.

Examples of Moderate-Intensity Exercise

These activities elevate breathing and heart rate while still allowing conversation, though not singing, during the activity. They typically use 3.5 to 7 calories per minute. This is not an exhaustive list

- Brisk walking (3–4.5 mph, around the neighborhood or campus)
- Recreational biking (flat terrain, under 10 mph)
- Water aerobics or light swimming
- Dancing (salsa, ballroom, or line dancing)
- Gardening or yard work (e.g., raking leaves, pushing a mower)
- Doubles tennis or pickleball
- Hiking on flat terrain (on even trails)
- Light jogging (short bursts or slow pace)
- Active play with kids (light chasing or games)
- General house cleaning (vacuuming, sweeping, mopping, washing windows)
- Carrying light loads (groceries, laundry), recreational sports (softball, volleyball)
- Yoga
- Downhill skiing, moderate intensity
- Skateboarding
- Weight training and bodybuilding (US Department of Health and Human Services, 2018). [20]

Examples of Vigorous-Intensity Exercise

- Running or jogging (over 5 mph, even short bursts)
- Circuit weight training
- Fast or uphill cycling (over 10 mph or using a stationary bike on high resistance)
- Swimming laps
- High-intensity interval training (HIIT)- short, intense workouts with rest periods
- Jumping rope
- Cross-country skiing or snowshoeing
- Downhill skiing
- Hiking uphill or with a heavy backpack
- Aerobic classes (Zumba, kickboxing, step)
- Singles tennis
- Kayaking, whitewater
- Martial arts (e.g., kickboxing)
- Aerobic dancing (Zumba, cardio step)
- Competitive sports (soccer, basketball, singles tennis-full court or competitive play)
- Heavy yard work or manual labor (e.g., digging, carrying heavy loads, chopping wood)
- In-line skating (US Department of Health and Human Services, 2018). [20]

Time

Fitness benefits occur when exercising for an extended period of **time**. Time refers to the duration of the exercise session or cumulative daily/weekly exercise. 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.

Type

The **type**, or mode, of exercise varies depending on the fitness component and an individual's personal fitness goals. Cardiorespiratory endurance is developed through continuous activities involving large muscle groups, such as walking, swimming, cycling, and running. Resistance exercises build muscular strength and endurance, while stretching exercises improve flexibility.

Volume

Volume is the product of frequency, intensity, and time. The FIT of exercise. It reflects the total amount of exercise being done and can be increased or decreased by manipulating these components. Importantly, changes in one variable can compensate for changes in another—such as increasing time while decreasing intensity—to maintain the same volume.

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 creating a jogging plan, an individual might organize two weeks as follows:

- 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.

Progression

Fitness levels eventually plateau as the body adapts to exercise training; therefore, improving fitness requires gradually increasing overload over time through **progression**. The rate of adaptation is influenced by both an individual's genetic makeup and the level

of effort applied during training. Progressing exercise volume slowly is critical to reducing the risk of injury. Gradual increases in weight, intensity, or duration as fitness improves are also recommended to promote safe advancement. Progression refers to the gradual increase in any of the FITT variables to stimulate continued improvement. For beginners, time is often the first variable increased, followed by frequency and intensity. However, for individuals with specific functional goals or chronic conditions, the most appropriate variable to adjust will depend on their unique needs.

Question

- Think back to a time when you tried to start or improve a fitness routine.
  - How well did you apply the principles of specificity, progressive overload, and recovery?
  - Looking back, what might you have done differently to improve your results or avoid setbacks?

Reversibility

Chronic adaptations are not permanent. As the saying goes, "Use it or lose it." Fitness is a reversible adaptation. The body adjusts to lower levels of physical activity the same way it adjusts to higher levels. The **principle of reversibility** suggests that activity must continue at the same level to maintain the same level of adaptation. As activity declines, called **detraining**, adaptations will recede. When a person stops exercising, up to 50% of fitness gains can be lost within two months. However, the rate of decline varies depending on the type of fitness. Strength fitness is highly resilient and can be maintained with resistance exercises as little as once a week. On the other hand, cardiovascular and cellular fitness decline more rapidly, sometimes within days or weeks. If the frequency or duration of training must be temporarily reduced, much of the fitness gained can be maintained by keeping the workout intensity consistent.

Individual Differences

The principle of individuality emphasizes that each person responds differently to exercise. There are large individual differences in our ability to improve fitness, achieve a desirable body composition, and learn and perform sport skills. People respond to training at different rates, so a program that works for one person may not be right for another person. Factors such as genetics, muscle fiber distribution, age, training history, and mental state all influence how someone will adapt to a given program. While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. The HERITAGE (Health, Risk Factors, Exercise Training, and Genetics) family study began in the early 1990s and was carried out in several phases through 2010 (Bouchard et al, 2022). [2] It included 855 participants from 218 families (black and white) who completed a 20-week endurance exercise program to help researchers study how genetics and family traits affect fitness and health outcomes. In the HERITAGE Family study, families of five (father, mother, and three children) participated in a 20-week training program. 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 in 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 that genes 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.

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 the 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.

Recovery is a vital component of any exercise program. Adequate rest between sessions prevents overtraining, supports

motivation, and reduces the risk of overuse injuries. Recovery needs vary based on training volume, intensity, and the individual. It can include rest between workouts, full rest days, and sufficient sleep. Without enough recovery, even highly motivated individuals may lose interest or become injured. Overtraining can be identified by decreased performance, persistent fatigue, or declining enthusiasm for exercise. Incorporating variation (e.g., cross-training) and ensuring enough rest, both physical and mental, is essential to long-term progress and well-being.

Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macro-cycles, respectively. An example of this is illustrated in Table 2.3.1

Table 2.3.1 Training Phases of a 4-week program

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 Table 2.3.1 shows, the volume and intensity change from week 1 to week 3. But in week 4, the volume and intensity drop 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. (Libretexts, n.d.) [13]

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.

Questions

- Explain how individual differences affect exercise programming.
- What are two signs of overtraining that may result from insufficient recovery?
- Describe how rest is relative in an exercise program.

Key Points

- The body adapts to physical stress to meet increased demands.
- The goal of training is to apply the right amount of stress to stimulate these improvements without causing injury.
- Train in a way that matches the fitness goal (e.g., runners should run).
- Fitness improves when the body is gradually exposed to increasing levels of stress.
- Gains are lost if training stops ("Use it or Lose it").
- People respond to exercise differently due to genetics, age, gender, and training history.

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2.4: Creating a Successful Fitness Plan



Figure 2.4.1: Starting a fitness program can be challenging, but working with a partner can help. (Box Jumps; Megan Holmes via Unsplash)

Introduction

Often, the hardest step in beginning a new routine is simply starting the new routine. Creating a fitness plan works best when getting started. 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

Starting a fitness program can be challenging. Fitness center attendance spikes in January as many aim to fulfill the top New Year's resolution: losing weight. However, by mid-February, up to 80% of new participants had quit, with attendance returning to pre-January levels by March.

Why does this happen? Many fail to see fitness as a lifestyle. The new year sparks ambitious resolutions, but unrealistic expectations for rapid results often lead to discouragement and abandonment of goals.

Reverting to teenage-level fitness may be appealing, but is often unrealistic for most adults. A successful fitness program must account for the demands and constraints of adult life. Otherwise, it risks being abandoned, with aspirations deferred until the next January.

Achieving optimal health and fitness requires time, consistency, and a lifestyle-oriented approach. True lifestyle changes are long-term, balanced, and sustainable, in contrast to fad diets that often lead to feelings of deprivation. Individuals are encouraged to set realistic goals and align their efforts with habits they can maintain. Shifting the mindset to prioritize long-term health and identifying meaningful reasons to adopt healthier routines are also essential.

The steps outlined below guide this process. Before beginning a fitness program, it is important to understand the safety considerations associated with exercise.

Safety First: Assessing the Risk

Participating in exercise and sports is usually a wonderful experience that improves wellness in both the short and long term. 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), the incidence of cardiac events is still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 experiences a cardiac event.

Getting Medical Clearance

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 (American College of Sports Medicine, 2018). [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.
- **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 130 mm/Hg systolic, 80 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 a 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 larger than 102 cm for men and larger than 88 cm for women, or a waist to hip ratio of less than 0.95 for men, or less than 0.86 for women, increases the risk of heart disease.
- **Sedentary lifestyle:** Persons not meeting physical activity guidelines set by the US Surgeon General's Report have an increased risk of heart disease.

Overall, the risk of death from exercise is small, and people are much safer exercising than engaging in many other common activities, including driving a car.

The health benefits of regular physical activity are well established, and more individuals are encouraged to engage in physical activity each day of the week. For most people, participating in physical activity is considered very safe. A commonly used tool for assessing physical health is the Physical Activity Readiness Questionnaire, which helps determine whether further guidance from a doctor or a qualified exercise professional is necessary before increasing physical activity levels.

Example 2.4.1

Completing the Physical Activity Readiness Questionnaire (PAR-Q+) is recommended before starting an exercise program (link is to the online version). The link goes to a website where there are two free ways to access the PAR-Q. To access, either choose Take the PAR-Q+ survey now or use your phone to scan the QR code that will take you to the survey. This questionnaire is intended to determine if there are any underlying health issues that should be discussed with a doctor before starting an exercise program. Based on your responses to the PAR-Q, you will be placed into a risk category: low, moderate, or high.

- **Low-risk** individuals include men younger than 45 and women younger than 55 who answer 'no' to all PAR-Q+ questions and have one or no risk factors. Although further screening is a good idea, such as getting a physician's approval, it isn't necessary.
- **Moderate-risk** persons are men aged 45 or older, women aged 55 or older, 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 that you get a physician's approval before beginning an exercise program.
- **High-risk** individuals answer 'yes' to one or more of the questions on the PAR-Q+. The physician's approval is required before beginning a program.

The complete PAR-Q+ is available for download in a fillable PDF.

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Once an individual has determined the ability to exercise safely, the next steps toward beginning a program can be taken. Preparing for an exercise program and ultimately adopting a healthier lifestyle requires careful planning.

The process involves the following steps:

- **Assess current fitness:** Identify the starting point.
- **Set goals:** Define what is to be achieved.
- **Create a plan:** Determine how those goals will be reached.
- **Follow through:** Begin the program!

Assess the Level of Fitness

To adequately prepare, individuals must take an honest look at their current level of fitness. This includes assessing physical activity and fitness across each of the five health-related components of fitness. Since multiple methods exist for evaluating fitness, the most appropriate option should be selected based on individual needs. Establishing a reliable estimate provides a snapshot of baseline fitness and health, serving as a reference point for measuring the effectiveness of a fitness program during future reassessments. These results assist in setting specific goals and developing a tailored fitness plan. Chapters 3, 4, 5, and 6 include assessment tests designed to evaluate cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition.

Question

- Why is it important to assess your health before beginning an exercise plan?
- Based on the 7 risk factors, where do you think you stand? (No need to share specifics—just reflect.)



Figure 2.4.2: (Gym equipment lying on ground; Gabriel Tiveron via Unsplash)

Set Goals

The ultimate goal of every health-focused fitness program is the same: lifelong wellness that promotes feeling and functioning at one's best for years to come. Using the map analogy, once individuals know their current location, they must determine

their destination and the most effective route for reaching it. The first step in this process is setting goals. In The 7 Habits of Highly Effective People, author Stephen Covey advises to “Begin with the end in mind.” Although Covey’s words are not directed specifically at fitness programs, the advice is highly relevant to anyone making a significant lifestyle change. Success requires developing a clear vision of the desired destination. Setting specific goals about how one wants to feel and look increases the likelihood of success, while the absence of specific goals can lead to misjudging progress and overlooking true achievements (Covey, 2003). [5]

Effective goal-setting involves clearly defining and measuring objectives. Individuals should identify exactly what they want to accomplish, ensure their goals can be measured, and establish a reasonable timeframe for achievement.

Goals that meet these standards are referred to as S.M.A.R.T. goals:

- **Specific**: Goals should be detailed and clearly defined.
- **Measurable**: Progress must be quantifiable to know when the goal has been achieved.
- **Attainable**: Goals should align with available resources, such as time, family support, and financial means.
- **Relevant**: Goals should be challenging but not exceed reasonable expectations.
- **Time-bound**: Each goal should include a deadline for completion.

A well-stated goal contains all of the S.M.A.R.T. components listed above. Take a look at the well-stated example below:

Example of an exercise S.M.A.R.T. goal

"I will improve my 12-minute jogging distance by 10% within 2 months of the first assessment."

Note that 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 contains 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 individuals know exactly what they want to achieve, the next step is to generate a strategy to reach those goals. This strategy should define the frequency, intensity, and duration of exercise sessions, while keeping in mind several key principles.

First, goals should serve as the foundation of the program. For example, if the goal is weight loss, the frequency, duration, and intensity of daily workouts should be structured to maximize calorie expenditure and support the body’s use of fat for fuel. If the goal is to improve speed, more workout time must be dedicated specifically to training that enhances performance in that area.

Follow the expert recommendations outlined in the Physical Activity Guidelines for Adults from the U.S. Department of Health and Human Services and the American College of Sports Medicine to ensure a safe and effective approach to exercise. These

highly reputable organizations have conducted extensive research to discover the optimal frequency, intensity, and duration for exercise.

Follow Through

Once individuals have assessed their current fitness levels, set goals using the SMART guidelines, and created a personalized fitness plan, they can take pride in the progress made toward achieving a healthier lifestyle. At this point, the focus shifts from preparation to action—putting the plan into practice. Having already invested time and energy in developing a thoughtful, well-structured program, individuals are now ready to reap the benefits of consistent execution. In many cases, the assessment, planning, and preparation are the most challenging steps; once the goals and methods are clear, success becomes a matter of follow-through.

However, sticking with a program often proves to be the most difficult part. To avoid losing momentum, it is important to identify potential barriers that could interfere with consistency. A shortage of time is one of the most frequently cited obstacles, as work, school, child care, and other daily responsibilities can limit opportunities for exercise. By making a list of the factors that prevent regular physical activity, analyzing the schedule, and finding realistic times to incorporate workouts, individuals can increase their chances of long-term adherence. Regardless of the chosen time of day, consistency is key to maintaining progress.

Guidelines for an Effective and Successful Exercise Program

Below are a few additional tips for achieving consistency in a daily fitness program:

- **Train the Way They Want Their Body to Change** – The body adapts to the specific type of training performed. Individuals who want to build strength should focus on resistance training, while those aiming to improve endurance should emphasize cardiovascular exercise. Aligning workouts with personal goals produces the best results.
- **Train Regularly** – Consistency is the foundation of progress. Engaging in physical activity on most days of the week helps build habits, enhances performance, and supports long-term health benefits.
- **Start Slowly and Progress Gradually** – Fitness is a long-term pursuit. Beginning too quickly can lead to injury or burnout, so it is important to give the body time to adapt. Individuals should start with manageable workouts and gradually increase intensity, duration, or frequency. Progress can be made by increasing workout volume (time and frequency) or intensity, but beginners should avoid changing both at once.
- **Warm Up and Cool Dow**n – A dynamic warm-up prepares the body for activity by increasing circulation and reducing injury risk. Cooling down afterward with light movement and stretching supports recovery.
- **Exercise Safely** – Proper technique, appropriate gear, and awareness of the environment are critical for preventing injuries and maintaining consistency. Safety measures include wearing helmets when skiing, snowboarding, or rock climbing, using protective eyewear, wearing bright clothing and safety lights, and exercising with a partner in less-populated areas.
- **Listen to the Body and Rest** – Fatigue, soreness, and pain are important signals. Adequate rest and sleep are essential for recovery, muscle repair, and overall performance.
- **Cycle Training Volume and Intensity** – To avoid plateaus and overtraining, individuals should vary workload by incorporating lighter training periods and recovery phases.
- **Vary Activities** – Preventing boredom and reducing overuse injuries can be achieved by incorporating a variety of exercises. For example, individuals might play basketball instead of walking, ride a bike, or explore new hiking trails. This variety promotes overall fitness and sustained engagement.
- **Train with a Partner** – A workout partner provides motivation, accountability, safety, and enjoyment.
- **Train the Mind** – Mental strength is as important as physical strength. Techniques such as positive self-talk, setting intentions, and maintaining focus help build resilience and commitment.
- **Fuel Activity Properly** – Balanced nutrition and hydration support training, energize workouts, and enhance recovery.
- **Have Fun** – Enjoyable activities increase adherence. Choosing workouts that individuals look forward to and celebrating small achievements helps sustain motivation.
- **Track Progress** – Tracking provides motivation and allows for informed adjustments to the program. Because results often occur gradually, maintaining workout journals, monitoring body composition, or using fitness apps helps highlight subtle improvements and sustain engagement.
- **Seek Guidance When Needed** – Consulting fitness professionals, physical therapists, or experienced peers can improve results and prevent setbacks. Support from friends, family, clubs, or online communities fosters accountability, encouragement, and motivation.
- **Maintain Perspective** – Fitness is a lifelong journey. Balancing it with other life commitments and remembering that wellness includes physical, mental, and emotional health ensures a holistic approach.

- **Think Long-Term, Think Lifestyle** – Exercise should become an enjoyable daily activity throughout life. Developing this routine takes time, patience, and persistence, but establishing exercise as a lifestyle habit leads to lasting results.
- **Adopt Healthier Eating Habits** – Nutrition complements training. A balanced diet accelerates results, supports overall health, and enhances feelings of success (Fahey et al, 2025). [9]

Key Points

- Start with a Plan and a Lifestyle Mindset: Beginning a fitness program is often the most challenging step. Individuals are encouraged to develop a plan and approach fitness as a long-term lifestyle rather than a temporary quick fix.
- Prioritize Safety: Tools such as the PAR-Q+ can be used to assess potential health risks. Medical clearance should be sought when necessary, particularly for individuals with risk factors like high blood pressure or a family history of heart disease.
- Assess the Starting Point: Evaluating fitness across key areas—including cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition—provides a clear baseline for progress.
- Set S.M.A.R.T. Goals: Goals should be Specific, Measurable, Attainable, Realistic, and Time-bound. This structure helps individuals stay focused, motivated, and accountable.
- Build a Personal Plan: Workout routines should be tailored to align with individual goals, with careful consideration of frequency, intensity, and duration.
- Be Consistent and Listen to the Body: Regular exercise combined with gradual progression leads to positive results. Rest, recovery, and variety are essential to prevent injury and avoid burnout.
- Track Progress and Stay Engaged: Monitoring improvements, celebrating small achievements, and keeping activities enjoyable helps maintain motivation and long-term commitment.
- Seek Support and Think Long-Term: Surrounding oneself with supportive individuals, seeking professional guidance when needed, and focusing on overall well-being encourages sustainable, lifelong health.

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2.5: Physical Activity Guidelines for Adults



Figure 2.5.1: A community park that has provided a variety of exercise machines open to the public to use. (A playground with a slide; Workman Kapotnya via Unsplash)

Introduction

Physically active adults 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. Individuals can improve their fitness level by simply adding more physical activity to their daily lives and reducing their sitting time.

Key Recommendations

Adults gain most of these health benefits when they do the equivalent of at least 150 minutes of moderate-intensity aerobic physical activity (2 hours and 30 minutes) each week. Adults gain additional and more extensive health and fitness benefits with even more physical activity. Muscle-strengthening activities also provide health benefits and are an important part of an adult's overall physical activity plan.

Avoid Physical Inactivity

All adults should avoid physical inactivity or being sedentary. Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits.

Do Aerobic Activity

Aerobic activity improves heart and lung function, boosts energy levels, and helps maintain a healthy weight. It's also a key factor in reducing the risk of chronic diseases like diabetes and hypertension. 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) or
- 75 minutes (1 hour and 15 minutes) each week of vigorous-intensity aerobic physical activity (such as jogging or swimming laps) or

- An equivalent combination of moderate- and vigorous-intensity aerobic physical 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, it is recommended that adults 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



Figure 2.5.2: Swimming laps is an example of vigorous aerobic physical activity. (Person Swimming; Mia Gracia Tabili via Unsplash)

Question

- How close are you to meeting the current physical activity recommendations?
- What's helping or holding you back?
- What are some simple changes you could make to increase your daily step count or weekly activity?

Examples of Different Aerobic Physical Activities and Intensities

The following are lists of moderate intensity activities and vigorous intensity activities (US Department of Health and Human Services, 2018). [20]

Moderate Intensity Activities

- Walking briskly (2.5 miles per hour or faster)
- Recreational swimming
- Bicycling slower than 10 miles per hour on level terrain
- Tennis (doubles)
- Active forms of yoga (for example, Vinyasa or power yoga)
- Ballroom or line dancing
- General yard work and home repair work
- Exercise classes like water aerobics

Vigorous Intensity Activities

- Jogging or running
- Swimming laps
- Tennis (singles)
- Vigorous dancing
- Bicycling faster than 10 miles per hour
- Jumping rope
- Heavy yard work (digging or shoveling, with heart rate increases)
- Hiking uphill or with a heavy backpack
- High-intensity interval training (HIIT)
- Exercise classes like vigorous step aerobics or kickboxing

Question

What are some simple changes you could make to increase your daily step count or weekly activity?

Muscle Strength

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. Preferably on non-consecutive days.

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 number of days a week of exercising will result in stronger muscles.

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.



Figure 2.5.3: Lifting weights can be a high-intensity muscle-strengthening activity. (Woman doing weight lifting; John Arano via Unsplash)

Recommendations for Adults

Physical activity refers to any movement that engages the body. It plays a critical role in supporting both physical and mental health, making it one of the most important contributors to overall well-being.

- Physical activity is among the most important actions individuals can take to protect and improve their health.
- Adults are advised to engage in at least 150 minutes of moderate-intensity physical activity each week, such as 30 minutes a day on five days of the week.
- In addition, adults should participate in muscle-strengthening activities at least two days per week.

Immediate Benefits of Physical Activity

The following list is from the CDC Physical Activity Basics document titled Benefits of Physical Activity (2024).

Brain Health

- **Immediate Benefits:** Improved cognition for children (6–13 years) and reduced anxiety for adults.
- **Long-Term Benefits:** Sharpens thinking, learning, and judgment skills with age; reduces depression and anxiety; improves sleep.

Managing weight

- **Maintaining Weight:** Aim for 150 minutes/week of moderate-intensity activity (e.g., dancing, yard work).
- **Losing Weight:** Combine high levels of physical activity with healthy eating patterns.

Reducing health risks

- **Cardiovascular Disease:** 150 minutes/week lowers risks for heart disease and stroke, improves cholesterol, and reduces blood pressure.
- **Type 2 Diabetes & Metabolic Syndrome:** Regular activity reduces risks, even below 150 minutes/week.
- **Infectious Diseases:** Reduces severe outcomes from COVID-19, flu, and pneumonia.
- **Cancer:** Lowers risks for at least eight common cancers; enhances quality of life for survivors.

Strengthening bones and muscles

- **Muscle Strengthening:** Activities like lifting weights build muscle mass, critical for older adults to combat muscle loss.
- **Bone Health:** Physical activity protects the joints and supports the ability to perform daily activities as individuals age.

Performing daily activities and preventing falls

- **For Older Adults:** Aerobic, muscle-strengthening, and balance activities lower risk of falls and hip fractures.
- **Functional Limitations:** Physically active individuals face fewer challenges with everyday tasks.

Increasing chances of living longer

- **Increased Lifespan:** 10 extra minutes of daily activity could prevent 110,000 deaths/year in U.S. adults aged 40+.
- **Steps Per Day:** 8,000–10,000 steps/day (younger adults) and 6,000–8,000 steps/day (older adults), lower risk of premature death.

Manage chronic health conditions & disabilities

- **Arthritis:** Reduces pain, improves function, mood, and quality of life.
- **Type 2 Diabetes:** Helps control blood sugar, reduces risks of heart disease and nerve damage.
- **Disabilities:** Supports daily activities and independence (CDC, 2024). [3]

Question

- Which benefit of physical activity is most motivating to you personally—mental health, weight control, preventing disease, or something else?

In summary, incorporating regular physical activity into an individual's routine serves as a powerful tool for enhancing overall health, supporting mental well-being, managing chronic conditions, reducing disease risk, and increasing both quality and length of life. In the Recommended Levels for Health Benefits box, there are three examples of exercise prescriptions that an individual can participate in weekly to enhance overall health (CDC, 2024). [4]

Recommended Levels for Health Benefits

Example 1



Moderate-intensity aerobic activity (such as brisk walking) for 150 minutes every week (for example, 30 minutes a day, 5 days a 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).

Example 2



Vigorous-intensity aerobic activity (such as jogging or running) for 75 minutes (1 hour and 15 minutes) 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).

Example 3



An equivalent mix of moderate- and vigorous-intensity aerobic activity on 2 or more days a 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).

Key Points

- Physical activity is essential for physical and mental health and reduces the risk of chronic disease, disability, and early death.
- Minimum Recommendation: Adults should get at least 150 minutes/week of moderate-intensity aerobic activity or 75 minutes/week of vigorous-intensity activity, or a combination of both.
- Activity should be spread throughout the week in bouts of 10 minutes or more.
- Adults should do muscle-strengthening exercises involving all major muscle groups at least 2 days per week, on non-consecutive days.

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2.6: Exercise Safety



Figure 2.6.1: Being able to swim is a safety prerequisite to getting on a paddleboard. (Person Paddleboarding; Hjaltte Gregerrsen via Unsplash)

Introduction

As physical activity rates among Americans increase, particularly in outdoor settings, safety concerns also rise. Unfortunately, the infrastructure in many American cities does not adequately support active lifestyles. Limited financial resources and a general de-emphasis on public health mean that local and state governments are unlikely to prioritize the development of sidewalks, walking trails, or bike lanes. In addition, time constraints and inconvenience make it difficult for individuals to access areas where such amenities are available. Consequently, many exercise participants share roads with vehicles or use isolated trails and pathways, which inherently increases safety risks.

A key principle of outdoor safety is to recognize and avoid extreme conditions. Individuals are advised to steer clear of heavily trafficked roads as well as extremely isolated areas. Likewise, exercising in overly populated spaces or in areas where no one is present can pose risks. Physical activity should also be avoided during extreme temperatures—whether excessively hot or cold—or at unsafe times such as early morning or late at night. To minimize risks, participants are encouraged to avoid using headphones that may reduce alertness, exercise with a partner, remain hydrated in hot weather, and wear proper clothing in cold environments to prevent frostbite. Extreme conditions demand heightened awareness and preparation.

Another fundamental principle, whether exercising indoors or outdoors, is the consistent use of common sense. The purpose of exercise is to promote health and enjoyment, and this should not be compromised by unsafe decisions such as running in 95-degree heat at midday or lifting heavy weights without a spotter. Before engaging in potentially risky activities, individuals should ask themselves, “Is there a safer alternative?”

Awareness of terrain and weather conditions is equally critical. While walking or jogging on trails can provide enjoyable experiences, uneven surfaces, roots, rocks, or slick conditions such as mud and ice can create hazards. Avoiding these risks helps ensure exercise sessions can be completed safely.

Many colleges and universities provide safety tips for their students. Individuals are encouraged to consult their institution’s website for additional guidance on maintaining safety while being physically active.

Environmental Conditions



Figure 2.6.2: Exercising in cold conditions may increase the risk of hypothermia and frostbite. (Two people walking on snow-covered ground; Bernard Hermant via Unsplash)

When engaging in cardiorespiratory exercise, particularly outdoors, it is important to recognize how environmental factors can significantly influence safety, performance, and overall well-being. High temperatures may lead to heat-related illnesses such as heat exhaustion or heat stroke, while cold conditions increase the risk of hypothermia and frostbite. Poor air quality, resulting from pollution, wildfire smoke, or allergens, can impair breathing and reduce exercise capacity, especially for individuals with asthma or other respiratory conditions. In addition, uneven or slippery surfaces, low visibility, and poorly lit areas elevate the risk of falls and injuries.

By following basic safety guidelines such as dressing appropriately for the weather, staying hydrated, monitoring air quality indexes, and selecting safe routes, individuals can reduce these risks. Learning to adjust activity levels, intensity, and environment when necessary supports both immediate safety and long-term adherence to a healthy and active lifestyle.

Heat-Related Illness

Heat-related illnesses, such as **heat cramps**, **heat exhaustion**, and **heat stroke**, have become a growing public health concern in the United States. Between 1999 and 2023, the U.S. recorded 21,518 deaths attributed to these conditions, with annual fatalities increasing from 1,069 in 1999 to a record 2,325 in 2023, a 117% rise over the 24 years (Grossi, 2024). [19] Notably, from 2016 to 2023, the age-adjusted mortality rate increased by 16.8% annually, reversing a previous downward trend and highlighting the escalating threat posed by extreme heat events. Among males, the highest number of heat-related deaths was for those aged 55–64 years (150), and among females, for those aged 65–74 years (58). The lowest numbers were for males (four) and females (two) aged 5–14 years. Approximately 72% of heat-related deaths were among males. (Xu, 2020). [22]

The primary risk factor associated with heat-related illness is hydration, which serves as the foundation of all heat-related conditions. Sweat loss often occurs at a faster rate than fluids can be replaced during exercise, particularly at high intensities. This imbalance, known as **dehydration**, can still occur even when individuals attempt to hydrate, as ingesting large amounts of fluid during exercise may lead to stomach discomfort. Therefore, hydration must begin before exercise and should become part of a person's daily routine.

Several practical methods can help monitor hydration levels and prevent illness. One commonly used method, though not entirely foolproof, is to monitor the color of urine. In a hydrated state, urination occurs frequently (every two to three hours), and the urine appears very light in color. In a dehydrated state, urination is infrequent, produced in low volumes, and appears darker yellow.

Another effective method involves weighing before and after a workout to determine how much water weight is lost, primarily through sweat. The goal is to maintain pre- and post-exercise body weight by drinking fluids during and after activity to replace what was lost. When combined with urine monitoring, this approach provides a relatively accurate assessment of hydration levels.

What are the Health Benefits of Water?

Water is essential for life; it makes up approximately 50% to 70% of your body weight and is involved in nearly every bodily function. According to the Mayo Clinic (2017), staying properly hydrated supports both immediate and long-term health in the following ways:

- Removes waste products through urination, perspiration, and bowel movements
- Regulates body temperature
- Lubricates and cushions joints
- Protects sensitive tissues and organs

Even mild dehydration can impair physical and mental performance by draining your energy and making you feel tired. Prioritizing daily water intake helps support everything from digestion and circulation to muscle and joint health (Mayo Clinic Staff, 2017). [14]

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. 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 (Libretexts, n.d.). [12] 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 of fluid needed, there is no dispute regarding the importance of continually monitoring hydration through one of the previously described techniques. Inadequate hydration results in reduced performance, compromised health, and the potential for serious illness.

It should be noted that electrolyte-based sports drinks, such as Gatorade and Powerade, are often used to support hydration. While effective, these beverages are specifically designed to replace electrolytes such as potassium, sodium, and chloride that are lost through sweating during physical activity. They also contain carbohydrates in the form of sugar to help maintain energy during prolonged exercise. However, the added sugar can contribute extra calories that may not be desirable. For activities lasting less than 60 minutes, water remains the recommended fluid. For activities extending beyond 60 minutes, a sports drink may be beneficial.

Staying Hydrated: Individual Needs Vary

Most healthy individuals can maintain proper hydration by simply drinking water and other fluids when they feel thirsty. While the old standard of “eight glasses a day” is still widely referenced, hydration needs are not one-size-fits-all. For some, fewer than eight cups per day may be sufficient, while others may require more based on several key factors:

- **Exercise**: Physical activity that induces sweating increases fluid loss. To stay hydrated, it is important to drink water before, during, and after exercise to replace what’s lost through perspiration.
- **Environment**: Hot or humid weather leads to greater sweat production and higher fluid needs. Similarly, high altitudes can accelerate fluid loss, increasing the risk of dehydration.
- **Overall Health**: Illnesses that cause fever, vomiting, or diarrhea can lead to significant fluid loss. In such cases, increased water intake or the use of oral rehydration solutions may be recommended. Other health conditions, such as urinary tract infections or kidney stones, may also require increased fluid consumption.
- **Pregnancy and Breastfeeding**: Fluid needs rise during pregnancy and lactation to support fetal development, milk production, and overall maternal health.

Understanding these factors allows individuals to better manage their hydration and overall well-being. Listening to your body’s thirst cues and adjusting fluid intake during periods of increased need can help prevent dehydration and support daily functioning (Mayo Clinic Staff, 2017). [14]

Individuals do not need to rely solely on drinking water to stay hydrated. Foods such as fruits and vegetables, along with beverages like milk, juice, and even coffee, contribute to daily fluid intake. However, it is best to limit sugary drinks, as they often provide excess calories with little nutritional benefit (Mayo Clinic Staff, 2017). [14]

A good indicator of proper hydration is rarely experiencing thirst and maintaining light-colored urine. To support adequate hydration, individuals should aim to drink water with meals, during physical activity, and whenever thirst arises. For personalized recommendations, consultation with a doctor or dietitian is advised.

Question

- How can you modify your exercise routine during extreme heat without sacrificing consistency?
- What are two signs that your body is adequately hydrated?
  - How can you use these signs to monitor your hydration throughout the day?
- Think about your daily routine.
  - What changes could you make to improve your hydration habits?
  - What about during exercise?
  - What about when you aren't feeling well?



Figure 2.6.3: It is important to stay hydrated while exercising in hot conditions. (Man Running in Mountains; Alessio Soggetti via Unsplash)

Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can be equally dangerous if proper precautions are not taken. To minimize the risk of cold-related illness, individuals must prevent excessive loss of body heat. The three primary concerns associated with cold-related illnesses are **hypothermia**, **frostnip**, and **frostbite**.

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 in 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 to maintaining blood flow and regulating temperature.

Stay Dry

Heat loss occurs 25 times 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 exercise involves continuous movement, the body naturally produces heat during the session. The key to maintaining safety in cold conditions is to direct moisture (sweat) away from the skin. This can be achieved most effectively by layering clothing. A base layer of moisture-wicking fabric should be worn against the skin, while additional breathable layers can be added on top. This combination channels moisture away from the skin and prevents outer layers from becoming saturated with sweat. On windy days, clothing that provides wind protection and allows for breathability should also be used.

Cover the Extremities

The parts of the body farthest from the heart, such as the toes, fingers, and ears, are most likely to become cold first. To reduce this risk, individuals should take appropriate precautions by wearing gloves, moisture-wicking socks, and a winter cap to protect the head.

Question

- How can you modify your exercise routine during extreme heat or cold without sacrificing consistency?

Key Points

- Limited Infrastructure: Many cities lack safe sidewalks, trails, and bike lanes, increasing the risk during outdoor exercise.
- Avoid Extremes: Steer clear of high-traffic or isolated areas, poor weather, and extreme heat or cold.
- Use Common Sense: Choose safer alternatives if conditions could compromise health or safety.
- Watch Terrain: Uneven, wet, or icy surfaces can increase the risk of falls and injuries.
- Hydration is Key: Dehydration is the top risk for heat illness. Begin hydrating before exercise and monitor urine color or body weight changes.
- Heat vs. Cold: Heat increases the risk of cramps, exhaustion, and stroke; cold can cause hypothermia and frostbite. Both require proper preparation.
- Dress for Conditions: In cold weather, wear moisture-wicking layers and cover extremities. Stay dry to maintain body heat.
- Air Quality Matters: Poor air from pollution or allergens affects breathing, especially for those with respiratory conditions.
- Plan Ahead: Check the weather, dress appropriately, stay alert, and follow local safety tips for a safer workout.

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2.7: Comprehension Check

Summary

Physical activity includes any bodily movement that burns energy, while exercise is structured and purposeful, aimed at improving fitness. Both are essential to health, but only regular, higher-intensity exercise leads to significant improvements in physical fitness—such as better cardiovascular endurance, muscular strength, flexibility, and body composition. National guidelines recommend at least 150 minutes of moderate or 75 minutes of vigorous aerobic activity weekly, plus strength training twice a week. Still, many Americans fail to meet these minimums, making public health promotion and personal goal setting crucial.

To improve fitness effectively and safely, individuals should follow key training principles: specificity (train the way you want your body to change), progressive overload (gradually increase stress), reversibility (use it or lose it), and individual differences (everyone adapts differently). The FITT-VP model (Frequency, Intensity, Time, Type, Volume, Progression) helps structure personalized programs, while attention to rest, safety, environment, and goal-setting supports long-term success. Emphasizing a lifestyle approach—rather than short-term motivation—can help individuals build consistent, lifelong physical activity habits.

Test Your Understanding

1. What is the difference between physical activity and exercise, and why is this distinction important when discussing physical fitness?
2. List the five components of health-related fitness and briefly describe how each contributes to overall wellness.
3. According to national physical activity guidelines, how much aerobic and muscle-strengthening activity should adults aim for each week?
4. Explain the principle of specificity and provide an example of how it applies to a fitness goal.
5. What is progressive overload, and how does the FITT-VP principle help apply this concept in a safe and effective way?
6. Define each element of the FITT-VP principle and describe how one might adjust these elements when designing a fitness program.
7. Why is rest and recovery (including the concept of periodization) important in a long-term fitness plan?
8. How does the principle of reversibility affect long-term fitness, and which components of fitness decline most rapidly with inactivity?
9. What factors contribute to individual differences in how people respond to the same exercise program?
10. What environmental and safety considerations should be taken into account when beginning or continuing an exercise program, especially outdoors?

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Chapter 2 Glossary

- **Adaptations**: The physiological changes that occur in the body in response to consistent physical activity or training. These adaptations can include increased cardiovascular efficiency, improved muscular strength and endurance, enhanced flexibility, and better metabolic function, all of which help the body perform exercise more efficiently over time.
- **Agility**: The ability to rapidly change direction, speed, or position of the body with control and efficiency. It involves a combination of balance, coordination, reaction time, and quickness, making it essential for sports and activities that require sudden movements and adjustments.
- **Atherosclerosis:** A condition in which fatty deposits, cholesterol, and other substances build up on the inner walls of arteries, forming plaques. This buildup can narrow or block arteries, reducing blood flow and increasing the risk of cardiovascular diseases such as heart attacks and strokes.
- **Balance**: Ability to maintain control of body position while stationary or in motion. It involves coordination, stability, and strength to prevent falls, enhance performance, and efficiently execute movements in sports and physical activities.
- **Body Composition**: The proportion of fat, muscle, bone, and other tissues in the body. It is a key indicator of overall health and fitness, often measured to assess the ratio of lean mass to body fat.
- **Cardiorespiratory endurance:** Cardiorespiratory endurance is the ability of the heart, lungs, and circulatory system to efficiently supply oxygen to working muscles during sustained physical activity. It is a key component of fitness that enhances overall stamina, reduces fatigue, and improves aerobic performance.
- **Coordination**: Ability to efficiently and smoothly integrate multiple body movements to perform tasks with precision and control. It involves the synchronization of muscles, senses, and motor skills to enhance performance in sports and physical activities.
- **Dehydration**: A condition that occurs when the body loses more fluids than it takes in, leading to an insufficient amount of water to maintain normal bodily functions. It can cause symptoms such as fatigue, dizziness, dry mouth, and impaired physical and cognitive performance, especially during exercise or in hot conditions.
- **Detraining**: The gradual loss of fitness and physiological adaptations that occur when an individual reduces or stops regular exercise. This can lead to declines in cardiovascular endurance, muscle strength, flexibility, and overall performance, depending on the duration and extent of inactivity.
- **Exercise:** A planned, structured, and repetitive physical activity performed to improve or maintain physical fitness, health, and overall well-being. It can include activities that enhance cardiovascular endurance, muscular strength, flexibility, and coordination.
- **FITT-VP Principle**: Guides exercise programming with six key factors: Frequency (how often), Intensity (effort level), Time (duration), Type (exercise mode), Volume (total workload), and Progression (gradual increase for improvement).
- **Flexibility**: The ability of a joint or group of joints to move through a full range of motion. It is essential for overall mobility, injury prevention, and optimal physical performance.
- **Frequency**:Frequency refers to how often an exercise or physical activity is performed within a specific time period, typically measured in sessions per week.
- **Frost bite**: Cold-related injury that occurs when skin and underlying tissues freeze due to prolonged exposure to extreme cold temperatures. It commonly affects extremities such as fingers, toes, ears, and the nose, leading to numbness, discoloration, and potential tissue damage.
- **Frost-nip**: A mild form of frostbite that occurs when the skin is exposed to cold temperatures, causing temporary numbness and redness without permanent tissue damage. It typically affects extremities like fingers, toes, ears, and the nose, and can be reversed by gradually warming the affected area.
- **Heat cramps**: Painful, involuntary muscle spasms that occur due to excessive loss of fluids and electrolytes through sweating, often during intense physical activity in hot conditions. They are an early sign of heat-related illness and can be relieved by rehydration and rest.
- **Heat exhaustion**: A heat-related illness caused by prolonged exposure to high temperatures and inadequate fluid intake, leading to symptoms such as heavy sweating, dizziness, nausea, weakness, and rapid pulse. If untreated, it can progress to heat stroke, a life-threatening condition.
- **Heat stroke**: Heat stroke is a severe, life-threatening heat-related illness that occurs when the body's temperature regulation system fails, causing core body temperature to rise above 104°F (40°C). Symptoms include confusion, loss of consciousness, rapid heartbeat, and hot, dry skin, requiring immediate medical attention to prevent organ damage or death.
- **Hypothermia**: A dangerous condition that occurs when the body loses heat faster than it can produce it, causing core body temperature to drop below 95°F (35°C). Symptoms include shivering, confusion, slowed heart rate, and loss of coordination, and if untreated, it can lead to unconsciousness and death.
- **Intensity**: The level of effort or difficulty at which a physical activity is performed. It is typically categorized as low, moderate,

or vigorous and can be measured using heart rate, perceived exertion, or other physiological markers to ensure appropriate workout effectiveness and safety.

- **Muscular endurance:** The ability of a muscle or group of muscles to sustain repeated contractions or maintain a contraction over an extended period of time. It is essential for activities requiring prolonged effort, such as cycling, running, or high-repetition resistance training.
- **Muscular strength:** Muscular strength is the maximum amount of force a muscle or muscle group can generate in a single effort.
- **Overtraining:** A condition that occurs when an individual exceeds their body's ability to recover from intense or excessive exercise, leading to decreased performance, fatigue, increased risk of injury, and other negative physiological and psychological effects. It results from inadequate rest, poor nutrition, or excessive training volume and intensity.
- **Periodization:** A structured approach to training that involves dividing a workout program into specific cycles or phases to optimize performance, recovery, and progression. It typically includes variations in intensity, volume, and exercise focus to prevent plateaus, reduce injury risk, and enhance overall fitness gains.
- **Physical activity:** Any movement of the body that requires energy expenditure, including daily activities such as walking, household chores, and recreational or structured exercise. It plays a key role in maintaining overall health, improving fitness, and reducing the risk of chronic diseases.
- **Physical fitness**: A set of physical attributes that allows the body to respond or adapt to the demands and stress of physical effort.
- **Physical training:** A structured and planned regimen of physical activities designed to improve specific aspects of fitness, such as strength, endurance, flexibility, or agility. It involves progressive overload, consistency, and variation to enhance overall performance and health.
- **Power**: The ability to generate force quickly, combining strength and speed to produce explosive movements. It is essential for activities like sprinting, jumping, and Olympic lifting, and is improved through strength and plyometric training.
- **Progression**: The gradual increase in intensity, duration, frequency, or difficulty of a workout over time to continually challenge the body and improve fitness levels. It is a key principle in training to ensure continuous improvement while minimizing the risk of injury or overtraining.
- **Progressive overload**: The gradual increase of stress placed on the body during exercise to stimulate muscle growth, strength, and endurance improvements. This can be achieved by increasing weight, repetitions, intensity, or training volume over time to continually challenge the muscles and promote adaptation.
- **Reaction time**: Reaction time is the amount of time it takes for the body to respond to a stimulus. It is a crucial component of athletic performance, especially in sports requiring quick reflexes, such as sprinting, boxing, or tennis.
- **Reversibility**: Reversibility is the principle that fitness gains and physiological adaptations from exercise are lost when training stops or is significantly reduced. This decline in strength, endurance, and flexibility can occur within weeks of inactivity, emphasizing the importance of consistent physical activity.
- **Sedentary**: In general, sedentary behavior refers to any waking behavior characterized by a low level of energy expenditure (less than or equal to 1.5 METs) while sitting, reclining, or lying. [20]
- **Specificity**: Principle that training should be tailored to target specific fitness goals, movements, or muscle groups to achieve optimal performance improvements. It means that adaptations in strength, endurance, or skill development are directly related to the type of exercise performed.
- **Speed**: The ability to move the body or a specific body part quickly from one point to another. It is a crucial component in athletic performance and can be improved through sprint training, strength development, and neuromuscular efficiency.
- **Stress:** The body's physical, mental, and emotional response to external pressures or demands. In the context of exercise, stress can be beneficial in promoting adaptations and growth, but excessive stress without adequate recovery can lead to fatigue, injury, or overtraining.
- **Time**: The duration of a workout session or the length of time spent performing a specific exercise.
- **Type**: The specific kind of physical activity performed, such as aerobic (cardio), resistance (strength training), flexibility, or neuromotor (balance and coordination) exercises.
- **Volume**: The total amount of work performed in a training session or over a specific period. It is typically calculated as the product of sets × repetitions × weight for resistance training or frequency × duration for aerobic exercise, influencing overall training load and progression.

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3: CARDIORESPIRATORY ENDURANCE



Figure 3.1: (Man Jumping by Venti Views on Unsplash)

Introduction

The cardiovascular and respiratory systems work in tandem to deliver oxygen and nutrients throughout the body while removing waste products. The cardiovascular system pumps blood, and the respiratory system manages gas exchange, ensuring that vital compounds reach the cells. Together, they generate energy (ATP), which powers all bodily functions. During physical activity, oxygen is crucial for energy production, relying on three energy systems: aerobic for endurance, anaerobic for short bursts of effort, and immediate for rapid energy needs. Regular exercise enhances cardiovascular and respiratory (CR) fitness, strengthening the heart, improving lung capacity, and lowering resting heart rate, which promotes more efficient energy production and overall health.

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 cardiorespiratory system

3.1: Cardiovascular and Respiratory System

3.2: The Cardiorespiratory System and Energy Production

3.3: The Benefits of Good Cardiorespiratory Health

3.4: Cardiorespiratory Fitness Assessment

3.5: Creating a Plan for Cardiorespiratory Fitness

3.6: Comprehension Check

3.7: Glossary

3.8: References

Thumbnail: A man jumping through the air, seen from the ground. (Man Jumping by Venti Views on Unsplash)
This chapter was remixed and authored by Cheryl Owiesny.

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3.1: Cardiovascular and Respiratory System



Figure 3.1.1: The north face of Mount Everest as seen from a base camp in Tibet. (Everest North Face; Luca Galuzzi via thegoonshow)

Introduction

Imagine, for a moment, climbing to the top of Mt. Everest as seen in Figure 3.1.1, 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 that 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 daily. 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 (heart and blood vessels) and **respiratory system** (blood vessels and lungs) operate 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?

Basic Physiology of Cardiorespiratory Endurance Exercise

A basic understanding of the body processes involved in **cardiovascular endurance** exercise can help individuals design safe and effective programs. The cardiovascular system focuses on the heart and blood vessels, which are responsible for circulating blood throughout the body, delivering oxygen and nutrients, and removing waste products. The **cardiorespiratory system** includes both the cardiovascular and respiratory systems, such as the lungs, and works together to deliver oxygen to the body and remove carbon dioxide.

The Cardiorespiratory System

The cardiorespiratory system is made up of the cardiovascular system (heart, blood vessels) and the respiratory system (air passages, lungs). The cardiorespiratory system circulates blood through the body, delivers essential oxygen, nutrients, and other key substances to the body's organs and tissues that need them. It also carries away and removes carbon dioxide and wastes.

Video: The Cardiorespiratory System 3.1.1

Flow Through the Heart

Length: 7:50 minutes

This educational video from Khan Academy provides a step-by-step explanation of how blood flows through the human heart and circulatory system. It's ideal for students studying human anatomy, physiology, or health sciences, and offers a clear visual overview of the heart's chambers, valves, and blood vessels.

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

Question 3.1.1

Video 3.2.1 Flow Through the Heart video explains how blood flows through the heart and circulatory system. Answer these questions.

- What is the main function of the heart valves, and what might happen if they fail to function properly?
- Compare pulmonary circulation and systemic circulation in terms of their starting points, destinations, and primary functions.

Heart

The heart is a four-chambered (two *atria* and two *ventricles)*, fist-sized muscle located just beneath the sternum (breastbone). The heart pumps oxygen-poor blood to the lungs and delivers oxygen-rich blood to the rest of the body. Arteries and veins go into and out of the heart. Arteries carry blood away from the heart, and veins carry blood to the heart. The flow of blood through the vessels and chambers of the heart is controlled by *valves*. Blood travels through two separate circulatory systems. The right side of the heart pumps blood to the lungs through **pulmonary circulation**. The left side of the heart pumps blood to the rest of the body in **systemic circulation**.

The path of blood flow through the heart and cardiorespiratory system is illustrated in Figure 3.1.2. Below are the steps of blood flow through the body.

1. Waste-laden, oxygen-poor blood travels through large vessels, called **venae cavae**, into the heart's right upper chamber, or **atrium**.
2. After the right atrium fills, it contracts and pumps blood into the heart's right lower chamber, or right **ventricle**.
3. When the right ventricle is full, it contracts and pumps oxygen-poor blood from the right ventricle through the pulmonary artery. The pulmonary artery carries this blood to the lungs.
4. In the Lungs, blood picks up oxygen and releases **carbon dioxide** during gas exchange in the tiny air sacs (alveoli). Oxygen moves from the blood to the lungs by a process called **diffusion**. During exercise, you breathe faster to promote the diffusion of these gases.
5. The clean oxygen-rich blood travels back to the heart through the pulmonary veins into the heart's left atrium.
6. After the left atrium fills, it contracts and pumps blood into the left ventricle.
7. When the left ventricle is full, it pumps blood through the **aorta**, the heart's largest artery, for distribution to the rest of the body's blood vessels (Fahey et al, 2025). [8]

The heart has four valves that prevent blood back-flow and keep blood moving in the right direction: the **tricuspid valve** opens to allow blood flow from the right atrium to the right ventricle; the **pulmonary valve** allows the blood flow from the right ventricle to the lungs; the **mitral valve** allows blood flow from the left atrium to the left ventricle; and the **aortic valve** allows blood flow

into the aorta.

The period of the heart's contraction is called **systole**; the period of relaxation is called **diastole**. During systole, the atria contract first, pumping blood into the ventricles. A fraction of a second later, the ventricles contract, pumping blood to the lungs and the body. During diastole, blood flows into the heart.

Video: 3.1.2 illustrates the essential function and anatomy of the human heart, showing how it pumps blood to deliver oxygen, nutrients, and water throughout the body.

Question

- How does understanding how your heart and lungs work together help you appreciate everyday physical activity?
- When was the last time you were short of breath from physical activity? What did it feel like, and what do you think your body was doing to try to recover?

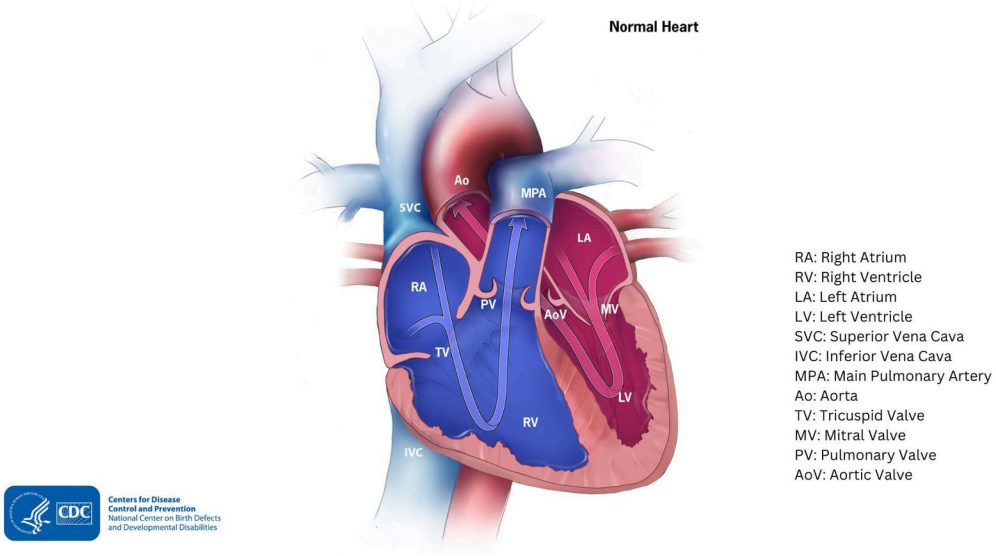


Figure 3.1.2: Blood flow through the heart discussed above. Blue arrows indicated oxygen-poor blood; red arrows indicated oxygen-rich blood. (Diagram of a normal heart; Center for Disease Control)

Blood pressure, the force exerted by blood on the walls of the blood vessels, is created by the pumping action of the heart. During **systole**, or the period when the heart is contracting, blood pressure is greater. During **diastole**, or the period when the heart is relaxing, blood pressure is lower. A person weighing 150 pounds has about 5 quarts of blood, which is circulated about once every minute at rest. Hypertension (high blood pressure) is a major risk factor for heart and kidney disease (Townsend et al, n.d.). [15]

The heartbeat, the split-second sequence of contractions of the heart's four chambers, is controlled by nerve impulses. These signals originate in a bundle of specialized cells in the right atrium called the pacemaker or sinoatrial (SA) node. The heart produces nerve impulses at a steady rate, unless it is sped up or slowed down by the brain in response to stimuli such as exercise

The Blood Vessels

Blood vessels are classified by size and function. **Veins** carry blood to the heart. **Arteries** carry it away from the heart. Veins have thin walls, but arteries have thick elastic walls that enable them to expand and relax with the volume of blood being pumped through them.

The blood vessels are lined with **endothelial cells** that secrete **nitric oxide**, a chemical messenger regulating blood flow. Inflammation, physical inactivity, poor diet, smoking, high blood pressure, or insulin resistance can promote blood vessel disease and interfere with nitric oxide secretion, which has a wide range of negative effects, ranging from erectile dysfunction to heart disease. Regular physical activity helps maintain healthy blood vessels and normal nitric oxide metabolism.

After leaving the heart, the aorta branches into smaller and smaller vessels. The smallest arteries branch still further into **capillaries**, tiny vessels only one cell thick. The capillaries deliver oxygen and nutrient-rich blood to the tissues and pick up oxygen-poor blood, waste-laden blood. From the capillaries, this blood empties into small veins (venules) and then into larger veins that return it to the heart to repeat the cycle.

Blood pumped through the heart doesn't reach the heart's own cells, so the organ has its own network of blood vessels called the **coronary arteries**. Two large vessels, the right and left coronary arteries, branch off the aorta and supply the heart muscles with oxygenated blood. A physically active lifestyle helps prevent coronary heart disease.

The Respiratory System

The **respiratory system** supplies oxygen to the body, carries off carbon dioxide—a waste product of body processes—and helps regulate acid produced during metabolism. Air passes in and out of the lungs as a result of pressure changes brought about by the contraction and relaxation of the diaphragm and rib muscles. As air is inhaled, it passes through the nasal passages, throat, larynx, trachea (windpipe), and bronchi into the lungs. The lungs consist of many branching tubes that end in tiny, thin-walled air sacs called **alveoli**.

Carbon dioxide and oxygen are exchanged between alveoli and capillaries in the lungs. Carbon dioxide passes from blood cells into the alveoli, where it is carried up and out of the lungs (exhaled). Oxygen from inhaled air is passed from the alveoli into blood cells; these oxygen-rich blood cells then return to the heart and are pumped throughout the body. Oxygen is an important component of the body's energy-producing system, so the cardiorespiratory system's ability to pick up and deliver oxygen is critical for the functioning of the body.

The Cardiorespiratory System at Rest and During Exercise

At rest and during light activity, the cardiorespiratory system functions at a fairly steady pace. Your heart beats at a rate of about 50–90 beats per minute, and you take approximately 12–20 breaths per minute. A typical resting blood pressure in a healthy adult, measured in millimeters of mercury, is 120 systolic and 80 diastolic (120/80 mmHg).

During exercise, the demands on the cardiorespiratory system increase. Body cells, particularly working muscles, need to obtain more oxygen and fuel and to eliminate more waste products. To meet these demands, your body makes the following changes:

- Heart rate increases, up to 170–210 beats per minute, during intense exercise.
- The heart's stroke volume increases, meaning that the heart pumps out more blood with each beat.
- The heart pumps and circulates more blood per minute as a result of the faster heart rate and greater stroke volume. During exercise, this cardiac output increases to 20 or more quarts per minute, compared to about 5 quarts per minute at rest.
- Blood flow changes, so as much as 85–90% of the blood may be delivered to working muscles. At rest, about 15–20% of blood is distributed to the skeletal muscles.
- Systolic blood pressure increases, while diastolic blood pressure holds steady or declines slightly. A typical exercise blood pressure might be 175/65. Diastolic pressure is particularly important during exercise because the blood flow to the coronary arteries that supply the heart muscle is greatest during the relaxation phase of the cardiac cycle.
- To oxygenate this increased blood flow, you take deeper breaths and breathe faster, up to 40–60 breaths per minute (Townsend, n.d.). [15]

Question

- When was the last time you were short of breath from physical activity?
  - What did it feel like?
  - What do you think your body was doing to try to recover?
- How might this information change the way you approach your personal fitness or exercise routine?

Key Points

- The cardiorespiratory system includes the heart, blood vessels, lungs, and airways working together to deliver oxygen and remove waste.

- The heart has four chambers and four valves, directing blood flow through the pulmonary and systemic circulation.
- During exercise, the body increases heart rate, stroke volume, breathing rate, and blood flow to muscles to meet oxygen demands.
- Blood pressure rises during exercise, primarily due to increased systolic pressure, while diastolic pressure remains stable or decreases slightly.
- Veins, arteries, and capillaries transport blood and are lined with cells that support healthy circulation.
- The respiratory system enables gas exchange through alveoli, where oxygen enters the blood and carbon dioxide is removed.
- Nitric oxide plays a critical role in blood vessel health and is enhanced by regular physical activity.
- A healthy cardiorespiratory system is essential for energy production, endurance, and disease prevention.

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3.2: The Cardiorespiratory System and Energy Production



Figure 3.2.1: (Running in the hot mountain; Brian Metzler via Unsplash)

Introduction

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 to eat and breathe to live.

Energy Production

Metabolism is the sum of all the chemical processes necessary to maintain the body. These processes require energy to build and repair tissues, contract muscles, conduct nerve impulses, regulate body temperature, and perform other vital functions.

The rate at which your body uses energy, called your **metabolic rate**, varies depending on your activity level. At rest, your metabolic rate is low. Walking raises it, while jogging can increase it by over 800% compared to resting levels. Highly trained distance runners can boost their metabolic rates by more than 2,000%.

Energy from Food

The body transforms chemical energy from food into forms that cells can immediately use or store for later. Efficient storage is essential because releasing all energy at once would be wasteful.

There are three primary energy-containing nutrients: carbohydrates (like sugar, wheat flour, and honey), fats (such as meat, nuts, and fried foods), and proteins (found in seafood, poultry, and dairy). During digestion, most carbohydrates break down into **glucose**, a simple sugar that circulates in the blood as "blood sugar" and provides a quick source of fuel to produce energy.

When energy is not immediately needed, glucose can be stored as **glycogen**, mainly in the liver and muscles, for later use. If glycogen stores are full and the body's immediate need for energy is met, the remaining glucose is converted to fat and stored in the body's fatty tissues.[8] Similarly, excess dietary fat is stored as body fat. While protein's main role is building and repairing tissues, it can also be broken down for energy if needed or stored as fat. In general, glucose, glycogen, and fat are the body's primary fuels; protein becomes a significant energy source only when the others are unavailable.

ATP: The Energy of Cells

Cells rely on adenosine triphosphate (ATP) as their immediate source of energy. When energy is needed, cells break down ATP, releasing it in a usable form. Because cells store only a small supply of ATP, they must continually produce more, especially during physical activity.

ATP is generated through chemical reactions that tap into stored fuels like glucose, glycogen, and fat. During exercise, the demand for ATP surges, prompting the body to mobilize its energy stores. Most ATP is produced within the **mitochondria**, the powerhouse of the cell. Having a high mitochondrial capacity is essential for optimal endurance, better health, and long-term vitality.

Within the context of fitness, the purpose of the cardiorespiratory system is not only to produce energy but also to adapt 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, this athlete can 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!



Figure 3.2.2: Using a rowing machine can be excellent cardiorespiratory exercise. (Indoor rowing; Victor Freitas via Unsplash)

Exercise and the Three Energy Systems

The muscles in your body use three energy systems to create ATP and fuel cellular activity. These systems use different fuels and chemical processes and perform different, specific functions during exercise. Our bodies draw on all three energy systems while active, depending on the duration of the activity.

Immediate/Explosive Energy System

The **immediate, or "explosive," energy system** delivers energy rapidly but only for a short duration. It powers activities lasting about 10 seconds or less, such as weightlifting, shot putting, or everyday movements like standing up from a chair or lifting a grocery bag. This system relies on stored ATP in cells and **creatine phosphate** (CP), a compound that helps regenerate ATP. However, CP levels deplete rapidly during exercise, limiting the system's capacity within seconds. To continue producing energy, cells must then transition to other energy systems to restore ATP and CP levels.

The non-oxidative (anaerobic) energy system is activated at the beginning of exercise and supports high-intensity activities lasting approximately 10 seconds to two minutes, such as a 400-meter sprint. In everyday life, this system helps with short

bursts of movement like running to catch a bus or quickly climbing multiple flights of stairs. It generates ATP by breaking down glucose and glycogen without requiring oxygen, which is why it is known as the anaerobic system. Although its energy production is limited, it can generate a large amount of ATP in a short period of time. For this reason, it is the most important energy system for very intense exercise.

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. This non-oxidative energy system has two primary limitations. First, the body's glucose and glycogen stores are finite, and when depleted, they can lead to fatigue, dizziness, and impaired judgment, as the brain and nervous system depend on carbohydrates for fuel. Second, the rapid metabolism within this system produces hydrogen and potassium ions that interfere with muscle contraction and metabolism, leading to fatigue. During intense activities like sprinting, large increases in hydrogen and potassium ions cause muscles to fatigue rapidly.

The anaerobic system also produces metabolic acids, but regular exercise improves the body's ability to manage them. Improved fitness allows individuals to train at higher intensities before experiencing a sharp increase in metabolic acids, a threshold known as the lactate threshold. One such acid, lactic acid, is commonly associated with fatigue during intense exercise. Lactic acid does not last long in the blood. It quickly breaks down into lactate and hydrogen ions (acid) as soon as it is produced. Lactate itself serves as an important energy source during both rest and exercise, and with training, the body becomes more efficient at utilizing it for fuel.

Oxidative Energy System (Aerobic)

The **oxidative (aerobic) energy system** powers physical activities lasting longer than two minutes, such as distance running, swimming, hiking, or even standing in line. Figure 3.2.1 a distance runner in the mountains and Figure 3.2.2 an indoor rower are examples of the oxidative (aerobic) energy system. This system requires oxygen to generate ATP, making it an aerobic system. While it produces energy at a slower rate compared to the other two systems, it has the advantage of sustaining energy production for much longer periods. As a result, it serves as the primary energy source for most daily activities.

In the oxidative energy system, ATP production occurs within cellular structures called mitochondria. These mitochondria can generate ATP using either carbohydrates (glucose and glycogen) or fats, providing the body with a much larger fuel reserve compared to the other two energy systems. The type of fuel used depends on exercise intensity, duration, and an individual's fitness level. Carbohydrates are the primary fuel source during higher-intensity exercise (above 65% of maximum effort), while fats are utilized during low-intensity activities.

At the beginning of prolonged exercise, carbohydrates serve as the main energy source, but as the workout continues, fat utilization increases. Individuals with higher fitness levels rely more on fat for energy, as improved conditioning allows them to perform activities at lower relative intensities. This adaptation is crucial because glycogen depletion is a limiting factor in the oxidative system. By utilizing more fat as fuel, a fit person can extend their endurance before glycogen levels run low and fatigue sets in.

Aerobic exercise and high-intensity interval training enhance the number and capacity of mitochondria. This increase in mitochondrial function is one of the most significant benefits of exercise, as mitochondrial health is closely linked to reduced disease risk and greater longevity.

Oxygen availability is another key factor that limits exercise capacity. The oxidative energy system's oxygen demand increases in proportion to exercise intensity—higher intensity requires greater oxygen consumption. However, the body's ability to increase oxygen use has a limit, known as **maximal oxygen consumption or VO_2 max**. This represents the highest rate at which an individual can consume oxygen during maximum physical effort and is measured in milliliters of oxygen per kilogram of body weight per minute or in liters per minute. In the symbol, V represents volume, the dot above it indicates per minute, the O_2 stands for oxygen, and max means maximum. VO_2max determines how intensely a person can perform endurance exercise and for how long, and it is considered the best overall measure of the capacity of the cardiorespiratory system.

Table 3.2.1 outlines the three energy systems your body uses to fuel movement, depending on the intensity and duration of activity. Each system plays a role depending on how hard and how long you're working. Understanding them helps explain how your body produces energy during different types of exercise.

Table 3.2.1 Characteristics of the Body's Energy Systems

Energy System	Duration of Activity for which the system predominates	Intensity of activity for which system predominates	Rate of ATP production	Fuel	Oxygen used?	Sample Activities
Immediate Energy System	0-10 seconds	High	Immediate, very rapid	Adenosine Triphosphate (ATP), Creatinine Phosphate (CP)	No	Weight lifting, picking up a bag of groceries
Nonoxidative Energy System	10 seconds- 2 minutes	High	Rapid	Muscle stores of glucose and glycogen	No	400-meter run, running up several flights of stairs
Oxidative Energy System	≥ 2 minutes	Low to moderately high	Slower, prolonged	The body stores glycogen, glucose, fat, and protein	Yes	1500-meter run, 30-minute walk, standing in line for a long time
*For most activities, all three systems contribute to energy production. The duration and intensity of the activity determine which system predominates.						

Energy Systems in Combination

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. Your body typically uses all three systems when you exercise. The intensity and duration of the activity determine which system predominates. 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.

Question

- How does understanding the body’s three energy systems help you choose the right type of exercise for your goals?
- Think of a time you felt winded during physical activity—what do you think was happening in your body at the cellular level?

Physical Fitness and Energy Production

Physically fit individuals can significantly increase their metabolic rate, allowing them to generate the energy needed for sustained or intense exercise. In contrast, those who are not physically fit struggle to respond to exercise in the same way. Their bodies are less efficient at delivering oxygen and fuel to working muscles, they burn fewer calories during and after exercise, and they have a harder time managing lactate and other substances produced during intense physical activity, which contribute to fatigue. As a result, they fatigue more quickly, their legs hurt, and they breathe heavily when walking up a flight of stairs. However, regular physical training can improve the body’s ability to produce energy and adapt to increased physical demands.

When designing an exercise program, it’s essential to focus on the energy system that aligns with your fitness goals. Because improving the functioning of the cardiorespiratory system is critical to overall wellness, endurance exercise that utilizes the oxidative energy system, activities performed at moderate to high intensities for a prolonged duration, is a key component of any health-related fitness program.

An improvement in CR functioning, or fitness level, requires adaptation of the system. Remember, the point is to generate ATP

more effectively so more work can be accomplished. To process more oxygen and deliver more oxygenated blood to the cells, the overall system must change to make this possible. Here is a list of adaptations that occur in the CR system as a result of regular 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 bloodstream 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-venous difference (a-VO_2diff).

These changes in the system are not permanent because of a process known as the principle of reversibility. The principle of reversibility was covered in Chapter 2. Following a period of inactivity, the benefits of chronic aerobic exercise will be reversed.

The Cardiorespiratory System at Rest and During Exercise



Figure 3.2.3: Cycling workouts have periods of rest between periods of exercise. (Stationary bike; Intenza Fitness via Unsplash)

Your cardiorespiratory system must adapt to meet your body's needs during exercise and general exertion.

At rest, your body works to maintain **homeostasis**, a stable, constant internal environment. If you're healthy, your resting heart rate is between 50 and 90 beats per minute, your breathing rate is around 12 to 20 breaths per minute, and your resting blood pressure is below 120 systolic and below 80 diastolic. During homeostasis, your oxygen and nutrient delivery match the needs of your cells. Your body breaks down fat via the oxidative energy system in order to supply ATP to the body. Although you "burn" fat for energy, your total energy expenditure is low.

Response to Exercise

Physical activity disrupts your body's homeostasis. During exercise, your body must increase blood flow to working muscles to maintain adequate oxygen and nutrient delivery. Your heart rate increases, and stronger heart contractions increase cardiac output, the amount of blood exiting your heart in one minute. Your breathing rate also increases to ensure that adequate oxygen is transferred into the blood for working muscles.

During exercise, the heart pumps more blood into the vessels, raising systolic blood pressure. The body directs this increased flow to working muscles, causing blood vessels to dilate and accommodate the demand. This dilation helps maintain or even lower

diastolic blood pressure during aerobic activity. Additionally, previously inactive capillaries open to enhance oxygen and nutrient exchange with muscles.

At the start of exercise, your body takes a few minutes to increase blood flow and activate the oxidative energy system. During this transition, it relies on the faster, immediate, and non-oxidative energy systems. Since oxidative ATP production is slower, your body may need to repeatedly use the non-oxidative system for quick energy bursts throughout your workout.

For example, if you are jogging and suddenly sprint to the end of the street, your oxidative energy system may not be able to supply ATP quickly enough. Your body will then draw upon the non-oxidative system (which breaks down glucose quickly) to supply the additional ATP you need.

Regular cardiorespiratory training produces a wide range of physiological adaptations that improve the efficiency of the cardiovascular, respiratory, and muscular systems. These changes not only enhance aerobic performance and energy production but also contribute significantly to long-term health, disease prevention, and overall wellness. As a result of consistent aerobic conditioning, the body undergoes the following beneficial changes:

Cardiorespiratory Training Decreases

- Resting heart rate
- Fatigue in respiratory muscles
- Lactic acid is produced in submaximal exercise
- Glucose is used for energy in exercise
- Percentage of body fat (with calorie restriction)
- Blood pressure
- LDL cholesterol
- Blood triglycerides

Cardiorespiratory Training Increases

- VO_2 max
- Maximal cardiac output
- Maximal stroke volume
- Heart contraction strength
- Left ventricle volume
- Total blood volume
- Plasma volume
- Red blood cell mass/hemoglobin
- Mitochondria density
- Capillary density
- Fat is used for energy in exercise
- Muscle endurance
- Muscle glycogen stores
- Muscle blood flow
- HDL cholesterol (Hopson et al, 2014) [13]

Question

- Why do you think highly trained athletes can perform at such high intensities for long durations compared to untrained individuals?
- If your cardiorespiratory system becomes more efficient, how might that change your everyday life or ability to participate in physical activities?

Key Points

- The cardiorespiratory (CR) system delivers oxygen to cells, enabling ATP (energy) production required for life and movement.

- ATP is produced using three energy systems: immediate (ATP-CP), non-oxidative (anaerobic), and oxidative (aerobic).
- Energy system dominance depends on exercise intensity and duration, but all systems work together.
- The oxidative (aerobic) system supports long-duration activities and is most influenced by cardiorespiratory training.
- Regular aerobic exercise increases oxygen delivery, improves mitochondrial function, and boosts VO_2 max.
- Cardiorespiratory adaptations include lower resting heart rate, greater stroke volume, increased fat use, and reduced fatigue.
- The principle of reversibility means fitness gains will decline without continued exercise.
- Designing effective exercise programs requires targeting the right energy systems based on fitness goals.

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3.3: The Benefits of Good Cardiorespiratory Health



Figure 3.3.1: Jogging is one of many activities that strengthen the heart and lungs and also provide physical, mental, and emotional benefits. (Man running; Hoang Loc on Unsplash)

Introduction

It's no secret that an invigorating cardio session can make you feel fantastic, but the amazing benefits of this practically perfect form of exercise don't end there. Cardiorespiratory endurance exercise, like walking, running, swimming, or cycling, helps the body become more efficient and able to cope better with physical challenges. Figure 3.3.1 is a man participating in jogging, one of many activities one can choose from to strengthen the heart and lungs, but also provides wide-ranging physical, mental, and emotional benefits. It also lowers the risk of many chronic diseases.

Improved Cardiorespiratory Functioning

Regular endurance exercise leads to short-term and long-term adaptations in the cardiorespiratory system, making daily tasks easier and improving the body's ability to handle physical challenges. These adaptations enhance overall cardiovascular efficiency and contribute to better health. Endurance exercise enhances the heart's health by doing the following:

- Enhances heart muscle efficiency, allowing the heart to pump more blood per beat, which lowers resting heart rate by 10–20 beats per minute compared to that of unfit individuals. This can result in up to 10 million fewer heartbeats per year.
- Strengthens heart contractions, making the heart more effective at circulating blood.
- Enlarges the heart’s cavity size (especially in young adults), allowing it to accommodate and pump more blood.
- Boosts blood volume, leading to larger stroke volume (more blood pumped per beat), improving circulation and helping with temperature regulation, which reduces strain on the heart.
- Reduces blood pressure, decreasing stress on arteries and lowering the risk of heart disease.
- Lowers cholesterol and triglycerides, while increasing HDL ("good" cholesterol), significantly reducing the risk of coronary artery disease.
- Stabilizes the heart's electrical activity, reducing the likelihood of cardiac arrest and other heart rhythm disorders.
- By consistently engaging in endurance exercise, individuals can achieve significant improvements in heart function, circulation, and overall cardiovascular health, leading to greater long-term fitness and disease prevention (Fahey et al, 2025). [8]

Improved Cellular Metabolism

- Regular endurance exercise enhances the body's metabolism at the cellular level, improving the efficiency of energy production and utilization. Cardiorespiratory training supports metabolism through the following mechanisms:
- Enhanced muscle efficiency: Trained muscles become more effective at utilizing oxygen and fuel, so they work more efficiently.
- Greater mitochondrial capacity: Endurance exercise increases both the size and number of mitochondria in muscle and brain cells, increasing the cells' energy capacity.
- Improved fuel utilization: Training prevents glycogen depletion and increases the muscle's ability to use lactate and fat as fuels.
- Optimized cell function: Increased activity of cell pumps for sodium, potassium, and calcium, which normalizes cell function and prevents fatigue and abnormal heart rhythms.
- Regular exercise may also help protect cells from chemical damage caused by agents called free radicals (Fahey et al, 2025). [8]

The most effective fitness programs for metabolic efficiency include a combination of long-duration, moderately intense endurance exercise and brief periods of more intense effort. For example, activities like jogging or cycling with short bursts of hill climbing encourage more efficient utilization of lactate and fats, optimizing metabolism over time.



Figure 3.3.2: "Protect Yo Heart" (Protect yourself, your heart, stay home; Illona Bellottoa on Unsplash)

Reduced Risk of Chronic Disease

Regular endurance exercise significantly reduces the risk of chronic, disabling diseases and helps individuals already living with these conditions improve their overall health. The greatest benefits are seen when sedentary individuals transition to a moderately active lifestyle, leading to substantial improvements in well-being and disease prevention. Figure 3.3.2 is a simple message: take care of your heart for long-term health.

Cardiovascular Disease

A sedentary lifestyle is a major risk factor for cardiovascular disease (CVD). CVD is a general category that encompasses several diseases of the heart and blood vessels, including heart disease, stroke, and high blood pressure. CVD is a general category that encompasses several diseases. Inactive individuals face a significantly higher risk of death from CVD than those who are physically fit.

Cardiorespiratory endurance exercise lowers your risk of CVD by doing the following:

- Promoting a healthy balance of fats in the blood. High concentrations of blood fats such as cholesterol and triglycerides are linked to CVD. Exercise raises levels of “good cholesterol” (high-density lipoproteins, or HDL) and may lower levels of “bad cholesterol” (low-density lipoproteins, or LDL).
- Reducing high blood pressure, which is a contributing factor to several kinds of CVD.
- Boosting cell pump activity (sodium-potassium and calcium pumps) that help maintain internal cellular health.
- Enhancing the capacity of cell mitochondria.
- Enhancing the function of the cells that line the arteries (endothelial cells).
- Reducing chronic inflammation.
- Preventing obesity and type 2 diabetes, both of which contribute to CVD (US Department of Health and Human Services, 2018). [17]

Details on various types of CVD, their risk factors, and a lifestyle that can reduce your risk for developing CVD are further explored in a later chapter.

Cancer

- Studies suggest exercise reduces the risk of colon, breast, reproductive, lung, endometrial, pancreatic, and prostate cancers.
- Physical activity during high school and college years may help prevent breast cancer later in life.

Type 2 Diabetes

Regular exercise helps prevent the development of type 2 diabetes, the most common form of diabetes. Physical activity is also an important part of treating the disease.

- Obesity is a key risk factor for diabetes, and exercise helps keep body fat at healthy levels.
- Even without fat loss, exercise improves control of blood sugar levels in many people with diabetes.
- Exercise metabolizes (burns) excess sugar and makes cells more sensitive to the hormone insulin, helping regulate blood sugar levels
- Physical activity has therapeutic effects, can reduce comorbidities, and can prevent risk factors that contribute to the progression of type 2 diabetes (US Department of Health and Human Services, 2018). [17]

Osteoporosis

A special benefit of exercise, especially for women, is protection against osteoporosis, a disease that results in loss of bone density and strength.

- Weight-bearing exercise—particularly weight training—helps build bone during the teens and 20's.
- People with denser bones can better endure the bone loss that occurs with aging.
- Stronger bones and muscles, along with better balance, reduce the risk of falls and fractures.

Inflammation

Inflammation is the body’s response to tissue and cell damage (from injury, high blood pressure, intense exercise), environmental toxins (e.g., cigarette smoke), or poor metabolic health (such as high blood fats and poor blood sugar control).

- Acute inflammation is a short-term response to exercise and helps the body improve fitness. For example, short-term inflammation triggers muscle protein synthesis, promoting muscle fitness and recovery.
- Chronic inflammation, on the other hand, is an abnormal, prolonged process that contributes to tissue breakdown and diseases such as atherosclerosis, cancer, and rheumatoid arthritis.
- Moderate endurance training (3–5 days per week) reduces chronic inflammation, particularly when accompanied by weight and fat loss.
- Excessive training (e.g., running multiple marathons per month or doing severe cross-training workouts 5–7 days per week) can lead to overtraining and increased chronic inflammation.

This concept follows the Goldilocks effect: The training program should be neither too much nor too little—it should be just right.

Deaths from All Causes

Physically active people have a reduced risk of dying prematurely from all causes, with the greatest benefits found in those with the highest levels of physical activity and fitness. Physical inactivity is a predictor of premature death and is as significant a risk factor as smoking, high blood pressure, obesity, and diabetes.

Question

- How does the “Goldilocks effect” apply to endurance exercise, and what are the risks of doing too little or too much?
- Imagine you are advising someone new to exercise who wants to reduce their risk for chronic disease. What types of endurance activities would you recommend, and why?

Better Control of Body Fat

Too much body fat is linked to a variety of health problems, including cardiovascular disease, cancer, and type 2 diabetes. Maintaining a healthy body composition can be challenging, especially for sedentary individuals, because a diet that contains all essential nutrients can be relatively high in calories. Excess calories are stored in the body as fat. Regular exercise increases daily calorie expenditure, which means a healthy diet is less likely to lead to weight gain. Endurance exercise burns calories directly and, if intense enough, continues to raise resting metabolic rate for several hours following an exercise session. A higher metabolic rate makes it easier for a person to maintain a healthy weight or to lose weight.

Improved Immune Function

Exercise plays a crucial role in supporting the immune system, which defends the body against colds, infections, and even serious illnesses like cancer. Moderate endurance exercise strengthens immunity, helping the body fight off infections more effectively. However, excessive training can temporarily weaken immune function, making individuals more susceptible to illness. Those who maintain regular physical activity tend to experience fewer colds and respiratory infections compared to those who are less active.

Exercise plays a key role in boosting immune function by supporting the body's specialized immune cells and chemical responses. Regular physical activity has also been linked to stronger, more resilient genes, which enhance overall immunity. Additionally, exercise helps maintain telomere length—the protective ends of DNA strands that naturally shorten over time. By staying active, you can slow down this process, keeping your immune system functioning effectively for longer.

In addition to regular moderate exercise, you can further strengthen your immune system by eating a well-balanced diet, managing stress, and getting seven to eight hours of sleep every night.

Improved Psychological and Emotional Well-being

Engaging in regular endurance exercise offers social, psychological, and emotional benefits. Developing new skills and self-discipline can improve self-confidence, while recreational sports provide a great way to connect with others, have fun, and challenge yourself.

Endurance exercise also plays a key role in reducing stress, anxiety, depression, anger and frustration. Helping to improve your mood while boosting cardiovascular health. In addition to disease prevention benefits, regular physical activity provides a variety of other benefits, including helping people sleep better, feel better, and perform daily tasks more easily (US Department of Health and Human Services, 2018). [17]

Key Points

- Cardiorespiratory endurance exercise improves heart, lung, and muscle efficiency, making daily activities easier and enhancing overall health.
- Regular exercise strengthens the heart, lowers resting heart rate, improves circulation, and reduces blood pressure and cholesterol.
- Endurance training boosts cellular metabolism by increasing capillary density, mitochondrial function, and fuel efficiency.

- Consistent physical activity lowers the risk of cardiovascular disease, type 2 diabetes, certain cancers, and osteoporosis.
- Moderate exercise reduces harmful chronic inflammation, while overtraining or inactivity can increase health risks (Goldilocks effect).
- Maintaining physical activity supports healthy body composition, strengthens the immune system, and promotes longer life expectancy.
- Exercise improves blood sugar regulation, prevents obesity, and enhances insulin sensitivity, crucial for diabetes prevention.
- Psychological and emotional well-being are enhanced through endurance exercise, leading to reduced stress, better sleep, and improved self-confidence.

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3.4: Cardiorespiratory Fitness Assessment

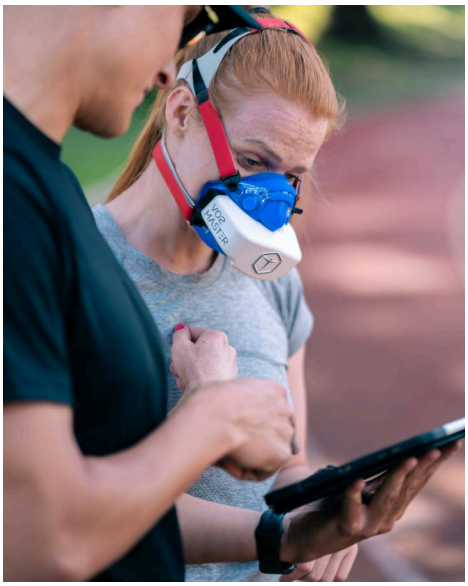


Figure 3.4.1: The VO_2 Master measures an individual's maximum oxygen consumption during intense exercise. It transmits test results to a mobile app. (Woman VO_2 master mask; VO_2master via Unsplash)

Introduction

Cardiorespiratory fitness varies among individuals, and most people have a general sense of their fitness level. For example, those who become easily winded after climbing a short flight of stairs or have difficulty walking briskly for more than 10 minutes may have a lower level of cardiorespiratory fitness.

Monitoring Heart Rate

Every time the heart contracts, it pumps blood into the arteries. **Heart rate** refers to the number of times the heart beats per minute (bpm). Monitoring resting heart rate (RHR) is a useful way to track changes in overall fitness. As the cardiorespiratory system becomes more conditioned, resting heart rate tends to decrease. With an increase in stroke volume, the heart does not need to beat as often to deliver adequate blood throughout the body. Even at rest, the heart can slow down while still providing sufficient oxygen to the body's cells. Heart rate serves as an indicator of how hard the heart is working during both rest and physical activity.
Affordable and accurate heart rate monitors are available for home use. In addition, many smartphone apps can measure heart rate, track distances, provide route maps, calculate running or cycling speed, estimate calories burned, and even monitor the heart's electrical activity during each beat.

When the heart contracts and forces blood through the arteries, this wave can be felt as a pulse. To determine heart rate manually, individuals can feel for their pulse at specific arteries in the body, most commonly the carotid artery in the neck or the radial artery in the wrist.

To measure heart rate manually, one should place the index and middle fingers on a pulse point, either at the radial artery or the carotid artery. The thumb should not be used, as it has its own pulse that may interfere with accuracy. Counting the pulse for a full minute during exercise is generally impractical, as heart rate begins to decline immediately after stopping activity, which may lead to an inaccurate reading. Instead, shorter time intervals are recommended: counting for 15 seconds and multiplying by 4, for 6 seconds and multiplying by 10, or for 10 seconds and multiplying by 6 to estimate beats per minute. Video 3.4.1 demonstrates how and where to measure the pulse accurately.

Before beginning a VO_2 max assessment, individuals should first measure their resting heart rate, as it is essential to the calculation process. Monitoring heart rate can help track improvements in cardiovascular fitness, ensure exercise is performed

within the appropriate intensity zone, monitor post-exercise recovery, and detect signs of overtraining or potential health concerns.

This short animated Video 3.4.1 introduces students to the basics of heart rate monitoring. The video demonstrates how to find and count your pulse using your wrist or neck. It explains how to calculate beats per minute and highlights how heart rate can change in response to physical activity or emotions.

Video 3.4.1 Brain Bites-Heart Rate

Length: 2 minutes 38 seconds

This is an instructional video for students to learn and practice taking their radial and carotid pulse and calculating their heart rate at rest and during exercise.

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

Question

- Why is it recommended to avoid using your thumb when checking your pulse?

Understand Maximal Oxygen Consumption

The body's ability to maintain a level of exertion (exercise) over an extended period of time is a key indicator of cardiorespiratory fitness. This fitness level is determined by how efficiently the body takes in, distributes, and utilizes oxygen during exercise. A crucial measure of cardiorespiratory endurance is maximal oxygen consumption (VO_2 Max), which represents the maximum amount of oxygen the body can use when an individual reaches peak effort. More accurate assessments require a lab-based VO2 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, it is time-consuming, expensive, and not widely available, making it impractical for most.

To effectively begin a personal fitness program, it is essential to assess your current fitness level. Multiple methods exist for assessing a person's level of fitness. Including walking and jogging assessments that estimate key physiological markers of heart and lung functioning capacity, particularly VO_2 max. Maximal oxygen consumption directly correlates with overall health and fitness. Since VO_2 max directly correlates with overall health and fitness, obtaining a reliable estimate provides valuable insight into an individual's current fitness level. Additionally, it serves as a baseline for future reassessments, allowing individuals to track improvements over time.
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. 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.

In Figure 3.4.1, a woman is wearing a VO_2 Master mask. The VO_2 Master is a portable, battery-powered device designed to conduct VO_2 max tests, which measure an individual's maximum oxygen consumption during intense exercise. It attaches to a standard silicone face mask and transmits test results to a compatible mobile app. This tells you how fit your heart, lungs, and muscles are, basically, how good your body is at using oxygen to make energy during exercise.

Question

- Have you ever felt out of breath during daily tasks like climbing stairs or brisk walking?

- What might that tell you about your current fitness level?
- Why do you think it's important to track improvements in heart rate and fitness over time?

Measuring Intensity

Intensity may be the most important aspect of the FITT-VP 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 (Max Heart Rate Method and Karvonen Method, or the **Heart Rate Reserve**). Keep in mind, finding the THR is the objective in both methods, even though slightly different numbers are used.
The first method, called the 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 = THRLow
   - MHR x .80 =THRHigh
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.

An example calculation with a female, aged 20:

1. MHR = 220 -20
   - MHR = 200 bpm;
2. THR_{low} = 200 x .60
   - THR_{low} = 120 bpm
3. THR_{high} = 200 x .80
   - THR_{high} = 160 bpm
4. 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.

Available online is the Target Heart Rate (THR) Calculator. The calculator on Heart Online assists individuals in determining their optimal heart rate ranges for exercise, ensuring workouts are conducted at desired intensities. It utilizes the Karvonen formula, which factors in an individual's heart rate reserve (HRR) and maximum heart rate (HR_max), to compute these ranges.

More to Explore

Calculator Soup is a website that has online calculators to assist in determining your target heart rate.

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.
   - THRlow = HRR x .60 + RHR
   - THRhigh = HRR x .80 + RHR
5. The resulting low and high THR numbers represent the range, or target intensity.
6. The Karvonen formula requires a few more steps, specifically, incorporating the resting heart rate. Using the same female in the example above, along with a randomly selected RHR, the THR looks like this:
7. MHR=220–20
   - MHR = 200
8. RHR = 72 bpm (randomly selected)
9. HRR=MHR–RHR
   - HRR=200–72
   - HRR = 128
10. THRlow=HRRx.60+RHR
    - THRlow=128x.60+72
    - THRlow = 149 bpm
11. THRhigh = HRR x .80 + RHR
    - THRhigh=128x.80+72
    - THRhigh = 174 bpm
12. THR=149–174 bpm

A comparison of the two methods reveals that the low and high ends of the Karvonen formula are much higher than the Max Heart Rate method, even though the 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.

Question

- What challenges or advantages might you face when trying to exercise at your target heart rate?

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, they 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 points of the scale are less intuitive than a typical scale of 1-10 (Borg, 1990). [5] By design, the 6 represents a resting heart rate of 60 bpm, and the 20 represents an exercise heart rate of 200 bpm, which is 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.

Another simple way to estimate cardiovascular exercise intensity is the Talk Test. Walking and jogging not only benefit physical health, but many also 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. As a rule of thumb, 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 breath. Like RPE, the Talk Test is yet another way to subjectively measure intensity, which can then correlate with heart rates.

Ratings of Perceived Exertion 3.4.1

The Borg Rating of Perceived Exertion (RPE) scales are valuable tools for assessing exercise intensity based on individual perception.
For a more detailed overview of the Borg RPE scales, including instructions and applications, refer to the following resource:

Borg Scale from HeartOnline.org

Cardiorespiratory Fitness Assessment

Assessing cardiorespiratory fitness is important because it helps you know your overall health scores. As a reminder, cardiorespiratory fitness is important because it:

- Lower your risk of chronic diseases like heart disease, obesity, diabetes, and some cancers
- Improve your ability to perform daily activities
- Track your improvements as you become more active

Choosing an Assessment Test

Several simple assessment tests provide reasonably good estimates of maximal oxygen consumption. Here is a list of commonly used assessments:

- The Cooper 1.5 Mile Walk/Run Test. Run 1.5 miles as fast as possible. If you cannot run the entire time, then take walking breaks. The finish time is used to estimate VO_2 max (maximum oxygen consumption), a key indicator of aerobic fitness. Best for relatively fit individuals.
- The 1-Mile Walk Test. Walk 1 mile as fast as possible while maintaining a steady pace. At the end, heart rate is recorded and used along with time, weight, and age to estimate VO_2 max. Ideal for less fit or older populations. A faster time and lower heart rate indicate a higher level of fitness.
- The 3-Minute Step Test. Involves stepping up and down on a platform (usually 12 inches) for 3 minutes at a set cadence (e.g., 96 bpm). Heart rate is measured immediately after stopping to assess recovery rate and cardiovascular endurance.
- The Beep Test. To assess cardiovascular endurance (aerobic fitness) by measuring how long a person can sustain running between two points in time with beeps that gradually increase in speed. This test is excellent for physically fit people who want to measure capacity for high-intensity exercise, such as sprints.
- 12-Minute Swim Test. To estimate aerobic capacity (VO_2max) by measuring the distance swum in 12 minutes. It's ideal for individuals who are more comfortable in the water or have joint limitations that make running problematic.
- 12-Minute Run The Cooper Run- Run or walk as far as you can in 12 minutes. The total distance covered is then used to

estimate VO_2max, a key indicator of aerobic capacity.

To assess yourself, choose one of these methods based on access to equipment, current physical condition, and preference. Before taking any of these tests, be sure to check in with your physician if you are ill or have any risk factors. In Section 3.10, Labs and Activities, detailed instructions on the assessments are provided.

Guidance Based on Current Level of Physical Activity

Are you inactive, insufficiently active, active, or highly active? Below is guidance specifically for your current fitness level.

Inactive means not getting any moderate- or vigorous-intensity physical activity beyond basic movement from daily life activities.

- For inactive people, that is, people who do not do any moderate or vigorous-intensity physical activity beyond basic movement from daily life activities:
  - Reducing sedentary behavior has health benefits. It reduces the risk of all-cause mortality, cardiovascular disease incidence and mortality, and the incidence of type 2 diabetes and some cancers. A good first step is to replace sedentary behavior with light-intensity physical activity. Previously, evidence that light-intensity physical activity could provide health benefits was not sufficient to support a recommendation.
  - No matter how much time they spend in sedentary behavior or light-intensity activity, inactive people can reduce their health risks by gradually increasing their moderate-intensity physical activity.

Insufficiently active means doing some moderate- or vigorous-intensity physical activity but less than 150 minutes of moderate-intensity physical activity a week or 75 minutes of vigorous-intensity physical activity or the equivalent combination. This level is less than the target range for meeting the key guidelines for adults.

- For insufficiently active people, that is, people who do some moderate- or vigorous-intensity physical activity, but who do not yet meet the key guidelines target range (150 to 300 minutes a week of moderate-intensity physical activity for adults):
  - Even small increases in moderate-intensity physical activity provide health benefits. No threshold must be exceeded before benefits begin to occur.
  - Greater benefits can be achieved by reducing sedentary behavior, increasing moderate-intensity physical activity, or a combination of both.
  - For any given increase in moderate-to-vigorous physical activity, the relative gain in benefits is greater for insufficiently active people than for people who are already meeting the key guidelines.

Active means doing the equivalent of 150 minutes to 300 minutes of moderate-intensity physical activity a week. This level meets the key guideline target range for adults.

- For active people, that is, people who already meet the key guidelines (150 to 300 minutes a week of moderate-intensity physical activity for adults):
  - Although those within the target range already have substantial benefits from their current volume of physical activity, more benefits can be gained by doing additional moderate-to-vigorous physical activity or reducing sedentary behavior.

Highly active means doing the equivalent of more than 300 minutes of moderate-intensity physical activity a week. This level exceeds the key guideline target range for adults.

- For highly active people, that is, people who do more than the equivalent of 300 minutes a week of moderate-intensity physical activity:
  - These people should maintain or increase their activity level by doing a variety of activities.

Question

- If you were to begin a fitness program, which assessment would best suit your current lifestyle and why?
- Explain why practicing taking your pulse before a fitness test is important.

Digging Deeper into Assessments

Here is a collection of websites offering assessment tools, VO_2 max calculators and charts, instructional videos, and more. I encourage you to explore these resources to deepen your understanding of fitness testing and exercise guidelines.

- The Beep Test Guide is a comprehensive resource on the Beep Test, providing detailed information on its purpose, procedures, and use for assessing aerobic fitness.
- Top End Sports provides a large variety of information on fitness testing, fitness training, nutrition, sports science, and more.
- Why I Exercise is an educational platform created by physical therapist Rob Cowell, PT, aimed at helping individuals assess and enhance their health and fitness through evidence-based tools and programs. It offers self-assessments, home workouts, health calculators, and educational content to support sustainable fitness habits. Overall, the website serves as a comprehensive resource for individuals seeking to improve their physical health through informed, practical, and accessible means.
- Exercise Prescription on the Internet has a calculator to calculate your estimated VO_2 max based on the distance in miles you cover during the 12-Minute Run test. A ranking of your fitness category based on your sex and age group is also provided.

Key Points

- Cardiorespiratory fitness reflects how efficiently the heart and lungs supply oxygen during physical activity.
- Resting heart rate tends to decrease as fitness improves due to a stronger, more efficient heart.
- VO_2 max is the most accurate indicator of cardiorespiratory fitness and can be estimated through field tests.
- Common field assessments include the 1-Mile Walk, 1.5-Mile Run, 12-Minute Run, 3-Minute Step Test, and Beep Test.
- Heart rate monitoring helps determine workout intensity and tracks progress.
- Target heart rate zones are calculated using either the Max Heart Rate or Karvonen methods.
- Other intensity tools include RPE scales and the Talk Test, which provide useful alternatives to heart rate monitoring.
- Selecting the right assessment depends on individual fitness level, goals, and equipment availability.

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3.5: Creating a Plan for Cardiorespiratory Fitness



Figure 3.5.1: A group of people participating in cycling class on the beach. (People sitting on brown beach; Oxana on Unsplash)

Introduction

Once cardiorespiratory assessments have been completed, the next step is to develop a structured fitness plan aimed at maintaining or improving your current level of fitness. A well-designed fitness program should be safe, effective, and tailored to individual goals, abilities, and health status. How about taking a group exercise cycling class outside on a beautiful beach, as seen in Figure 3.5.1?

Developing a Cardiorespiratory Fitness Program

Start by identifying your personal cardiorespiratory fitness goals—whether you aim to improve endurance, lose weight, manage stress, or enhance overall cardiovascular health. These goals will guide your program design and help you stay motivated over time.

To achieve these goals, apply the principles of adaptation that govern how the body responds to training. Two essential principles are:

Specificity – Training should be specific to the type of fitness you want to improve. For cardiorespiratory endurance, choose aerobic activities that involve large muscle groups, such as walking, running, swimming, or cycling.

Progressive Overload – To see continued improvements, gradually increase the demands placed on your cardiorespiratory system. This may involve increasing the duration, intensity, or frequency of your workouts.

These principles are applied using the FITT-VP Principle, which provides a guideline for organizing your exercise program. By applying these principles and adjusting your routine over time, you can build a cardiorespiratory fitness program that promotes long-term health, performance, and well-being.

This section will also touch on warm-up and cool-down, maintaining cardiorespiratory fitness, and exercise safety and injury prevention.

FITT-VP Principle for Cardiorespiratory Fitness

The FITT-VP framework—Frequency, Intensity, Time, Type, Volume, and Progression—provides the foundation for designing a safe and effective cardiorespiratory fitness program. Understanding how to apply each component will help individuals improve endurance, cardiovascular health, and overall fitness in a structured and sustainable way (Bushman, 2017). [6]

Frequency

How often do you exercise

Recommendation:

Healthy adults should engage in cardiorespiratory exercise 3 to 5 days per week.

Application:

- For moderate-intensity activities (like brisk walking), aim for at least 5 days per week.
- For vigorous-intensity activities (like running or interval training), 3 days per week may be sufficient.
- A combination of moderate and vigorous activity on alternate days is also effective.

Why It Matters:

Regular frequency ensures ongoing cardiovascular adaptations and helps establish a consistent exercise habit. Too little may limit benefits; too much without rest may lead to over-training.

Intensity

How hard does a person exercise?

Recommendation:

Exercise should be performed at a moderate to vigorous intensity, depending on fitness level and goals.

Common Methods to Monitor Intensity:

- Heart Rate Reserve (HRR) method: 40–85% of HRR is the recommended range.
- Target Heart Rate Zone: 50–85% of MHR. See Table 3.6.1
- Rating of Perceived Exertion (RPE): Aim for 12–16 on the Borg scale (6–20 scale) or 4-6 on the modified Borg scale.
- Talk Test: You should be able to talk, but not sing, during moderate-intensity activity; vigorous activity allows only brief phrases.

Why It Matters:

Working at the right intensity ensures that the cardiovascular system is being challenged enough to improve, without excessive strain that increases the risk of injury or burnout.

Table 3.5.1: Target Heart Rate Zones by age

Age	Target Heart Rate Zone 50-85%	Age-Predicted Maximum Heart Rate	15 Second Count (beats)
20 years	100-170 beats per minute (bpm)	200 bpm	25-43
30 years	95-162 bpm	190 bpm	24-41
35 years	93-157 bpm	185 bpm	23-39

Age	Target Heart Rate Zone 50-85%	Age-Predicted Maximum Heart Rate	15 Second Count (beats)
40 years	90-153 bpm	180 bpm	23-38
45 years	88-149 bpm	175 bpm	22-37
50 years	85-145 bpm	170 bpm	21-36
55 years	83-140 bpm	165 bpm	21-35
60 years	80- 136 bpm	160 bpm	20-34
65 years	78-132 bpm	155 bpm	20-33
70 years	75-128 bpm	150 bpm	19-32

Table 3.6.1 shows target heart rate zones for different ages. Based upon the HR_{max} method, where 220 - age=HR_{max} and the training zone is 50-85%.Individuals with low fitness levels should start below or at the low end of these ranges (American Heart Association, 2024). [3]

Table 3.5.2: Ratings of Perceived Exertion

Rating	Definition
0	Nothing at all
0.5	Very, very easy
1	Very Easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very Hard
8	
9	Very, very hard
10	Maximal

Table 3.6.2 Ratings of Perceived Exertion (RPE) provide a simple way to understand how hard your body feels like it's working during physical activity. Instead of using tools like heart rate monitors, RPE uses your own sense of effort to guide intensity. This helps you stay safe and exercise effectively. On the commonly used Modified Borg CR10 Scale, 0 means "rest" and 10 means "maximum effort." A rating between 4 and 6 usually feels "somewhat hard" and reflects moderate intensity (Borg, 1990). [5]

Time (Duration)

How long does each session last?

Recommendation:

- 20–60 minutes per session of continuous or accumulated activity.
- Minimum of 10 minutes per bout to count toward daily/weekly goals.
- Weekly target: at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity.

Application:

- Beginners may start with shorter durations (10–20 minutes) and increase over time.
- Time can be accumulated in multiple bouts across the day (e.g., 3 x 10-minute walks).

Why It Matters:

Sufficient time is needed to produce health and fitness benefits. However, even short bouts offer advantages for those just starting out or with limited time.

Type (Mode)

What kind of activity done

Recommendation:

Choose aerobic exercises that involve large muscle groups and are performed in a rhythmic, continuous fashion.

Examples:

- Low-impact: Walking, elliptical, swimming, cycling
- High-impact: Running, stair climbing, aerobic dance
- Recreational: Hiking, cross-country skiing, rowing, paddleboarding

Application:

- Select activities that are enjoyable and accessible to increase adherence.
- Consider physical limitations, joint health, and fitness level when selecting the mode.

Why It Matters:

Aerobic exercise specifically trains the cardiovascular and respiratory systems. Choosing enjoyable activities increases consistency and long-term success.

Volume

What amount of exercise was performed?

Recommendation:

Exercise volume for CR endurance can be estimated using several measures:

- Training volume is the product of frequency, intensity and time.
- 150 minutes per week of moderate intensity activity
- Calories: 1,000 calories per week in moderate intensity activity
- Minimum of 500–1,000 MET-minutes per week (can be calculated using exercise duration, intensity, and frequency).
  - For more information on **METs** and **MET-minutes** see 3.5.1
- 10,000 steps per day is a general benchmark for activity, but not specific to intensity.

Application:

Example:

- 30 minutes of moderate-intensity activity (4 METs) × 5 days/week = 600 MET-min/week.
  - (4METs) x 5 days/per week= 20 mets x 30 min= 600 MET min/week
  - or 4METs x 30 min a day=120METs, 120 METS per day x 5 days= 600 MET min/week
- Tracking tools like fitness apps and smartwatches can help monitor volume.

Why It Matters:

Volume represents the total dose of exercise. This is directly tied to health outcomes, such as reduced disease risk and improved cardiovascular function. Increasing volume is the best way to improve fitness. Too much volume can lead to injury and overtraining. Using activity trackers can help monitor progress.

All About METs

Understanding METs and MET-Minutes. A MET is a unit of measure.

What is a MET?

- MET stands for Metabolic Equivalent of Task. It is a standardized unit used to estimate the amount of energy the body uses during physical activity, compared to at rest.
- 1 MET = is the energy used when resting quietly, such as sitting or lying down. It is roughly equivalent to consuming 3.5 ml of oxygen per kg of body weight per minute (ml/kg/min).
- This is considered a baseline or resting metabolic rate.
- Activities are then rated based on how much more energy they require than resting:
  - Light activity (like slow walking) might be 2-3 METs.
  - Moderate activity (like brisk walking) is around 3-6 METs.
  - Vigorous activity (like running) is often 6 METS or higher.

Put in simple terms, a MET measures how hard your body is working during an activity compared to just sitting still (US Department of Health and Human Services, 2018). [17]

What is a MET-Minute?

A MET-Minute is a measure of training volume equal to exercise intensity expressed in METs times the total exercise time (METs x time). It reflects the total volume of physical activity.

Formula:

MET-minutes = MET value × minutes of activity

Example Calculations:

Brisk walking (5 METs) for 30 minutes:

5 METs × 30 minutes = 150 MET-minutes

Jogging (10 METs) for 20 minutes:

10 METs × 20 minutes = 200 MET-minutes

Weekly Total:

150 MET (brisk walk) + 200 MET (jog) = 350 MET-minutes per week (US Department of Health and Human Services, 2018) [17]

How Many MET-Minutes Do You Need?

According to the ACSM and CDC, to achieve substantial health benefits, adults should aim for:

- 500–1,000 MET-minutes per week of moderate to vigorous physical activity (Garber et al, 2011). [11]

This level of activity is associated with:

- Lower risk of cardiovascular disease
- Improved fitness and endurance
- Reduced risk of chronic disease and mortality

Why METs and MET-Minutes Matter

- METs help standardize intensity across different activities.
- MET-minutes help track the total "dose" of exercise, regardless of activity type.
- They are useful for goal setting, monitoring training load, and comparing energy expenditure across activities.

MET Value to Estimate Calories

- When the MET value is known for a given exercise, you can estimate how many calories you burned per minute. This is the formula.
  - MET value of activity x 3.5 x ___body weight in kg ÷ 200=____calories burned per minute
  - calories burned per minute x duration = total calories burned
  - In the formula 3.5 = oxygen consumption at rest (in mL/kg/min, 200= a constant that converts oxygen consumption (in mL/min) to kcal/min. These numbers are constants and do not change (Bushman, 2017). [6]

Table 3.5.3: MET Values of Selected Activities

Activity	METs
Vacuuming, general, moderate effort	3.0 METs
Cooking or food preparation, moderate effort	3.5 METs
Child care: standing, dressing/bathing, light effort	3.5 METs
Tennis, Doubles	4.5 METs
Salsa dancing, with partner	4.8 METs
Zumba, group class	6.5 METs
Soccer, casual, general	7.0 METs
Shoveling snow, vigorous effort	7.5 METs
Calisthenics, vigorous effort (e.g., burpees, ropes)	7.5 METs
Yoga, Hatha, high intensity	8.0 METs
Basketball, game	8.0 METs
Jumping rope, Digi-Jump, 120 jumps/minute	9.0 METs
Aerobic step exercise, 10–12 inch step	9.0 METs
Elliptical trainer, vigorous effort	9.0 METs
Running, 6 mph (10 min/mile)	9.3 METs

Activity	METs
Carrying groceries upstairs	5.3 METs
Bicycling, mountain, uphill, vigorous	14.0 METs

Table 3.5.3 presents a list of activities, including both structured exercises and Activities of Daily Living (ADLs), along with their corresponding MET values based on data from the 2024 Adult Compendium of Physical Activities. Activities are arranged from lowest to highest MET values to highlight the varying intensity levels (Ainsworth et al, 2024). [4]

Progression

How the challenge is increased over time (overload).

Recommendation:

Increase one variable at a time (typically duration or frequency before intensity), especially in beginners.

Application:

- Initial phase (first 4–6 weeks): Focus on building frequency and time.
- Improvement phase: Gradually increase intensity or incorporate intervals.
- Maintenance phase: Adjust volume and intensity to maintain gains and avoid plateaus.

Why It Matters:

An individual's rate of progression depends on their goals, fitness level, health, age, and adaptation to training. Motivation can be a big part of adherence to an exercise program. Highly motivated people are willing to put up with high levels of discomfort that come with intense training programs. A less motivated person will often stop exercising if the program is too intense or uncomfortable. Gradual progression prevents injury, supports adaptation, and keeps the program challenging and effective over time. Too much too soon can lead to fatigue, overuse injuries, or burnout.

Question

- What are your personal goals for improving cardiorespiratory fitness?
  - How can they influence your activity choices?
- Which types of aerobic activities do you enjoy?
  - How likely are you to stick with them long-term?
- Think of a time when you felt motivated to exercise.
  - W hat helped you stay consistent?
  - How can you replicate that now?

Warm-up and Cool-down

Preparing for your cardiovascular exercise helps optimize safety as well as enjoyment. A proper warm-up and cool-down are essential components of any exercise session, helping to prepare the body for physical activity, reduce the risk of injury, and promote effective recovery.

Warm-up

A proper warm-up gradually prepares the body for more intense exercise by increasing blood flow, raising muscle temperature, and enhancing joint mobility. It typically includes:

- 5–10 minutes of light aerobic activity (e.g., brisk walking or slow cycling)
- Dynamic stretches or mobility drills that mimic the movements of the upcoming activity

Benefits:

- Reduces risk of injury
- Enhances performance
- Improves muscle elasticity and oxygen delivery

Cool-Down

Cooling down helps return the body to its resting state, prevents blood pooling, and reduces muscle soreness. It typically includes:

- 5–10 minutes of low-intensity movement (e.g., slow walking)
- Static stretching of major muscle groups
- Cool down at least until your heart rate drops below 100 bpm.

Benefits:

- Aids recovery
- Prevents dizziness
- Improves flexibility

Building Cardiorespiratory Fitness

To improve cardiorespiratory fitness, exercise must progressively challenge the heart and lungs. However, increasing the frequency, intensity, and duration of exercise carefully to avoid injury and overtraining. The FITT-VP principle is a useful guide:

- **Frequency**: 3–5 days per week
- **Intensity**: Moderate to vigorous (40–85% of heart rate reserve or VO_2 max)
- **Time**: 20–60 minutes per session, amount is determined by your fitness level (very unfit, fewer minutes vs experienced athlete, more minutes)
- **Type**: Aerobic activities (e.g., running, swimming, cycling)
- **Volume**: 500–1000 MET-minutes/week
- **Progression**: Gradual increases in duration and intensity over time. The initial stage of a program may last three to six weeks. The beginning stage is to help your body and schedule adjust to the exercise program. The next phase is the improvement stage anywhere from four to six months. In this stage, slowly and gradually increase the amount of overload until you reach your target level of fitness.
- Improvements are typically seen within 4–6 weeks of consistent training, with VO_2 max and endurance capacity increasing

Question

- What strategies will help you monitor your intensity level and avoid over-training or under-training?
- How do you plan to safely progress your workouts over time to continue making improvements without risking injury?

Types of Interval Training:

Interval training involves alternating periods of higher-intensity exercise with periods of lower-intensity recovery or rest. This method is widely used to enhance both aerobic and anaerobic fitness and is highly effective for improving cardiorespiratory endurance in less time than traditional steady-state exercise. A type of interval training called high-intensity interval training (HIIT) is the most effective in improving fitness rapidly.

- **High-Intensity Interval Training (HIIT):**

Short bursts (20–90 seconds) of near-maximal effort followed by equal or longer rest periods.

Example: 30-second sprint / 90-second walk × 6 rounds.

- **Aerobic Interval Training**:

Longer intervals (1–5 minutes) at moderate to high intensity (e.g., 70–85% of max heart rate), interspersed with active recovery. Example: 3 minutes jog / 2 minutes walk × 4 rounds.

- **Fartlek Training ("speed play")**:

Unstructured intervals alternating fast and slow paces based on terrain or effort, often used by runners.

Physiological Benefits:

- Increases VO_2 max
- Enhances stroke volume and cardiac output
- Improves lactate threshold and fat-burning efficiency
- Provides after-burn effect, Excess Post-Exercise Oxygen Consumption (EPOC), leading to higher post-exercise calorie burn

Advantages for Students and the General Population:

- Time-efficient
- Adaptable to all fitness levels
- Can be done with walking, running, cycling, swimming, and group fitness formats

Safety Considerations:

- Should be preceded by a proper warm-up and followed by a cool-down
- Beginners should start with moderate intervals before progressing
- Individuals with cardiovascular or metabolic conditions should consult a healthcare provider before engaging in high-intensity formats

Four Components of Interval Training

- **Intensity of Work Interval**

The level of effort during the high-intensity phase (e.g., moderate, vigorous, near-maximal).

Often measured using heart rate, pace, RPE (Rating of Perceived Exertion), or power output.

- **Duration of Work Interval**

How long the high-intensity effort lasts (e.g., 30 seconds, 3 minutes).

Longer intervals target aerobic endurance; shorter ones target speed and power.

- **Duration of Recovery Interval**

The length of the rest or low-intensity period between efforts.

Can be passive (complete rest) or active (light movement like walking).

- **Number of Repetitions (or Sets)**

How many times is the work/recovery cycle repeated?

Total volume is adjusted based on fitness goals and training level.

Maintaining Cardiorespiratory Fitness

Once desired fitness levels are reached, they can be maintained with a slightly reduced training load:

- Frequency: 2–3 days per week may be sufficient
- Intensity: Maintain intensity to preserve cardiovascular adaptations
- Variety: Cross-training and active lifestyle habits help prevent plateaus and overuse injuries

Missing several weeks of aerobic training can lead to a decline in endurance levels. Continued consistency, even at a reduced volume, helps maintain long-term cardiovascular health.

Exercise Safety and Injury Prevention



Figure 3.5.2: Protective gear, such as the helmets that these skaters wear, is important for staying safe. (A group of people riding skateboards down a street; Finden Marketing on Unsplash)

Exercising safely is essential to maximize benefits and minimize the risk of injury or health complications. Environmental conditions and personal behaviors can significantly impact exercise safety. Wearing protective equipment such as a helmet, as seen in Figure 3.5.2, is an important safety consideration. Below are key considerations for avoiding injury and staying safe during exercise.

Hot Weather and Heat Stress

Risks:

- **Dehydration**: excessive loss of body fluids
- **Heat cramps**: involuntary cramping and spasms in the muscle
- **Heat exhaustion**: caused by prolonged exposure to high temperatures and dehydration
  - Symptoms include:
    - Rapid, weak pulse
    - Low blood pressure
    - Headache
    - Faintness, weakness, dizziness
    - Profuse sweating
    - Pale face
    - Psychological disorientation
    - Normal or slightly elevated core body temperature (US Department of Health and Human Services, 2018) [17]
- **Heat stroke (life-threatening)**: A severe and often fatal heat illness characterized by significantly elevated core body

temperature. Is a major medical emergency resulting from the brain's temperature regulatory center (US Department of Health and Human Services, 2018) [17]
    - Symptoms include:
        - The body does not sweat
        - Body temperature rises
        - Hot, flushed skin (dry or sweaty), red face
        - Chills, shivering
        - Very high or very low blood pressure
        - Confusion, erratic behavior
        - Convulsions, loss of consciousness
        - Seizures (US Department of Health and Human Services, 2018) [17]

Prevention Strategies:

- Hydrate before, during, and after exercise
- Wear lightweight, breathable, light-colored clothing.
- Sunburn- wear sun-protective clothes, hat, sunglasses, and sunscreen (applied often).
- Exercise during cooler parts of the day (morning or evening)
- Allow time to acclimate to the heat
- Listen to your body—stop if you feel dizzy, nauseated, or weak (US Department of Health and Human Services, 2018) [17]

Cold Weather

Risks:

- **Hypothermia**: Low body temperature due to exposure to cold conditions.
- **Frostbite**: Freezing of body tissue characterized by pallor, numbness, and loss of cold sensation.
- **Slippery surfaces**: Increase fall risk.
- **Wind chill**: A measure of how cold it feels based on the rate of heat loss from exposed skin caused by cold and wind.

Prevention Strategies:

- Dress in layers that can be removed as you warm up
- Use moisture-wicking base layers and windproof outerwear
- Protect extremities (hats, gloves, wool socks)
- Avoid cotton, which retains moisture and accelerates heat loss
- Stay dry and shorten workouts in very low temperatures

Signs of Hypothermia:

Shivering, slurred speech, loss of coordination, drowsiness

Poor Air Quality

Risks:

- Irritation of the lungs and airways
- Exacerbation of asthma or other respiratory conditions
- Reduced oxygen delivery and performance

Prevention Strategies:

- Check the Air Quality Index (AQI) before outdoor workouts
    - AQI 0–50 = good; 51–100 = moderate; >100 = unhealthy for sensitive groups
- Exercise indoors when the air quality is poor
- Avoid high-traffic areas with vehicle emissions
- Shorten the duration or lower the intensity on bad air days

Common Exercise Injuries

Examples:

- Sprains (ligament injury)
- Strains (muscle or tendon injury)
- Shin splints
- Tendinitis
- Stress fractures

Prevention Strategies:

- Warm up properly and cool down after each session
- Progress gradually (follow the “10% rule”: increase volume no more than 10% per week)
- Wear appropriate footwear for your activity
- Use good form and technique
- Cross-train to reduce overuse
- Rest when needed—listen to your body
- Cross-train - don't do the same sport year-round.

When to Seek Medical Attention:

- Persistent pain, swelling, or limited mobility
- Pain that worsens with activity or interferes with daily function
- Head and eye injuries
- Broken bones
- Internal disorders: chest pain, fainting, elevated body temperature, intolerance to hot weather
- Injuries that take along time to heal.
- Swelling increases or doesn't improve
- Joint instability or inability to bear weight
- Numbness, tingling, or severe bruising (American College of Sports Medicine, 2018) [2]

Managing Minor Exercise Injuries



Figure 3.5.3: This player's injury is minor and can be taped for support to allow her to return to the game. (Injured lacrosse player Jeffrey F Lin on Unsplash)

Most minor injuries related to physical activity, such as muscle strains, joint sprains, or bruises, can be managed effectively at home with early care. Prompt and appropriate treatment helps reduce recovery time and prevent further damage. Oftentimes,

athletes will sustain an injury during competition that can be taped for them to return to playing, as seen with this lacrosse player in Figure 3.5.3.

1. Use the R.I.C.E. Method (first 24–48 hours):
   - **Rest**: Stop the activity to avoid worsening the injury. Allow time for healing.
   - **Ice**: Apply ice packs for 15–20 minutes every 2–3 hours to reduce swelling and pain.
   - **Compression**: Wrap the injured area with an elastic bandage to minimize swelling, but avoid wrapping too tightly.
   - **Elevation**: Raise the injured limb above heart level to help reduce swelling.
2. Pain Management:
   - Some experts recommend over-the-counter anti-inflammatory medications (e.g., ibuprofen, aspirin, or naproxen).
   - They may help reduce pain and inflammation.
   - Avoid using heat immediately, as it can increase swelling—save it for later stages of recovery.
3. Gradual Return to Activity:
   - Resume activity slowly, starting with light movement and stretching.
   - If pain returns, stop and rest again.
   - Strengthening and mobility exercises may be added as healing progresses.

Preventing Injuries

Exercise injuries are common and often preventable. The following are suggestions on how to prevent exercise injuries.

- Warm Up and Cool Down
- Train regularly
- Progress Gradually
- Use Proper Technique
- Wear Appropriate Footwear and Gear
- Choose activity-specific shoes with proper cushioning and support
- Use protective gear (e.g., helmets, pads) when needed
- Cross-Train to Avoid Overuse
- Listen to Your Body
- Stay Hydrated and Fuel Properly
- Adjust for Environment
- Maintain Flexibility and Strength
- Monitor Surfaces and Surroundings
- Don't exercise when you are ill or over-trained.
- Stretch and mobility exercises were performed (US Department of Health and Human Services, 2018). [17]

Key Points

- Cardiorespiratory assessments provide a baseline and guide fitness programming tailored to individual needs and goals.
- A successful fitness program is safe, effective, and personalized, taking into account fitness level, health status, preferences, and goals.
- Goal setting (e.g., improving endurance, managing stress, or enhancing health) helps maintain motivation and guides program design.
- The principles of training—specificity and progressive overload—are essential for improving cardiorespiratory endurance.
- The FITT-VP principle offers a structured framework for program design.
- Monitoring intensity using methods such as heart rate zones, the talk test, or RPE helps ensure effective and safe training.
- Warm-up and cool-down periods enhance performance, reduce injury risk, and support recovery.
- Consistency and progression are key to maintaining cardiorespiratory fitness long-term.

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3.6: Comprehension Check

Summary

This chapter examines the structure and function of the cardiorespiratory (CR) system, highlighting its crucial role in supporting physical activity and overall health. The cardiovascular and respiratory systems work together to deliver oxygen to the body's tissues and remove waste products, enabling the production of adenosine triphosphate (ATP)—the body's primary energy currency. Three energy systems—immediate, non-oxidative (anaerobic), and oxidative (aerobic)—supply ATP based on activity intensity and duration. Regular aerobic exercise enhances the efficiency of the CR system by lowering resting heart rate, increasing oxygen delivery, improving mitochondrial function, and boosting VO_2 max. These adaptations help individuals perform daily activities more easily, improve endurance, and reduce the risk of chronic diseases.

The chapter also emphasizes the importance of assessing cardiorespiratory fitness using reliable tools such as the 1-Mile Walk Test, 12-Minute Run, 3-Minute Step Test, and others. VO_2 max, a key indicator of aerobic fitness, can be estimated through these submaximal field assessments. In addition, students learn how to measure and interpret heart rate to monitor exercise intensity, using methods like target heart rate zones, the Karvonen formula, the Rating of Perceived Exertion (RPE), and the Talk Test. Accurate assessment and monitoring not only guide effective training but also allow individuals to track progress and make informed decisions about their fitness goals.

Test Your Understanding

1. What two systems make up the cardiorespiratory system?
2. Describe the flow of blood through the heart, starting from the right atrium.
3. What physiological changes occur in the heart during exercise?
4. What role does nitric oxide play in the blood vessels?
5. Why is systolic pressure higher during exercise while diastolic pressure stays the same or decreases?
6. What is ATP, and why is it vital for the body?
7. List and briefly describe the three energy systems used to produce ATP.
8. Which energy system predominates during a 30-minute jog? A 10-second sprint?
9. What are two key limitations of the anaerobic (non-oxidative) energy system?
10. What adaptations occur in the cardiorespiratory system with consistent aerobic training?
11. How does the body's use of carbohydrates and fats shift during prolonged aerobic exercise?
12. What is VO_2 max, and why is it considered an important measure of cardiorespiratory fitness?
13. Name two differences between the Max Heart Rate Method and the Karvonen Formula for determining target heart rate.
14. How does resting heart rate change as cardiorespiratory fitness improves?
15. What is the purpose of using the RPE scale or Talk Test during exercise?

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Chapter 3 Glossary

- **Adenosine Triphosphate**: Is the basic form of cellular energy found in the body. The energy source for cellular processes.
- **Alveoli**: Tiny air sacs in the lungs that allow the exchange of oxygen and carbon dioxide betweenn the lungs and blood.
- **Aorta**: The body's largest artery; receives blood from the left ventricle and distributes it to the body.
- **Aortic Valve**: The heart valve between the left ventricle and the aorta that prevents the back flow of blood into the left ventricle.
- **Arteries**: Vessels that carry blood away from the heart.
- **Atrium**: One of the two upper chambers of the hear in which blood collects before passing to the ventricles.
- **Blood Pressure**: The force exerted by blood on the walls of the blood vessels, created by the pumping action of the heart.
- **Calorie**: How much energy the food provides.
- **Capillaries**: Very small blood vessels that distribute blood to all parts of the body.
- **Carbon Dioxide**: A gas produced during the metabolism of carbohydrates, fats, protein, and acids. During exercise, the body manages increased levels of carbon dioxide by breathing faster. Plants use carbon dioxide to capture energy through photosynthesis, but high levels of carbon dioxide are toxic to the body.
- **Cardiac Output**: The volume of blood pumped by the heart per minute via heart rate and stroke volume.
- **Cardiovascular System**: The system that circulates blood throughout the body and consists of the heart and blood vessels.
- **Cardiorespiratory System**: The system that circulates blood through the body; consists of the heart, blood vessels and respiratory system. Cardiorespiratory system supports encompasses both cardiovascular and respiratory systems.
- **Coronary arteries**: A pair of large blood vessels that branch off the aorta and supply the heart muscle with oxygenated blood.
- **Creatine Phosphate**: A molecule that is sotred in muscle cells and used in the immediate energy system to donate a phosphate to make ATP.
- **Diastole**: The period of the heart's relaxation.
- **Diffusion**: The process by which oxygen moves from the lungs to the blood and carbon dioxide moves from the blood to the lungs; faster breathing concentrates oxygen and decreases carbon dioxide in the lungs and promotes diffusion.
- **Diffusion Capacity**: The amount of oxygen that enters the blood stream from the lungs.
- **Endothelial Cells**: Cells lining the blood vessels.
- **Glucose**: A simple sugar circulating in the blood that can be used by cells to fuel adenosine triphosphate (ATP) production.
- **Glycogen**: A complex carbohydrate stored principally in the liver and skeletal muscles; the major fuel source during most forms of intense exercise. Glycogen is the storage form of glucose.
- **Heart Rate**: The number of times your heart beats per minute (bpm).
- **Heart Rate Reserve**: The difference between maximum heart rate and resting heart rate; used in one method for calculating target heart rate zone.
- **Homeostasis**: A state of stability and consistency in a persons physiological functioning.
- **Immediate ("Explosive") Energy System**: The system that supplies very short bursts of energy to muscle cells through the breakdown of cellular stores of ATP and creatine phosphate (CP).
- **Maximal Oxygen Consumption or VO_2 max**: The highest rate of oxygen consumption an individual is capable of during maximum physical effort, reflecting the body's ability to transport and use oxygen; measured in milliliters if oxygen used per kilogram of body weight per minute.
- **MET**: A unit of measure that represents the body's resting metabolic rate - that is, the energy requirement of the body at rest.
- **MET-minute**: A measure of training volume equal to exercise intensity expressed in METs times the total exercise time (METs x time).
- **Metabolic Rate**: The rate at which the body uses energy.
- **Metabolism**: The sum of all chemical processes in the body that convert food into energy to support bodily functions such as breathing, digestion, and physical activity.
- **Mitochondria**: Cell structure that convert the energy in food to a form the body can use.
- **Mitral Valve**: The heart valve that lies between the left atrium and left ventricle that prevents the back flow of blood into the left atrium.
- **Nitric Oxide**: A gas released by the endothelial cells to promote blood flow. The capacity of these cells to release nitric oxide is an important marker of good health.
- **Non-oxidative Energy System**: The system that supplies energy to muscle cells for highly intense exercise of short duration by breaking down muscle stores of glucose and glycogen; called the anaerobic system because chemical reactions take place without oxygen and produce lactic acid.
- **Oxidative (Aerobic) Energy System**: The system that supplies energy to cells for long periods of activity through the breakdown of glucose, glycogen, and fats; called the aerobic system because its chemical reactions require oxygen.

- **Progressive Overload**: The training principle that progressively increasing amounts of stress on the body causes adaptation that improves fitness.
- **Pulmonary Circulation**: The part of the circulatory system that moves blood between the heart and lungs; controlled by the right side of the heart.
- **Pulmonary Valve**: The heart valve between the left ventricle and the aorta that prevents the back flow of blood into the left ventricle.
- **Rating of Perceived Exertion (RPE)**: A system of monitoring exercise intensity by assigning a number to the subjective perception of target intensity.
- **Respiratory System**: The lungs, airways (like the trachea and bronchi), and the muscles that control breathing, supplies oxygen to the body and removes carbon dioxide.
- **Stroke Volume**: The amount of blood the heart pumps with each beat.
- **Systemic Circulation**: The part of the circulatory system that moves blood between the heart and the rest of the body; controlled by the left side of the heart.
- **Systole**: The period of the heart's contraction.
- **Specificity**: The training principle that developing a particular fitness component requires exercises specifically designed for that component.
- **Target Heart Rate Zones**: the range of heart rates that should be reached and maintained during cardiorespiratory endurance exercise to obtain optimal training effects.
- **Tidal Volume**: the amount of oxygen entering the lungs with each breath
- **Tricuspid Valve**: The heart valve between the right atrium and the right ventricle that prevents the back flow of blood into the right atrium.
- **Veins**: Vessels that carry blood to the heart.
- **Venae Cavae**: The large veins through which blood is returned to the right atrium of the heart.
- **Ventricle**: One of the two lower chambers of the hear from which blood flows through arteries to the lungs and other parts of the body.

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3.8: References

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4: MUSCULAR STRENGTH AND ENDURANCE



Figure 4.1: Doing dip exercises works the tricep muscle. (Man exercising in dip station; John Fornander via Unsplash)

Introduction to Muscular Strength and Endurance

Muscles play a vital role in physical activity, supporting movement and posture, utilizing the majority of the body's energy expenditure. Muscles enable the body to perform daily tasks with greater ease and contribute significantly to our overall wellness by promoting an active and healthy lifestyle. Muscular strength refers to the amount of force a muscle can exert in a single maximal effort, while muscular endurance is the ability to sustain repeated muscle activity over time. Together, these components form the foundation of muscular fitness, which is influenced by both controllable factors, like training, and uncontrollable ones, such as genetics or age. Resistance training is one of the most effective strategies for improving both muscular strength and endurance. Maintaining muscle fitness enhances mobility, supports functional movement, and contributes to a healthy body composition—key elements of lifelong wellness. This chapter will explore the importance of muscular strength and endurance as dimensions of wellness and guide students in learning how to develop a personalized muscle fitness training program, beginning with proper assessment and goal setting.

Learning Objectives

- Describe muscular structure and function
- Identify types of muscles
- Identify elements of muscle fitness
- Identify the factors that affect muscle fitness
- Identify the benefits of muscle endurance and strength
- Differentiate among the types of muscle contractions
- Differentiate between the short-term and long-term effects of exercise on muscles
- Differentiate between atrophy and hypertrophy
- Describe an effective resistance exercise program
- Assess your muscular strength and endurance
- Identify common supplements marketed for increased strength and endurance
- Recognize the dangers of supplements

4.1: Muscle Strength and Endurance

4.2: Muscular Physiology
4.3: Training - The Effects of Exercise on Muscles
4.4: Types of Muscular Contractions for Training
4.5: Resistance Training Programming
4.6: Supplements
4.7: Comprehension Check
4.8: Glossary
4.9: References
4.10: Detailed Accessible Description

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4.1: Muscle Strength and Endurance



Figure 4.1.1: (Grayscale Photo of Man Working Out; Edgar Chaparro via Unsplash)

Introduction

Muscle strength and endurance is one of the five components of fitness. Muscle fitness is an important part of one's overall health and wellness. There are many components to muscle fitness, such as muscle force, muscle endurance, muscle strength, and muscle power. There are a variety of factors that affect muscle fitness such as age, biological sex, genetic makeup, injuries, and training. Training is one factor that can be controlled. Exercise plays a crucial role in shaping and strengthening muscles by triggering adaptations that improve their performance. Resistance training promotes muscle hypertrophy, increasing muscle size and strength, while endurance exercises enhance muscular endurance and efficiency. These changes occur as muscles respond to stress, repair, and grow stronger, highlighting the body's remarkable ability to adapt to physical activity. Exercise affects the muscles in the body, with the effects varying based on the type of activity and the muscle groups used. Some exercises involve short, powerful muscle contractions, while others rely on longer, endurance-based contractions. Exercise causes both immediate effects, such as increased blood flow and muscle activation, and long-term effects, including improved strength, endurance, and muscle growth.

Muscle Fitness

Muscle fitness refers to the strength, endurance, and overall health of the muscles in your body. It encompasses both muscular strength, which is the ability to exert force, and muscular endurance, which is the ability to sustain repeated movements over time. Although lifting weights can improve muscle fitness, other activities can also result in individual gains. Improving muscle fitness through resistance training, bodyweight exercises, and proper nutrition enhances physical performance, supports joint health, and reduces the risk of injury. Whether for daily activities or athletic performance, maintaining muscle fitness is essential for overall well-being.

Question

- How do I know if I have muscle fitness?
- Do I have to lift weights?

Components of Muscle Fitness

The components of muscle fitness include muscle force, muscle endurance, muscle strength, and muscle power.

Muscle force is the strength that muscles use to push, pull, or lift things. It depends on how many muscle fibers are working and how strong they are. More muscle force helps with activities like lifting heavy objects or pushing against resistance. Muscle force plays a role in everyday activities like carrying a heavy backpack across campus, lifting textbooks, or even standing up from a low seat. For example, when a student picks up a loaded backpack from the floor and swings it onto their shoulders, their arm, back, and leg muscles generate force to overcome gravity and complete the movement. Building muscle strength through regular exercise can make these daily tasks easier and reduce the risk of injury.

Muscle Endurance

Muscle endurance is the ability of a muscle or group of muscles to sustain repeated contractions or maintain a contraction over an extended period without fatigue. It is essential for activities that require prolonged muscle engagement, such as carrying a backpack for long distances, maintaining posture during long study sessions, or engaging in endurance-based exercises like cycling or running. Developing muscle endurance can improve overall physical performance and reduce the risk of injury. Muscle endurance is also used while carrying a heavy backpack across campus throughout the day. The muscles in the shoulders, back, and legs must sustain repeated contractions over an extended period to support the weight and maintain posture while walking between classes. Building muscle endurance helps students avoid fatigue and discomfort during long days on campus.

Muscle Strength

Muscle strength is the maximum amount of force a muscle or group of muscles can generate in a single effort. It reflects the muscle's ability to overcome resistance and is typically measured through exercises like a one-rep max bench press or squat. Stronger muscles enhance overall physical performance, support daily activities, and reduce the risk of injury. Muscle strength is being used with the same heavy backpack. Lifting a heavy backpack off the ground or carrying a loaded laundry basket up a flight of stairs requires the muscles to generate a high amount of force in a single effort to overcome resistance.

Muscle Power

Muscle power is the ability of a muscle to generate force quickly, combining both strength and speed. It is the rate at which work is performed, typically measured as force multiplied by velocity. Muscle power is crucial for explosive movements such as sprinting, jumping, and lifting weights rapidly. Developing muscle power enhances athletic performance and overall functional movement efficiency. For example, jumping to spike a volleyball or sprinting to catch a bus uses muscle power. These movements require the muscles to generate a strong and explosive force in a short amount of time.

Factors that Affect Muscle Fitness

Many factors influence muscle fitness, including genetics, age, biological sex, training methods, nutrition, injuries, and recovery. Genetics determines muscle fiber composition and overall potential for strength, endurance, and power. Age and biological sex also play a role, as muscle mass naturally declines with age, and hormonal differences impact muscle development. Proper training techniques, balanced nutrition, and sufficient rest are essential for muscle growth and repair, while injuries can hinder progress and require careful rehabilitation to maintain muscle fitness.

Age

Muscle mass and strength typically start to decrease around the age of 30 for both men and women (American College of Sports Medicine, 2021). [1] This decline becomes more pronounced after the age of 50, especially for women, due to the hormonal changes linked to menopause. In men, the gradual reduction of testosterone levels also contributes to the loss of muscle mass. However, engaging in regular physical activity, particularly strength training, can help slow down this process and help mitigate this decline in maintaining muscle fitness as people age.

Between the ages of 20 and 60, individuals who engage in regular physical activity and strength training can maintain most of their muscle fitness, with peak levels typically occurring around age 30. However, those who lead a sedentary lifestyle and do

not engage in muscle-strengthening exercises experience a gradual decline in muscle mass and strength after the age of 30. A biological male who does not participate in muscle fitness activities may lose approximately 30 percent of their peak strength by the time they reach 60. Although there is a large reduction of testosterone and growth hormone, consistent muscle fitness training can offset the loss of muscle mass (Angadi et al, 2023). [2] Even older adults who have never trained can see significant differences in muscle strength and balance, which can drastically improve the quality of life.

Question

- Is it true that as I get older, I start to lose my muscles?

Biological Sex

Biological sex plays a significant role in muscle fitness due to differences in hormone levels, muscle composition, and fat distribution. Testosterone, which is present in higher levels in males, promotes greater muscle mass and strength by enhancing protein synthesis and muscle fiber growth. As a result, males generally have a higher proportion of lean muscle mass compared to females, contributing to differences in absolute strength. However, females also benefit from strength training and can achieve significant muscle fitness improvements, particularly in relative strength and muscular endurance. Additionally, estrogen influences fat distribution and muscle recovery, allowing females to maintain flexibility and endurance-based muscle performance. While biological sex affects muscle fitness potential, proper training, nutrition, and exercise adherence play crucial roles in maximizing strength and overall muscle health for all individuals.

“The Biological Basis of Sex Differences in Athletic Performance,” published in the *Journal of Applied Physiology* shows how anatomical and physiological differences between males and females, such as variations in muscle mass, hormone levels (notably testosterone and estradiol), and neuromuscular function, contribute to disparities in strength, power, and endurance (Andgadi et al, 2023). [2] These factors also significantly influence responses to exercise training and athletic performance.

Genetic makeup

Genetic makeup plays a significant role in an individual’s muscle fitness by influencing factors such as muscle fiber composition, hormone levels, and overall physical potential. People inherit different proportions of fast-twitch and slow-twitch muscle fibers, which affect their ability to develop strength, power, or endurance. Additionally, genetic differences in hormone production, such as testosterone and growth hormone, can impact muscle growth and recovery. Some individuals may naturally have a higher baseline of muscle mass or strength, while others may need to put in more effort to achieve similar results. Research on resistance training has shown a wide variation in how individuals respond to training programs, with genetics estimated to account for 80–90% of the differences in strength gains (Riebe et al, 2018). [21] Although genetics sets the foundation for muscle fitness, training, nutrition, and lifestyle choices remain critical factors that individuals can control to optimize their muscular development.

Question

- How much of my muscle strength is determined by genetics?

Injuries

Injury can significantly impact muscular fitness by limiting mobility, reducing strength, and causing muscle atrophy due to inactivity. When a muscle, tendon, or joint is injured, individuals often need to modify or stop their regular exercise routines, leading to a decline in muscle strength and endurance. Extended periods of immobilization can result in muscle loss, decreased flexibility, and joint stiffness, making it harder to regain previous fitness levels. Additionally, injuries may cause imbalances in muscle function, as other muscles compensate for the weakened or injured area, potentially leading to further strain or discomfort. Proper rehabilitation, including physical therapy and gradual strength training, is essential for rebuilding muscle fitness and preventing long-term deficits.

Training

Training for muscle fitness is essential for maintaining strength, endurance, and overall physical health. Regular resistance training helps preserve muscle mass, which naturally declines with age, reducing the risk of weakness and injury. Strength training also supports joint stability, improves posture, and enhances daily functional movements, making everyday tasks easier. Additionally, building muscle fitness can boost metabolism, aiding in weight management and overall energy levels. Since training is a factor that individuals can control, incorporating a structured muscle fitness program into a routine promotes long-term health, reduces the risk of chronic diseases, and enhances overall quality of life.

Key Points

- Muscle fitness is a vital component of overall health and includes muscle strength, endurance, force, and power.
- Exercise, particularly resistance and endurance training, promotes muscle growth, strength, and performance through the body's natural adaptive processes.
- Muscular strength is the maximum force a muscle can exert in one effort; muscular endurance is the ability to sustain repeated contractions over time.
- Muscle force supports daily tasks like lifting heavy objects and standing up; it depends on the number and strength of engaged muscle fibers.
- Muscle power combines strength and speed, enabling explosive movements like sprinting and jumping.
- Age negatively affects muscle mass and strength over time, but regular strength training can help slow this decline.
- Biological sex influences muscle development due to hormonal differences, but both males and females benefit from strength training.
- Genetics determines traits like muscle fiber type and hormone production, influencing potential for strength and endurance.
- Injuries can reduce muscle function and fitness by limiting activity and causing muscle atrophy; rehabilitation is key to recovery.
- Training is the most controllable factor affecting muscle fitness and contributes to strength, joint health, posture, and injury prevention.

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4.2: Muscular Physiology

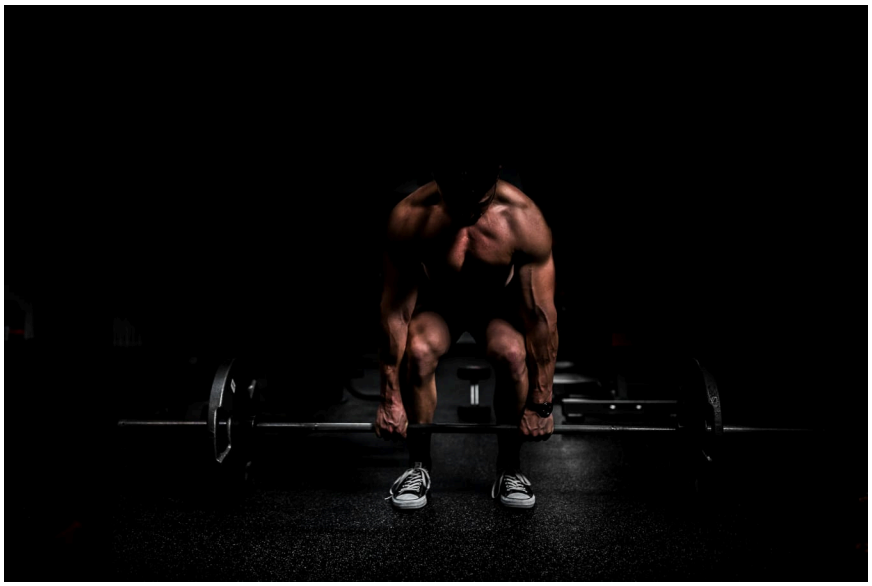


Figure 4.2.1: (Topless man in black shorts sitting on black and silver barbell; Anastase Maragos via Upsplash)

Introduction

Muscles are essential components of the human body, responsible for movement, posture, and the generation of force. They play a vital role not only in physical activity but also in maintaining essential physiological functions such as breathing and circulation. Understanding muscle physiology provides insight into how muscles generate force, adapt to different types of activity, and recover after exertion or injury.

Muscles are highly specialized tissues designed to contract forcefully and generate the force required for movement. Powered by individual muscle cells, these contractions work together to perform essential functions ranging from voluntary actions like walking and talking to involuntary processes such as pumping blood through the heart and moving food through the digestive system.

With over 600 muscles in the human body, they enable everything from subtle gestures like blinking to complex movements like running. Without muscle cells, basic tasks and vital physiological functions would not be possible, underscoring their crucial role in human life.

Muscle tissue is broadly classified into three types: skeletal, cardiac, and smooth, each with unique structural and functional characteristics. Skeletal muscles, which are the focus of this chapter, are voluntary muscles attached to the skeleton, enabling purposeful movement and activity. These muscles are further divided into specialized fiber types that determine their function and performance in activities ranging from endurance sports to explosive power tasks.

This section explores the foundational concepts of skeletal muscle physiology, including muscle structure, contraction mechanisms, energy metabolism, and fiber type specialization.

Types of Muscle

There are three main types of muscle tissue found in the human body: skeletal muscle, cardiac muscle, and smooth muscle. Each type has distinctive structural features to highlight its differences.

- **Skeletal Muscle -** Skeletal muscle is a type of muscle attached to bones that enables movement and helps maintain posture. It functions under voluntary control and plays a crucial role in actions such as walking, lifting, and standing upright. This

muscle type is primarily responsible for body movement.

- **Cardiac Muscle** - Cardiac muscle is a special type of muscle found only in the heart. It works automatically to pump blood through the body, using steady, rhythmic contractions controlled by the heart's pacemaker and the nervous system. This is the muscle responsible for the contraction of the heart.
- **Smooth Muscle** - Smooth muscle is a type of muscle found in the walls of organs like the stomach, intestines, and blood vessels. It works automatically to help move food, control blood flow, and perform other functions. This is the muscle responsible for many tasks, including the movement of food along the intestines, the enlargement and contraction of blood vessels, the size of pupils, and many other muscular contractions.

Figure 4.2.2 illustrates the three types of muscle tissue in the body.

- The section on the left highlights smooth muscle with a magnified view of its elongated, non-striated fibers and an organ system depiction. The smooth muscle is illustrated with spindle-shaped (tapered at both ends), non-striated fibers. Each fiber has a single, centrally located nucleus. This type of muscle is found in the walls of hollow organs such as the intestines, blood vessels, and the bladder, and it controls involuntary movements like digestion and blood vessel constriction.
- The section in the middle focuses on cardiac muscle with striated, branched fibers and an anatomical representation of the heart. In the middle, the cardiac muscle, found only in the heart, is shown with shorter, branched fibers that also have striations, but unlike skeletal muscle, they contain only one or two centrally located nuclei. A key feature shown in this tissue is the presence of intercalated discs—specialized connections between cells that help coordinate the heart's contractions.
- The section on the right features skeletal muscle with striated fibers and a depiction of a muscle-tendon-bone structure. The skeletal muscle is shown with long, cylindrical fibers that are striated (showing visible bands) and have multiple nuclei located along the edges of the cells. These muscles are attached to bones and are responsible for voluntary movements, such as walking or lifting objects.

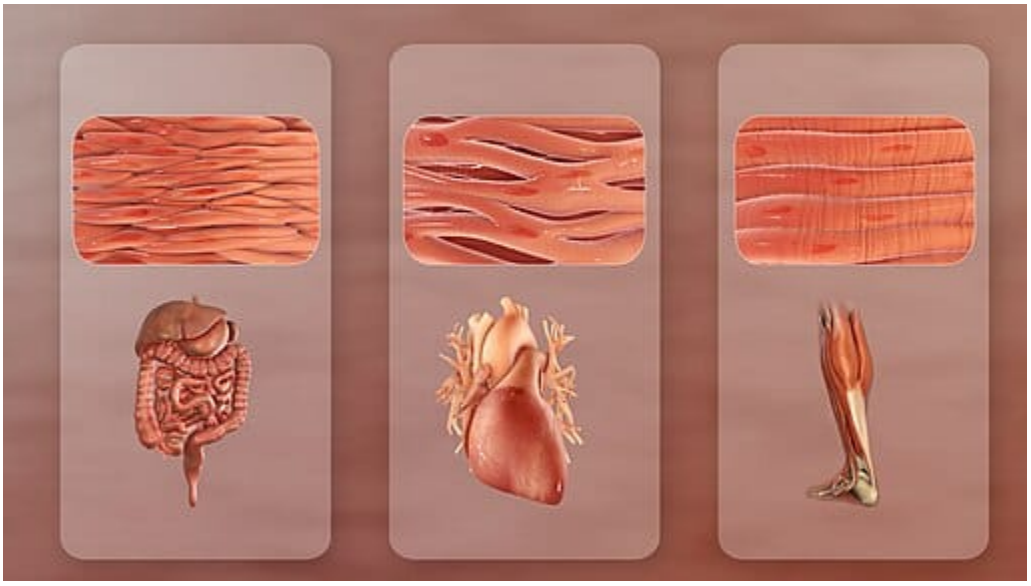


Figure 4.2.2: From left to right: smooth muscle, cardiac muscle, and skeletal muscle. (CC BY-SA 4.0 via Wikimedia Commons)

Question

- What are the different types of muscles?
- Muscles just determine how strong I am, right?

Skeletal Muscle Structure and Function

Skeletal muscles are connected to the skeleton and are responsible for the movement of the limbs, torso, and head. They operate under voluntary control, allowing individuals to consciously initiate muscle contractions and regulate the strength of those contractions. 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 a muscle fiber is consciously contracted, such as when the bicep is engaged

to bend the arm upward, a signal is transmitted from the brain through the spinal cord to the targeted 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 are required to contract in order to bend a limb; however, if a heavy weight needs to be lifted, a significantly larger number of muscle fibers are recruited to act. This is called muscle **fiber recruitment** (Betts et al, 2013). [5]

The ends of the muscle connect to the bone through the **tendons.** 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**.

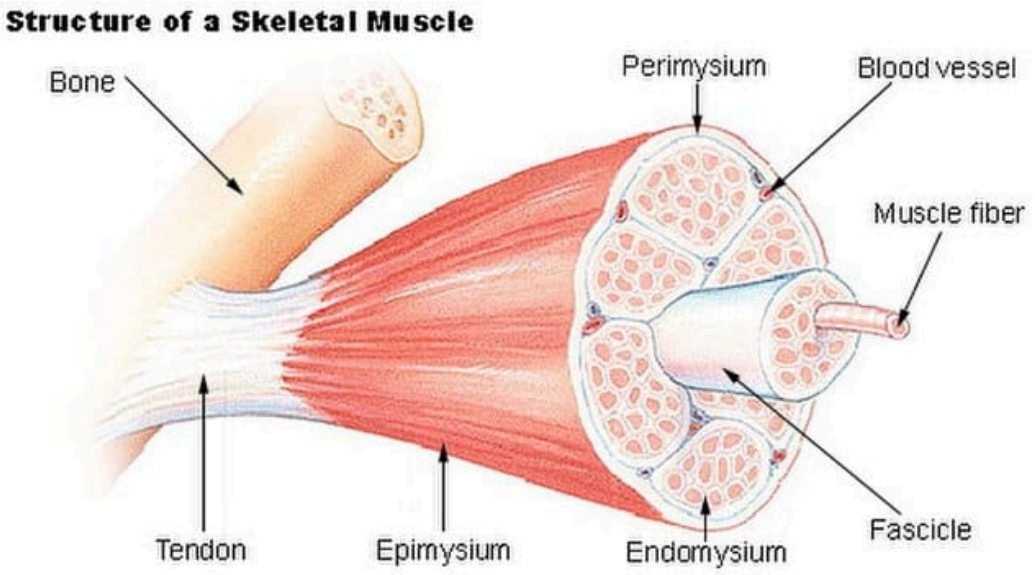


Figure 4.2.3: A skeletal muscle with the bone, tendon, epimysium, endomysium, fascicle muscle fiber, blood vessel, and perimysium labeled. (Public Domain via Wikimedia Commons)

Figure 4.2.3 illustrates the layered structure of skeletal muscle, from the protective epimysium surrounding the entire muscle to the endomysium enclosing individual fibers within fascicles. It highlights the muscle's intricate organization, essential for movement and force generation, as well as the tendon connecting the muscle to the bone. Blood vessels supplying oxygen and nutrients are also depicted, emphasizing their role in muscle function. The image includes labeled parts: bone, tendon, epimysium (outer connective tissue layer), perimysium (surrounding muscle fascicles), endomysium (surrounding individual muscle fibers), fascicle (a bundle of muscle fibers), muscle fiber, and blood vessel. The muscle is shown in cross-section to highlight internal organization. This labeled diagram shows the detailed internal structure of a skeletal muscle, starting from its connection to the bone and moving inward through various layers of organization.

On the left side, the bone is shown where the skeletal muscle is attached via a tendon, a white, cord-like structure that connects muscle to bone. The muscle is connected to the bone by the tendon, which is the strong connective tissues that transmit force to enable movement. Surrounding the entire muscle is the **epimysium**, a dense layer of connective tissue providing protection and structure, which encloses all muscle compartments. Inside the muscle, bundles of muscle fibers, called **fascicles,** and within each fascicle are the individual muscle fibers (muscle cells). The fascicles are encased by the **perimysium.** Each muscle fiber is surrounded by a thin layer of tissue called the **endomysium**, which insulates and facilitates nerve impulses. A group of muscle fibers surrounded by the perimysium is called a muscle **fasciculus**. A muscle is made up of many muscle fasciculi. A blood vessel is also labeled, running between the fascicles, indicating the presence of vascular support to deliver oxygen and nutrients to the muscle tissue. **Blood vessels** run through the muscle tissue, delivering oxygen and nutrients essential for function. Each muscle fiber is surrounded by connective tissue called an **external lamina.** Overall, the muscle's organization relies on multiple layers of connective tissue, from the epimysium to the endomysium, ensuring structural integrity and efficient operation[6].

The labels in Figure 4.2.3 and Figure 4.2.4 emphasize the structural organization and connective tissue layers of a skeletal muscle. Specifically, they highlight the hierarchical arrangement from the entire muscle down to individual muscle fibers, and the supporting tissues that surround and protect these components. Here's what each label emphasizes:

- Bone – Shows where the muscle attaches, emphasizing the skeletal connection that allows movement through contraction.
- Tendon – Highlights the connective tissue that anchors muscle to bone, transmitting the force generated by muscle contraction.
- Epimysium – Emphasizes the outermost layer of connective tissue that surrounds the entire muscle, providing overall protection and structure.
- Perimysium – Points to the connective tissue that groups muscle fibers into bundles called fascicles, indicating the mid-level of muscle organization.
- Endomysium – Identifies the fine connective tissue that wraps around individual muscle fibers, supporting each muscle cell and allowing for capillary and nerve access.
- Fascicle – Emphasizes a bundle of muscle fibers, an intermediate structural unit within the muscle.
- Muscle Fiber – Highlights a single muscle cell, the basic functional unit responsible for contraction.
- Blood Vessel – Points out the vascular network within muscle tissue, underscoring the supply of oxygen, nutrients, and removal of waste, crucial for muscle function and endurance.

Figure 4.2.4 provides an enhanced view of the structure of skeletal muscle in three parts, from the whole muscle to fascicles to individual muscle fibers, and highlights the protective and supportive connective tissues that organize and bind the muscle components together. Overall, the labels are designed to help visualize how skeletal muscle is compartmentalized, organized, and supported at different levels—from macroscopic to microscopic structures.

The top illustration labels the skeletal muscle, the epimysium (outer layer), and the muscle fascicles - showing the comprehensive muscle fiber bundle. An arrow points to the magnified view of the muscle fascicle in the middle illustration, including the bundle of muscle fibers surrounded by the perimysium that make up the fasciculus, as well as the endomysium within the fascicles. It labels the muscle fascicle, perimysium, endomysium, and muscle fibers. An arrow from the middle illustration of the muscle fibers points to an even more magnified illustration of the muscle fiber, which is covered by the **sarcolemma**, which is also labeled in the bottom illustration.

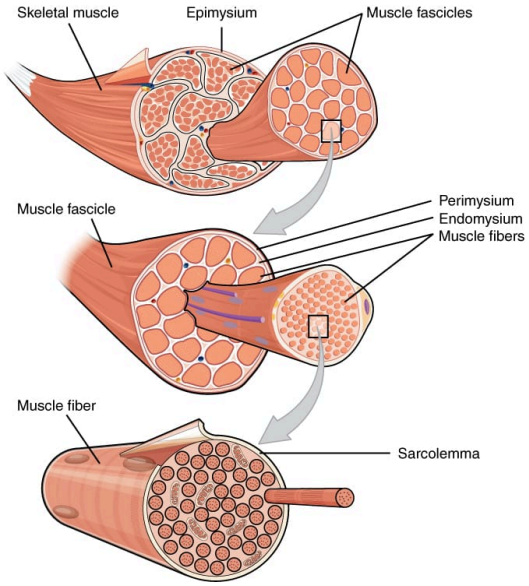


Figure 4.2.4: The three connective tissue layers bundles of muscle fibers called fascicles, are covered by the perimysium. Muscle fibers are covered by the endomysium. (CC BY 4.0; Openstax College via Wikimedia)

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 (Cooper Institute for Aerobics Research, 1994). [7]

Question

- What makes my muscles work?

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 supplies oxygen to the cardiac muscle cells. Unlike skeletal muscle cells, 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 (Chen et al, 2022). [6]

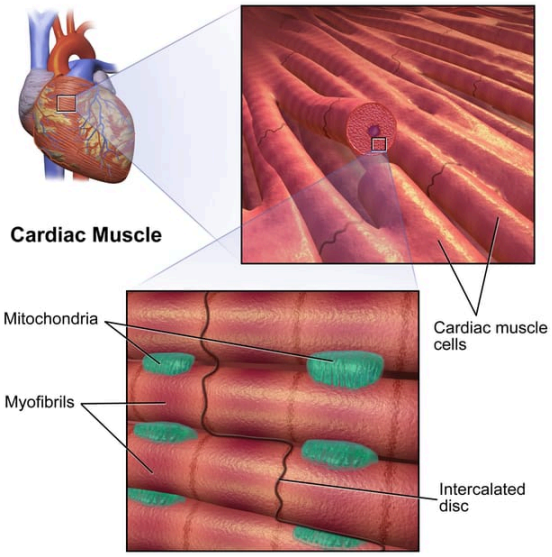


Figure 4.2.5: Cardiac muscle is found in the walls of the heart. The close-up view reveals mitochondria providing energy and myofibrils responsible for the muscle's contraction. (CC BY 4.0; Bruce Blas via Wikimedia Commons)

Figure 4.2.5 is an illustration showing the structure of cardiac muscle of both the heart muscle and a magnified view of the cardiac muscle cells, mitochondria, myofibrils, and the intercalated disc. It highlights the specialized cardiac muscle cells, interconnected by intercalated discs, which facilitate synchronized contractions of the heart. On the left, a human heart is depicted with a highlighted region indicating the area being magnified. The first zoomed-in view shows cardiac muscle fibers, which are striated and branched. A further magnified section reveals detailed structures within the cardiac muscle cells, including:

- Mitochondria, shown as green oval-shaped organelles within the muscle cells, represent the high energy demands of cardiac tissue.
- Myofibrils, depicted as long, cylindrical structures aligned within the muscle cells, are responsible for contraction.
- Intercalated discs, represented as dark, irregular lines between adjacent cells, signify the specialized junctions that enable synchronized contraction and electrical connectivity.

The labels identify "Cardiac muscle cells," "Mitochondria," "Myofibrils," and "Intercalated disc." The illustration emphasizes the cellular and subcellular anatomy of cardiac muscle tissue.

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.

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 several 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 was previously described as muscle **fiber recruitment**. When lifting a light object, such as a book, only a small number of muscle fibers will be recruited. However, those who 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 triceps muscle. This is the same for every movement in the body. There will always be one contracting muscle and one relaxing muscle. Take a moment to think about these simple movements, and it will soon become obvious that unless the opposing muscle is relaxed, it will decrease the force generated by the contracting muscle (Epstein, 2014). [8]

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.

Skeletal Muscle Pairs

To move the bones of the body, a skeletal muscle must be attached to a fixed art of the skeleton. The connection between agonist and antagonist muscle groups can be seen in Table 4.2.1. 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 triceps extension, as is illustrated in Figure 4.2.6.

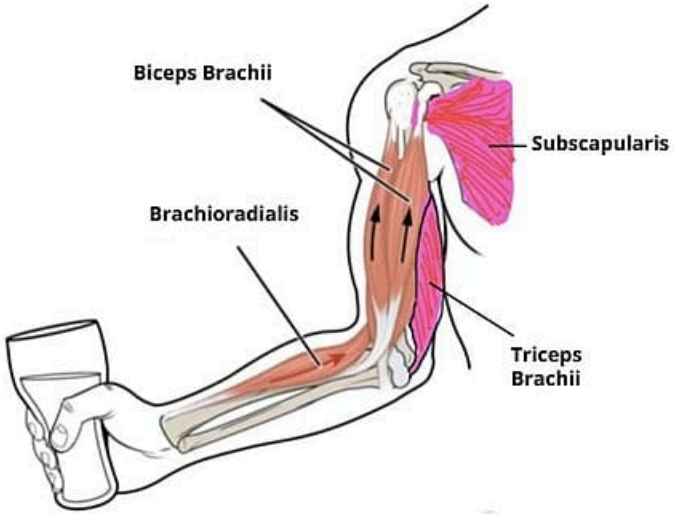


Figure 4.2.6: Synergist, antagonist, agonist, and fixator muscle groups work together to lift a cup. (CC BY 4.0; Rachel Sanchez via Wikimedis Commons)

A labeled anatomical illustration of the human arm in a flexed position, holding a glass of water, is depicted in Figure 4.2.6. The image highlights several muscles and their roles during elbow flexion. The Biceps Brachii, located on the front of the upper arm, is shown as the prime mover (agonist) responsible for flexing the elbow. The Brachioradialis, running along the forearm, is labeled as a synergist, assisting in the motion. The Triceps Brachii, located on the back of the upper arm, is identified as the antagonist, opposing the movement. The Subscapularis, located near the shoulder joint, is labeled as a fixator, stabilizing the shoulder during the action. Arrows along the muscles indicate the direction of movement or contraction.

Table 4.2.1: ***Agonist and Antagonist Muscle Pairs***

Agonist (Prime Mover)	Antagonist
Latimus Dorsi (upper back)	**Deltoids** (Shoulder)
Triceps (back of upper arm)	**Biceps** (front of upper arm)
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)

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 a **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 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.



Figure 4.2.7: A biceps curl. On the left, the eccentric contraction is shown with the arm lengthened. On the right, the concentric contraction is shown with arms bent. (CC BY-SA 3.0 via Wikipedia Commons)

Types of Muscle Fibers

Two main types of muscle fiber help the body (Epstein, 2014) [8]:

- **Type I** - These muscle fibers are also known as slow-twitch fibers or highly-oxidative fibers**.** They are muscle fibers that are highly resistant to fatigue and specialized for endurance activities. They rely primarily on aerobic metabolism, have a high density of mitochondria, and are rich in myoglobin, giving them a red color and enabling sustained, low-intensity contractions over long periods.
- **Type II** - These muscle fibers, also known as fast-twitch fibers or low-oxidative fibers, are specialized for quick, powerful movements and activities requiring bursts of strength or speed. They have a higher capacity for anaerobic metabolism, fewer mitochondria, lower myoglobin content, and fatigue more quickly compared to Type 1 fibers, making them ideal for activities like sprinting or weightlifting.

Additionally, Type II muscle fibers can be further split into **Type IIa** and **Type IIb**.

- **Type IIa** - These muscle fibers, also known as fast oxidative fibers, are a subtype of fast-twitch fibers that combine characteristics of both endurance and power.
- **Type IIb** - These muscle fibers, also known as fast glycolytic fibers, are a subtype of fast-twitch fibers specialized for short, explosive bursts of power and speed.

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 resemble Type I fibers strongly, but following a period of strength training, they will start to resemble Type IIb fibers strongly. In fact, following several years of endurance training, they may end up being almost identical to slow-twitch muscle fibers.

Question

- Have you ever wondered why some people seem naturally better at sprinting, jumping, or lifting heavy weights while others can run for miles with ease?

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.

Question

- Can you think of three types of physical activity that use "slow" muscles?

Slow-Twitch Muscle Fibers

1. **Endurance and Stamina** – These fibers are built for sustained activities like long-distance running and cycling.
2. **Fatigue-Resistant** – They rely on oxygen (aerobic metabolism) for energy, allowing them to work for long periods without tiring quickly.

Question

- What types of exercise might use "fast" muscles?

These fibers are larger in size, have a decreased blood supply, have smaller mitochondria and fewer 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, 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.

Fast-Twitch Muscle Fibers

1. **Power and Speed** – These fibers generate quick, explosive movements, making them ideal for sprinting, jumping, and heavy lifting.
2. **Fatigue Quickly** – They use anaerobic energy, which allows for short bursts of strength but leads to quicker fatigue.

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 more 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.

Motor Units

A **motor unit** consists of a single **motor neuron** and all the **muscle fibers** it innervates. Basically, a motor unit is made up of a nerve connected to several muscle fibers. When the motor neuron sends an electrical signal, all the connected muscle fibers contract at the same time. This is the basic way the nervous system controls muscle movement. The size of motor units varies depending on the muscle's function—smaller motor units are found in muscles used for fine, precise movements (such as those

in the hands), while larger motor units are found in muscles responsible for powerful, gross movements (like those in the legs). Each motor neuron within a motor unit sends its signal to muscle fibers through a long, slender extension called an **axon**. The axon carries electrical impulses from the spinal cord to the muscle and branches out at the end to connect with multiple muscle fibers at sites called **neuromuscular junctions**. This connection allows the neuron to control the timing and strength of muscle contraction.

Motor units play a key role in muscular strength. The number of motor units recruited depends on how much strength is required to complete a task. When a person lifts a heavy object, the body responds by activating more motor units and increasing the rate at which they fire. This allows the muscles to produce more force. Strength training improves this process by enhancing the nervous system's ability to recruit motor units more effectively and in better coordination. These changes lead to increased strength, often before any significant muscle growth occurs.

Motor units are also important for muscular endurance, which is the ability to sustain muscle activity over time. Endurance training primarily involves slow-twitch muscle fibers, which are controlled by smaller motor units. These fibers are more efficient at using oxygen and are more resistant to fatigue. With regular training, these motor units become better at supporting prolonged activity, such as during long-distance running or cycling.

Overall, motor units are essential for regulating both the **force** and **duration** of muscle contractions. **Muscle learning**, also known as **neuromuscular adaptation**, refers to the nervous system's ability to become more efficient at activating motor units through repeated practice or training. Early gains in strength during a new exercise program are often due to improved motor unit recruitment, coordination, and firing patterns rather than muscle growth. With consistent training, the brain and spinal cord learn to better control muscle contractions, resulting in more precise and powerful movements. This process is especially important in developing new skills, improving technique, and enhancing overall performance. Adaptations in motor unit recruitment and efficiency are a key part of how the body improves strength and endurance in response to different types of physical training.

Anterior and Posterior View of Major Muscles

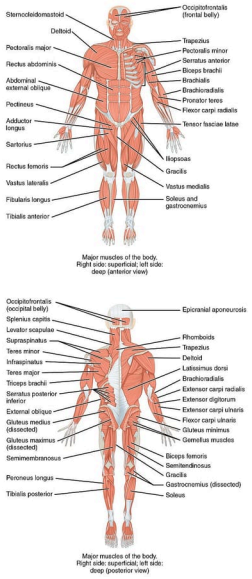


Figure 4.2.8: Anatomical representation of the major muscles in the human body, including superficial and deeper layers of muscle tissue. Top: anterior (front) view; bottom: posterior (back) view. (CC BY 4.0 by OpenStax via Wikipedia Commons) Alternative Text Description.

Figure 4.2.8 is a diagram that is an excellent reference for understanding the spatial arrangement and functions of both superficial and deep muscle groups in the human body. This top Illustration is a labeled anatomical diagram that displays the major muscles of the human body from an anterior (front-facing) perspective. The right side of the body (viewer's left) shows the superficial muscles, while the left side (viewer's right) displays deeper muscles. The bottom anatomical diagram shows a labeled view of the major muscles on the back (posterior side) of the human body. The right side of the body (viewer's left) displays deep muscles, while the left side (viewer's right) shows superficial muscles.

In the anterior view, muscles such as the sternocleidomastoid, pectoralis major, rectus abdominis, biceps brachii, rectus femoris, and tibialis anterior are labeled. These muscles are responsible for actions like head rotation, arm movement, trunk flexion, and leg extension.

In the posterior view, muscles like the trapezius, latissimus dorsi, triceps brachii, gluteus maximus, biceps femoris, and gastrocnemius are identified. These muscles support movements like shoulder elevation, arm extension, hip extension, and plantar flexion.

For a complete explanation and descriptive alternative text of Figure 4.2.8 can be found in section 4.11.

Key Points

- Muscles enable movement and vital functions such as posture, breathing, circulation, and digestion through voluntary and involuntary contractions.
- There are three types of muscle tissue:
- Skeletal (voluntary) – moves the skeleton.
- Cardiac (involuntary) – contracts the heart.
- Smooth (involuntary) – controls functions of internal organs and blood vessels.
- Skeletal muscles are made up of fibers and motor units, and their contractions are triggered by electrical signals from the nervous system.
- Muscle contraction occurs via the Sliding Filament Theory, where actin filaments slide over myosin filaments within sarcomeres, shortening the muscle.
- Muscle structure is organized by connective tissues (epimysium, perimysium, endomysium) and supported by tendons, blood vessels, mitochondria, and glycogen stores.
- Muscles contract in different ways:
- Isometric (no movement),
- Isotonic (movement), including concentric (shortening) and eccentric (lengthening) phases.
- Agonist (prime mover) and antagonist muscles work in pairs during movement, with additional roles played by synergists and fixators.
- Skeletal muscle fibers are of different types, with distinct functions and characteristics:
- Type I (slow-twitch) – endurance, fatigue-resistant, aerobic.
- Type II (fast-twitch) – power/speed, fatigue quickly, anaerobic.
- Fast-twitch fibers are subdivided into:
- Type IIa – adaptable, combines endurance and power traits.
- Type IIb – high power, very fast, fatigues quickly.
- Muscle fiber composition is genetically determined, but training can improve characteristics of both slow and fast-twitch fibers, though not completely convert one into the other.

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4.3: Training - The Effects of Exercise on Muscles



Figure 4.3.1: A woman prepares for a weighted squat. (Woman lifting barbell by Sven Mieke via Unsplash)

Introduction

Exercise involves a series of muscle contractions that can vary in duration and intensity depending on the type of physical activity performed. Short-duration activities, such as sprinting or weightlifting, rely on quick, powerful contractions, while long-duration activities, like running or cycling, require sustained, endurance-based muscle contractions. The effects of exercise on muscles can be categorized into short-term and long-term impacts. Resistance training promotes muscle hypertrophy, increasing muscle size and strength, while endurance exercises enhance muscular endurance and efficiency. These changes occur as muscles respond to stress, repair, and grow stronger, highlighting the body's remarkable ability to adapt to physical activity. Exercise affects the muscles in the body, with the effects varying based on the type of activity and the muscle groups used. Some exercises involve short, powerful muscle contractions, while others rely on longer, endurance-based contractions. Exercise causes both immediate effects, such as increased blood flow and muscle activation, and long-term effects, including improved strength, endurance, and muscle growth. These adaptations highlight the body's remarkable ability to respond and adjust to physical demands. Since muscles are highly adaptable tissues that respond to the demands of physical activity and changes in use, making use or disuse is responsible for overall fitness and wellness. One result is muscle atrophy, which is the shrinking of muscle size and loss of strength that commonly occurs due to prolonged inactivity, aging, or specific medical conditions. On the other hand, muscle hypertrophy refers to the growth and strengthening of muscle fibers resulting from regular use, particularly through resistance training. Exploring these processes is crucial for understanding how muscles adapt to exercise, recover from injuries, and respond to rehabilitation efforts.

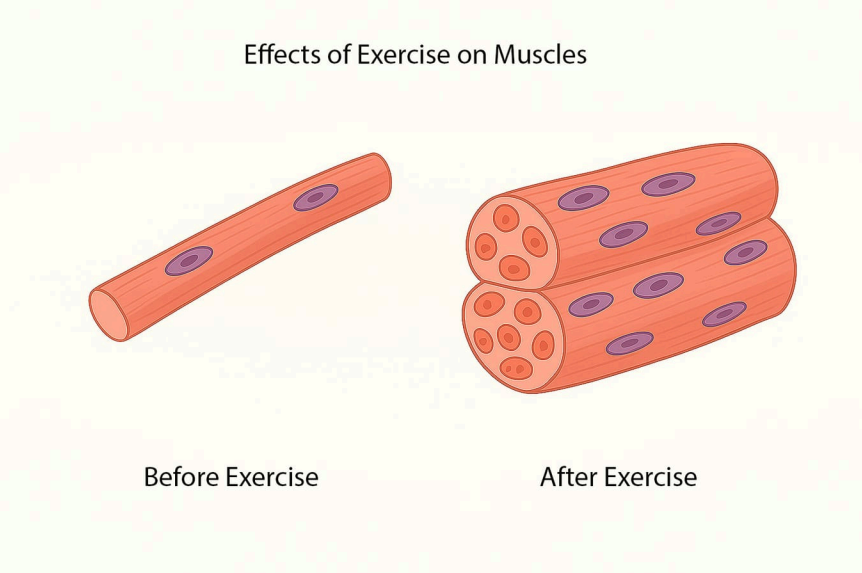


Figure 4.3.2: This educational image titled *"Effects of Exercise on Muscles"* shows a side-by-side comparison of muscle fibers before and after regular exercise. On the left side, labeled "Before exercise," there is a single, thin muscle fiber with a smooth texture. It contains a few dark purple oval structures representing nuclei. On the right side, labeled "After exercise," there are multiple thicker muscle fibers grouped together. These fibers appear larger and contain more nuclei (dark purple ovals) and mitochondria (small red circles), indicating increased cellular activity and energy production due to exercise. This visual emphasizes how muscles adapt and grow stronger with regular physical activity. It shows hypertrophy (muscle fiber enlargement), increased mitochondrial density, and improved cellular structure after exercise. (CC BY 4.0 by ChatGPT)

Immediate, Short-Term Effects

The effects of exercise on muscles vary depending on the type and duration of the activity, with aerobic and anaerobic exercises impacting muscles in distinct ways. Aerobic exercise, such as long-distance running or swimming, involves endurance-based activities that rely heavily on Type I (slow-twitch) muscle fibers. These fibers are specialized for sustained contractions over extended periods. They are supported by an ample oxygen supply, which prevents the buildup of lactic acid and minimizes short-term muscle fatigue. During prolonged aerobic activity, muscles shift their metabolic pathways to favor fat as the primary source of ATP production, sparing glycogen reserves (Elgaddal et al, 2022). [9]

In contrast, anaerobic exercise, like sprinting or weightlifting, depends on **Type II muscle fibers**, which generate short, powerful contractions. These fibers rely on readily available ATP, glucose, and glycogen to fuel high-intensity efforts. This reliance on anaerobic metabolism leads to the accumulation of **lactic acid**, which, while not the direct cause of muscle fatigue, inhibits ATP production and contributes to the fatigue process. Recent research suggests that ion imbalances, such as calcium shortages, may play a more direct role in muscle fatigue during intense activity.

Muscle soreness, previously attributed to lactic acid buildup, is now understood to result from microscopic tears in muscle fibers caused by eccentric contractions. These small tears stimulate repair and adaptation processes, ultimately strengthening the muscle over time. This differentiation between aerobic and anaerobic effects highlights the complexity of muscle responses to various forms of exercise.

Long-Term Effects

Question

- When I start working out, how long does it take before I see my muscles get bigger?

Muscle hypertrophy, the increase in muscle size as a result of exercise, particularly resistance or weight training, is one of the most prominent long-term effects of regular physical activity. Interestingly, exercising specific muscles can also lead to hypertrophy in the corresponding muscles on the opposite side of the body, a phenomenon known as **cross-education**. This

effect demonstrates the interconnected nature of the nervous and muscular systems in response to training.

Opinions among experts vary regarding the most effective methods to achieve hypertrophy, as distinct training approaches can emphasize muscle growth, strength, power, or endurance. However, it is generally accepted that consistent anaerobic strength training, involving progressive overload, is essential for promoting muscle hypertrophy over time. In addition to increasing muscle mass, such training also improves muscular strength and endurance, showcasing its comprehensive benefits for overall fitness.

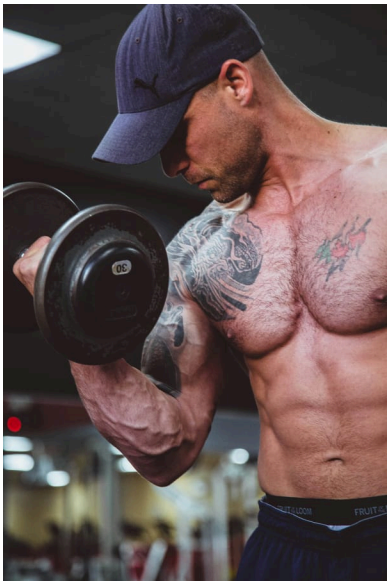


Figure 4.3.3: A man performs a bicep curl. (Topless man holding black dumbell in right hand by Alora Griffiths via Upsplash)

Muscle Atrophy

Question

- When I stop exercising for a time, do my muscles turn to fat?

The good news is that muscle fibers cannot turn into fat tissue. Conversely, fat tissue does not change into muscle mass. Fat tissue and muscle tissue are fundamentally different in structure and function, and one cannot transform into the other. However, getting older or having a sedentary lifestyle can cause muscle mass to decrease and fat cell size and number to increase due to a caloric imbalance. Muscle **atrophy** is the decrease in muscle strength due to a decrease in muscle mass, or the number of muscle fibers. Atrophy can be partial or complete, varying in the extent of muscle weakness. Muscle atrophy is often a result of diseases such as cancer, AIDS, congestive heart failure, chronic obstructive pulmonary disease, renal failure, and burns. Starvation can also result in muscle atrophy. Simple disuse of muscle, either due to a sedentary lifestyle or because of bed rest, can also cause muscle atrophy.

Muscle atrophy is typical to some extent during aging. Atrophy over time due to aging is known as **sarcopenia**. Though not completely clear, it is suspected that the cause of sarcopenia is a combination of the decline of satellite cells to regenerate cells of skeletal muscle fibers, as well as a decreased sensitivity or availability of hormone cues, including growth factors, that stimulate maintenance of muscles through regeneration of muscle fiber cells from satellite cells.

Loss of muscle not due to atrophy or sarcopenia is indicative of diseases that result in structural defects of muscles (muscular **dystrophy**) or autoimmune responses that degrade muscle structure (**myopathies**).

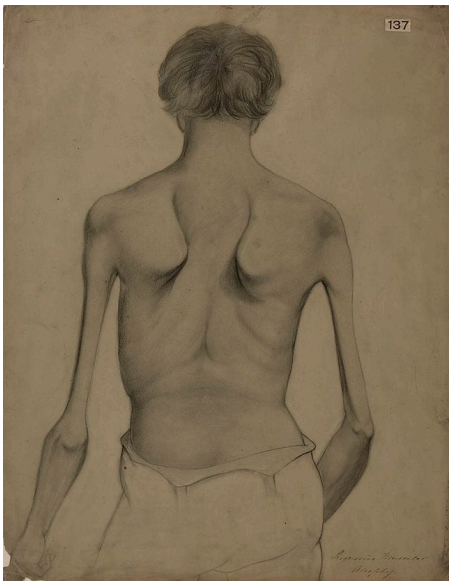


Figure 4.3.4: This illustration depicts the back view of an individual with visible signs of progressive muscular atrophy, characterized by pronounced skeletal structure and muscle wasting. (CC BY 4.0 via Wikimedia Commons)

Muscle Hypertrophy

Muscle hypertrophy is an increase in the size of a muscle through an increase in the size of its component cells. It differs from **muscle hyperplasia**, which is the formation of new muscle cells. Depending on the type of training, hypertrophy can occur through increased sarcoplasmic volume or increased contractile proteins.

A range of stimuli can increase the volume of muscle cells, including strength training or anaerobic training. These changes occur as an adaptive response that serves to increase the ability to generate force or resist fatigue in anaerobic conditions.

Several biological factors, such as age and nutrition, can affect muscle hypertrophy. During puberty in males, hypertrophy occurs at an increased rate. Natural hypertrophy normally stops at full growth in the late teens. An adequate supply of amino acids is essential to produce muscle hypertrophy. As testosterone is one of the body's major growth hormones, on average, men find hypertrophy much easier to achieve than women. Taking additional testosterone, as in anabolic steroids, will increase results. It is also considered a performance-enhancing drug, the use of which can cause competitors to be suspended or banned from competitions. In addition, testosterone is also a medically regulated substance in most countries, making it illegal to possess it without a medical prescription (Flynn et al, 2018). [10]



Figure 4.3.5: This man's well-defined shoulder, back, and arm muscles emphasize his muscle tone and strength. (Topless man with black background by Nigel Msipa via Upsplash)

Benefits of Muscle Fitness

Question

Is it true that having more muscles will help me live longer?

Developing muscle fitness through exercise provides numerous benefits for overall health and well-being. Engaging in strength training and resistance exercises helps build and maintain muscle mass, which is essential for strength, endurance, and functional movement. Improved muscle fitness enhances metabolism, supports body weight management, and reduces the risk of chronic diseases such as osteoporosis and type 2 diabetes. Additionally, strong muscles contribute to better posture, injury prevention, and overall physical performance in daily activities. By incorporating regular muscle fitness training, individuals can improve their quality of life and maintain long-term health and mobility (Kenney, 2020). [11]

1. **Increased Muscle Mass and Strength** – Helps improve physical power, making everyday tasks easier.
2. **Enhanced Metabolism** – More muscle mass leads to a higher resting metabolic rate, aiding in weight management.
3. **Improved Bone Health** – Strength training increases bone density, reducing the risk of osteoporosis as one ages.
4. **Better Posture and Stability** – Strengthening muscles supports better alignment and reduces the risk of falls or injuries.
5. **Enhanced Athletic Performance** – Builds endurance and power for sports and physical activities.
6. **Reduced Risk of Chronic Diseases** – Helps lower the risk of heart disease, type 2 diabetes, and other metabolic disorders.
7. **Improved Mental Health** – Exercise releases endorphins, which help reduce stress, anxiety, and depression.
8. **Increased Functional Strength** – Makes daily activities, such as carrying groceries or climbing stairs, easier.
9. **Greater Endurance and Stamina** – Improves muscular fatigue resistance for prolonged activities.
10. **Injury Prevention and Recovery** – Strengthening muscles and joints reduces the likelihood of injuries and aids in recovery.

Key Points

- Physical activity promotes muscle adaptation because the body adjusts to varying physical demands by enhancing muscular strength, endurance, or power based on the activity performed.
- Exercise impacts muscles in the short and long term: short-term effects include fatigue and muscle tension, while long-term effects lead to strength, endurance, and structural adaptations.
- Aerobic exercise uses Type I (slow-twitch) muscle fibers, which enable endurance.
- Anaerobic exercise primarily relies on Type II (fast-twitch) muscle fibers, contributing to muscle fatigue.
- Muscle fatigue during anaerobic exercise is linked to ion imbalances and inhibited ATP production, while muscle soreness

stems from microscopic tears during eccentric contractions, triggering repair and strengthening over time.

- Muscle hypertrophy from weight or resistance training is one of the most prominent long-term effects of regular physical exercise.
- Muscle atrophy refers to the decrease in muscle mass leading to muscle weakness or a decrease in the ability to generate force.
- Atrophy has several causes, including disease, starvation, and simple disuse.
- Muscle hypertrophy differs from muscle hyperplasia, which is the formation of new muscle cells.
- A range of stimuli can induce muscle cell hypertrophy, including strength training or anaerobic training.
- Biological factors such as age and nutrition can affect muscle hypertrophy.
- There are numerous benefits to participating in a muscle strength and endurance training regimen.

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4.4: Types of Muscular Contractions for Training



Figure 4.4.1: Muscles, big and small, are key to all essential movement. (Topless Man Wearing Black and White Cap; Gorilla Freak via Unsplash)

Introduction

Muscle contractions are essential for all movement, allowing us to perform actions like lifting, walking, or maintaining posture. These contractions are classified based on how the muscles produce force and whether they change length during activity. Isotonic contractions, such as concentric and eccentric movements, involve changes in muscle length, while isometric contractions create force without changing muscle length. Each type has a specific role in daily activities and exercise, helping us understand how muscles work and adapt to physical demands.

Muscle fiber generates tension through the action of actin and myosin cross-bridge cycling. While under tension, the muscle may lengthen, shorten, or remain the same. Although the term contraction implies shortening, when referring to the muscular system, it means muscle fibers generate tension with the help of motor neurons. Several types of muscle contractions occur, and they are defined by the changes in the length of the muscle during contraction.

Types of Muscular Contractions

- **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 a **dynamic contraction**. During this contraction, the muscle fattens, and there is movement at the joint.

In contrast to isotonic contractions, an **isometric contraction** generates force without changing the muscle's length or moving the joints. For example, when gripping an object, the muscles in the hand and forearm produce enough force to hold it steady without altering their length or moving the joints of the hand. An example of an isometric exercise is holding a plank position as is seen in Figure 4.4.2. In this exercise, the core, shoulders, and leg muscles contract to maintain the body in a straight line without any movement or change in muscle length.



Figure 4.4.2: This woman holding a plank position, an example of an isometric exercise. (CC BY 4.0; Uma Prykhodko via Wikimedia Commons)

In the plank position, the muscles are engaged to maintain stability without any visible change in length or movement of the joints. The core muscles, including the abdominals and obliques, work to keep the spine aligned and the body in a straight line from head to heels. The shoulders, arms, and chest provide support by stabilizing the upper body, while the quadriceps, glutes, and calves maintain lower body alignment. This full-body exercise improves muscular endurance, posture, and stability.

An **isotonic contraction** maintains constant tension in a muscle as it changes length, occurring only when the muscle's maximal force exceeds the load. These contractions can be concentric, where the muscle shortens (e.g., lifting a weight), or eccentric, where the muscle lengthens (e.g., lowering a weight). For example, during a bicep curl, the bicep shortens as it lifts the weight (concentric contraction) and lengthens as the weight is lowered (eccentric contraction).



Figure 4.4.3: A biceps curl. On the left, the eccentric contraction is shown with the arm lengthened. On the right, the concentric contraction is shown with arms bent. (CC BY-SA 3.0 via Wikipedia Commons)

Types of Isotonic Contraction

- **Concentric** - This is when the muscle contracts and shortens against resistance. This may be referred to as the lifting or positive phase. An example would be the lifting phase of the bicep curl as is depicted in Figure 4.4.3 in the photo on the right

or in Figure 4.4.4 with the middle image and the image on the right.

- **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, as depicted in Figure 4.4.3 with the image on the left or in Figure 4.4.4 with the image depicted on the left.



Figure 4.4.4:This image illustrates the phases of a bicep curl, highlighting concentric and eccentric isotonic contractions. During the lifting phase, the bicep undergoes a **concentric contraction**, shortening as it generates force to raise the weight. In the lowering phase, the bicep performs an **eccentric contraction**, lengthening under tension to control the descent of the weight. (CC BY-SA 3.0 via Wikimedia Commons)

Concentric Contractions

A **concentric contraction** is a type of muscle contraction in which the muscles shorten while generating force. This is typical of muscles that contract due to the sliding filament mechanism, and it occurs throughout the muscle. Such contractions also alter the angle of the joints to which the muscles are attached, as they are stimulated to contract according to the sliding filament mechanism.

This occurs throughout the length of the muscle, generating force at the **musculotendinous junction**, causing the muscle to shorten and the angle of the joint to change. For instance, a concentric contraction of the biceps would cause the arm to bend at the elbow as the hand moves from near the leg to close to the shoulder (a biceps curl). A concentric contraction of the triceps would change the angle of the joint in the opposite direction, straightening the arm and moving the hand toward the leg.



Figure 4.4.5: A squat is a fundamental lower-body workout. (CC0 1.0 via Wikipedia Commons)

In Figure 4.4.5, a woman is in the lowered squat position, with her knees bent and thighs parallel to the floor, maintaining proper posture with her back straight and chest upright. Her arms are raised in front of her for balance, and her feet are firmly planted shoulder-width apart. When she rises back to a standing position, a concentric contraction occurs in the quadriceps, hamstrings, and glutes as these muscles shorten to extend the knees and hips. Squats are highly effective for building strength, improving balance, and enhancing mobility in the lower body.

Eccentric Contractions

An **eccentric contraction** occurs when a muscle elongates under tension, often acting as a “brake” to control or decelerate movement against an opposing force stronger than the muscle’s contraction. This type of contraction can be voluntary, such as controlling the descent of a heavy object, or involuntary, when the load exceeds the muscle’s lifting capacity, like lowering a barbell that is too heavy to lift during a failed rep. Eccentric contractions are critical for smooth movement and joint stability, as they decelerate motion or reposition loads. Strength training involving both eccentric and concentric contractions has been shown to enhance muscle strength more effectively than concentric-only exercises.

An example of an eccentric exercise is the lowering phase of a "good morning" exercise as is depicted in Figure 4.4.6. During this movement, the hamstrings, glutes, and lower back muscles elongate under tension as the barbell is slowly lowered back to the ground, controlling the descent of the weight. This emphasizes the eccentric contraction as the muscles work to decelerate the load.



Figure 4.4.6: A man performing the good morning exercise with a barbell. On the left, he begins in a stand, in the middle, he lowers the weight, keeping his spine straight, and on the right, he ends with the barbell on the ground (CC BY-SA 3.0 via Wikimedia Commons)

Key Points

- Isometric contractions generate force without changing the length of the muscle
- Isotonic contractions generate force by changing the length of the muscle and can be concentric contractions or eccentric contractions.
- A concentric contraction causes muscles to shorten, thereby generating force.
- Eccentric contractions cause muscles to elongate in response to a greater opposing force.

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4.5: Resistance Training Programming



Figure 4.5.1: (Woman Using Dumbbells; Cathy Pham via Unsplash)

Introduction

Designing a resistance exercise program can seem like a daunting task. However, the basics are straightforward to grasp. By following a few key guidelines, it's possible to create an effective program tailored to an individual's needs and goals. For instance, fitness level plays a crucial role in determining the starting point and progression of a program. Other factors, such as specific goals (e.g., building strength, improving endurance, or enhancing muscle tone), available equipment, and the individual's schedule, should also be considered. This section explores the fundamental principles of resistance training programming, providing a clear framework to help you design safe, efficient, and personalized workouts for any fitness level.

Understanding your muscular strength and endurance is essential for tracking progress, setting realistic fitness goals, and designing an effective resistance training program. Strength assessments measure the maximum force a muscle can produce, while endurance tests evaluate a muscle's ability to sustain repeated contractions over time. These assessments help identify strengths, weaknesses, and imbalances, guiding adjustments to training routines for optimal performance and injury prevention.

Assess Muscular Fitness

It is important to assess one's muscular strength and endurance prior to beginning any fitness program for the following reasons:

- **Establishes a Baseline**: Assessing muscular strength and endurance helps determine an individual's current fitness level, allowing for realistic goal-setting and progress tracking over time.
- **Identifies Imbalances or Weaknesses**: Pre-exercise assessments can highlight muscle imbalances, postural issues, or areas of weakness that may increase injury risk if not addressed.
- **Guides Program Design**: Knowing initial strength and endurance levels enables the creation of a personalized and appropriately challenging exercise regimen.
- **Monitors Health and Safety**: Assessments help ensure individuals are physically prepared for exercise, which is particularly important for older adults or those with chronic conditions.

Question

- How do I know how strong I am?

Muscle Fitness Tests

There are a variety of muscle fitness tests to assess muscular strength and endurance. These include:

- The functional leg strength tests and muscular strength tests
- The 60-second sit-up test
- The push-up/modified push-up test
- The squat endurance test.

These have rating scales based on biological sex. Creating a quality resistance training program begins with assessing muscular strength and endurance. Assessing your muscular strength and endurance can be found in Labs and Activities.

Putting Together Your Program

Once you have decided that you are ready to begin your muscle fitness program, here are the next steps:

Equipment

It is important to decide what equipment to use for your training program. This may be based on what equipment and/or facilities you are able to access.

Equipment/Exercise options for all levels

- **Free weights** (e.g., dumbbells, barbells)
- **Weight machines** (e.g., leg press, chest press)
- **Bodyweight exercises** (e.g., push-ups, pull-ups)
- **Resistance bands or tubing**
- **Isometric exercises** (e.g., wall sits, planks)
- **Plyometric or power-based exercises** (e.g., jump squats, medicine ball throws)
- **Functional resistance training** (e.g., kettlebell swings, TRX suspension exercises



Figure 4.5.2: These dumbbells are examples of free weights. (Grayscale picture of dumbbells; Luis Reyes via Upsplash)

Select the Type of Muscular Training

The next step is to decide the type of muscular training that will fit both your fitness goals and the equipment and facilities options you have available. Different types of resistance training affect muscles in different ways. While these methods have been

around for a long time, some may offer new and creative ways to challenge your muscles that you haven't yet explored. You can use them on their own, combine them, or pair them with more traditional equipment like machines or free weights. Doing so can add variety to your workouts and help you achieve better results.

In most types of resistance training, you'll use some kind of equipment to create resistance. What makes each method unique is how the resistance is applied. For example, you might use a dumbbell in multiple training styles, but the way you move it—and the muscles it targets—can vary depending on the method you're using.

- **Dynamic Constant Training**
  As the name suggests, the most distinctive feature of **dynamic constant training (DCT)** is that the resistance is constant. A clear example of dynamic constant resistance training (DCT) can be observed when using free weights or resistance machines that maintain a consistent level of resistance throughout the movement. In this form of training, the resistance does not change in magnitude but is redirected across different planes of motion within the targeted muscle group. For instance, when using a shoulder press machine, the resistance remains uniform throughout the entire range of motion—from the starting position at the bottom, through the lift to the top, and back down again. Although the direction of the resistance shifts to follow the movement's arc, its intensity stays the same, requiring the muscles to exert continuous force.
- **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, **dynamic variable training (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 typically operates with fixed resistance points, offering limited variability during an exercise. In contrast, the Strive line of equipment provides users with greater control over resistance levels throughout the movement. Strive machines effectively utilize the Dynamic Variable Training (DVT) principle by allowing resistance to be adjusted at the beginning, middle, or end of the range of motion. This feature enables users to align resistance with their individual joint strength, whether greater at the start or end of a movement. As a result, the Strive line is among the most adaptable equipment available, designed specifically to support the DVT approach by allowing users to customize their workouts according to their unique biomechanical needs.

- **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 involves muscle contractions without joint movement, as seen when swimmers push their hands against a

solid wall, exerting their body weight into a fixed surface. Another common example of isometric training includes pressing the palms together to engage the pectoral and biceps muscles. Wall presses typically activate the anterior deltoids, chest, and biceps. Research has shown that isometric training is effective for increasing strength; however, the strength gains are typically limited to the specific joint angle at which the contraction occurs. For example, if the highest resistance is applied at the midpoint of a biceps contraction, the majority of strength improvement will be concentrated at that point. A well-designed isometric training program can target and enhance strength in specific muscle groups.

- **Isotonic Training**
  The **isotonic training** 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.

Important Terminology

- A **set** refers to a group of consecutive repetitions (reps) of an exercise performed without rest. For example, performing 10 squats in a row constitutes one set of squats. After completing a set, a rest period typically follows before starting another set of the same or a different exercise. Sets are a key component in structuring a workout and are often adjusted based on the training goal, such as building strength, endurance, or muscle size.
- A **repetition** refers to one complete movement of an exercise, including both the lifting (concentric) and lowering (eccentric) phases. For example, in a bench press, lowering the weight to the chest and then pressing it back up counts as one repetition. Repetitions are grouped into sets and are a fundamental measure of volume in a workout, with the number of reps often tailored to specific fitness goals, such as strength, hypertrophy, or endurance.
- **Repetition maximum (RM)** refers to the maximum amount of weight a person can lift for a specified number of repetitions with proper form. For example, a 1RM is the maximum weight that can be lifted for one complete repetition, while a 10RM is the maximum weight that can be lifted for ten repetitions. RM is often used to gauge strength levels and determine appropriate resistance for training based on specific goals, such as strength, power, or muscular endurance.

FITT Principle

The **FITT Principle** for resistance programming provides a framework to create effective strength-training programs. This principle ensures a structured approach to progressively overload muscles, optimize recovery, and meet strength or hypertrophy goals.

F - Frequency

Frequency: The number of resistance training sessions per week, typically 2–4 sessions depending on goals and recovery needs.

I - Intensity

Intensity: The amount of resistance used, often based on a percentage of an individual's repetition maximum (e.g., 70% of 1RM) or the number of repetitions performed per set.

T - Time

Time: The duration of the workout, which includes the total time spent training or rest intervals between sets.

Specifically, time can mean:

- The total length of the training session (e.g., 45 minutes per workout)
- The amount of time spent on each set or exercise (e.g., 30 seconds per set)

- The rest periods between sets or exercises (sometimes considered as part of the overall timing)

T - Type

Type: The specific resistance exercises chosen, focusing on targeted muscle groups or training methods (e.g., free weights, machines, bodyweight exercises).

Resistance Exercise Programming using the FITT Principle

The **FITT formula—Frequency, Intensity, Time, and Type**—is a valuable framework for designing an effective muscle fitness training program. Applying this principle helps individuals structure their workouts to maximize strength, endurance, and overall muscle function. By adjusting these variables, individuals can progressively challenge their muscles, leading to improvements in performance and reducing the risk of plateaus. Additionally, the FITT formula allows for personalized training plans that accommodate different fitness levels and goals. Understanding and implementing this approach ensures a well-balanced routine that promotes long-term muscle development and overall physical health.

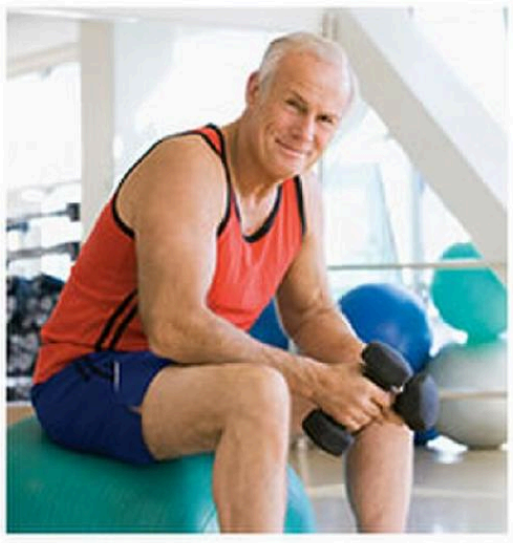


Figure 4.5.3: (Public Domain; The National Institute of Health via Wikimedia)

Frequency of Exercise: How Often Should I do Resistance Training?

Beginner:

- 2-3 days per week
- Full-body workout of all 6 body areas: Chest, back, arms, legs, abdominals, and core.
- 48 to 72 hours of rest in between workouts

Intermediate to High Level:

- 4-5 days per workout; often performing split workouts. For example, on Monday and Thursday, exercise the chest, shoulders, triceps, and abdominals. On Tuesday and Friday, work out the back, legs, and biceps.
- 48 to 72 hours of rest in between workouts

Getting Appropriate Rest

DOMS - Delayed Onset Muscle Soreness is a common result of over-training. This can happen when you do not take appropriate rest between workout sessions or when you are first beginning a workout training regimen.

Intensity of Exercise

The intensity of exercise determines how much weight one should lift for each exercise. This can be determined using the 1RM assessment or by starting with body weight exercises or low weights using proper form.

Beginner:

60%-70% of maximum strength (can be determined by 1RM)

Intermediate to High level:

70%-90% of maximum strength

Time of Exercise

The fitness level of the individual will determine how many sets, how many reps, and how much rest in between sets should be applied in each workout session.

Beginner:

- 1 -3 sets
- 10 - 12 repetitions
- 30 seconds to 1 minute of rest

Intermediate to High Level: Endurance

- 2 -3 sets
- 12 - 20+ repetitions
- 30 seconds to 1 minute of rest

Intermediate to High Level: Strength

- 3 - 5 sets
- 2 - 6 repetitions
- 2 minutes to 5 minutes of rest

Types of Exercises

> **Reminder**
>
> Specificity Principle - you must work each muscle group to have strength gains in that particular part of the body

Basic Exercises by Major Muscle Group

Chest (Pectoralis Major and Minor):

- Chest Press - Barbell (bench) press, free weight press, or machine chest press
- Push-ups (body weight)
- Chest Dip (body weight)

Shoulders (Deltoids):

- Shoulder Press (Free weights or machine)
- Lateral Raise (Free weights)

Back (Lattisimus Dorsi, Rhomboids, Trapezius)

- Lateral Pull Down (Machine)
- Row (Seated machine row or free weights)
- Chin Pull Ups (body weight)
- Upright Row (Free Weights)

Arms (Biceps and Triceps):

- Biceps Curls (Bar, free weights, bands or machine)
- Triceps Extension (Machine, free weights)
- Triceps Dip (body weight)

Legs (Quadriceps - thighs, gluteus maximus - bottom, hamstrings - backs of thighs, Gastrocnemius - calves, abductors and adductors - inner and outer thigh):

- Squats (Body weight, machines, or free weights)
- Leg Press (machine)
- Lunges (body weight or free weight)
- Deadlift - (Free weights)
- Hamstring curl (machine)
- Step Ups (Body weight)
- Standing or seated heel raise (body weight, free weights, or machine)

Core (Rectus abdominis - front abdominals, obliques - side abdominals), erector spinea - lower back, gluteus maximus, abductors and adductors, hip flexors):

- Prone (Front) Plank (body-weighted isometric exercise)
- Side Plank/Bridge (body-weighted isometric exercise)
- Back (glute) bridge (body weight)
- Quad-Hip Extension "Bird-Dog" (Body weight)
- Abdominal Crunch (body weight, free weights, machine options)

More to Explore

- This book is designed to provide basic information and outlines for creating an exercise program. For a comprehensive guide of different exercises broken down by muscle group to add to your program as you progress, here is an Exercise and Muscle Directory. This directory provides a variety of exercise options by muscle group and equipment, and often provides a video example of the exercise being performed with proper form.

Maintaining a Resistance Training Exercise Program

- **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.



Figure 4.5.4: A man performing the good morning exercise with a barbell. He begins in a stand, then lowers the weight, keeping his spine straight, and ends with the barbell on the ground (CC BY-SA 3.0 via Wikimedia Commons)

Resistance Training Recommendations for Healthy Adults

- **Integrate both concentric and eccentric muscle actions**
- **Integrate 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
  - Periodization for Weight Training



Figure 4.5.5: A common exercise in core strength training plans is a traditional sit-up. (Woman Exercising Indoors; Jonathan Borba via Unsplash)

Periodization for Weight Training

- **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.

More to Explore

This book is designed to provide basic information and outlines for creating an exercise program. For more individualized options and guidelines for creating your own periodization for weight training, see this Guide to Periodization.



Figure 4.5.6: (Man Carrying Blue Kettle; Taco Fleur via Unsplash)

Exercise Order for Resistance Training

Question

How can I get the most out of my resistance training program?

The general guidelines for exercise order when training all major muscle groups in a workout are 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 before performing the bench press. This is especially effective when long rest intervals are used (Aragon, 2021). [3]

Weight Training Safety and Injury Prevention

Question

What are some strategies for lifting weights without getting hurt?

There are a variety of strategies that should be used by anyone performing a weight training or resistance training program. Here are some to implement:

- **Warm Up Properly**: Begin each session with 5–10 minutes of light aerobic activity and dynamic stretching to prepare muscles and joints for exercise.
- **Use Proper Technique**: Perform each exercise with correct form and controlled movements to minimize stress on joints and

connective tissue.
- **Start with an Appropriate Load**: Begin with lighter weights, especially for new exercises, and gradually increase resistance based on individual strength progression.
- **Progress Gradually**: Follow the principle of progressive overload by increasing intensity, volume, or complexity slowly to avoid overtraining or strain.
- **Incorporate Rest and Recovery**: Allow adequate rest between sets and schedule recovery days between sessions targeting the same muscle groups.
- **Use Spotters and Safety Equipment**: When lifting heavy, especially during exercises like bench presses or squats, use a spotter and appropriate equipment like lifting belts or safety bars.
- **Balance Your Training Program**: Train all major muscle groups evenly to avoid muscular imbalances, which can contribute to joint instability and injury.
- **Stay Hydrated and Fuel Properly**: Maintain adequate hydration and nutrition to support muscle function, energy levels, and recovery.
- **Avoid Training Through Pain**: Discomfort and fatigue are expected, but sharp or persistent pain can indicate injury. Stop and assess before continuing.
- **Listen to Your Body**: Adapt training based on how you feel—modifying intensity, duration, or volume as needed to prevent overuse injuries.

Key Points

- **Comprehensive resistance training involves multiple techniques**: An effective resistance training program incorporates a range of methods to address various fitness goals, progressing from foundational exercises to more specialized movements.
- **Understanding training variables enhances program design**: Familiarity with diverse training modalities, types of resistance (e.g., free weights, machines, body weight), and the optimal sequence of exercises contributes to the development of a balanced and well-rounded physique.
- **Individual outcomes may vary**: While such training methods may not necessarily lead to competitive-level performance, they foster meaningful personal improvements in strength, coordination, and physical awareness.
- **Resistance training promotes body awareness**: Engaging in varied forms of resistance and movement helps individuals better understand their physical capabilities, limitations, and functional patterns.
- **Self-awareness supports adaptive training**: Developing an understanding of how one's body responds to different stimuli enables individuals to tailor workouts effectively based on daily readiness, enhancing long-term adherence and progress.

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4.6: Supplements



Figure 4.6.1: The display showcases a wide variety of products commonly marketed for health, wellness, or performance enhancement. Each bottle represents different formulations aimed at addressing specific dietary or fitness needs, from vitamins to muscle-building supplements. (Assorted Labeled Bottles on display shelf; Angel Sinigersky via Unsplash)

Introduction

Supplements are widely marketed as tools to enhance resistance training outcomes, promising benefits such as increased muscle growth, improved recovery, and accelerated fat loss. They have become a popular addition to fitness routines, especially among those looking to optimize performance and achieve specific training goals. While supplements like protein powders, creatine, and pre-workout formulas can complement a balanced diet and structured training program, they are not magic solutions.

It is crucial to understand that the effectiveness and safety of supplements vary widely. Many products are not regulated as strictly as medications, which can lead to issues with quality, misleading claims, or even harmful ingredients. Misuse or over-reliance on supplements can also pose health risks, including gastrointestinal distress, kidney strain, or hormonal imbalances.

Many active individuals turn to nutritional supplements or performance-enhancing substances to improve their physical performance and appearance. While some supplements may provide specific benefits when used appropriately, the majority are often ineffective, unnecessarily expensive, or even harmful. Misleading marketing and limited regulatory oversight can lead to unrealistic expectations or risky use.

For most people, a well-rounded and balanced diet tailored to their activity level is the safest and most effective strategy for meeting nutritional and performance goals. Whole foods provide a broad spectrum of essential nutrients that supplements alone cannot replicate. While supplements may have a place in specific circumstances, they should never replace proper nutrition, nor should they be taken without understanding their potential risks.

Performance Aids Marketed for Building Muscle:

A wide variety of supplements are marketed to support muscle growth and development. These products often promise increased strength, faster recovery, and enhanced performance. Below is a list of the most popular types of muscle-building supplements, along with a comparison of their advertised benefits versus what scientific evidence actually supports. Potential side effects associated with each supplement are also included to help users make informed decisions about their use.

Question

- Can protein shakes or bars really help me get bigger muscles?

The necessary amount of protein for an average person who exercises regularly is 0.36 grams per pound of body weight. Someone like a college athlete, who participates in a more rigorous training regimen, would require no more than 0.10 grams of protein per pound of body weight. Protein sources from whole foods are generally better than protein bars or shakes because those food sources don't have additives and additional calories, or sugar.

More to Explore

- There are many protein powders on the market. For more detailed information about specific protein powders and the differences between them, can be found in this article about Protein Supplements.

1. **Protein Powders** (Whey, Casein, Plant-Based)
   - Supposed Benefits: Provide essential amino acids to promote muscle repair and growth after workouts; convenient source of high-quality protein.
   - Actual Effects: Has no significant impact if dietary protein intake is sufficient; may support protein synthesis when consumed immediately before or after weight training.
   - Potential Side Effects: May pose risks for individuals with liver or kidney conditions; replacing protein-rich foods with amino acid or polypeptide supplements could lead to nutrient deficiencies.
2. **Creatine**
   - Supposed Benefits: Increases strength and power by boosting phosphocreatine stores in muscles, improving energy availability for high-intensity exercise.
   - Actual Effects: Can enhance muscle growth and performance in certain high-intensity exercises.
   - Potential Side Effects: No immediate side effects are known, and long-term effects are still unknown.
3. **Branched-Chain Amino Acids (BCAAs)**
   - Supposed Benefits: May reduce muscle soreness, prevent muscle breakdown during exercise, and support recovery.
   - Actual Effects: The effectiveness of BCAAs may be limited if dietary protein intake is already adequate, as sufficient dietary protein provides all essential amino acids, including BCAAs.
4. **Beta-Alanine**
   - Supposed Benefits: Delays muscle fatigue by buffering acid buildup during intense exercise, potentially increasing endurance and strength.
5. **L-Glutamine**
   - Supposed Benefits: Supports muscle recovery and immune system health, particularly after intense workouts.
6. **Testosterone Boosters**
   - Supposed Benefits: Claimed to enhance muscle growth by increasing testosterone levels, often marketed to aging individuals.
7. **Anabolic Steroids**
   - Supposed Benefits: Claims to enhance muscle growth, strength, recovery, endurance, and fat metabolism.Actual Effects: Include increased muscle mass, strength, and recovery speed, along with improved athletic performance.
   - Potential Side Effects: They can cause severe side effects such as hormonal imbalances, cardiovascular issues, liver damage, mood swings, high blood pressure, tumors, and reproductive dysfunction. They can also cause psychological disturbances, masculinization in women and children, and depressed testosterone levels.

Caution

- Anabolic steroids are a controlled substance in the United States of America and are very dangerous when taken without a doctor's supervision.

Question

- If steroids are really bad, why do so many people use them to improve their performance?

Anabolic steroids are made from testosterone and can help to increase muscle size and strength. However, the side effects can be physically detrimental. In most cases, athletes use steroids for professional and financial gain despite the risk of severe physical and mental health consequences.

More to Explore

- Find out what is true and what isn't: Claims versus actual effects of performance aids



Figure 4.6.2: (CC BY-SA 3.0; via Wikimedia Commons).

More to Explore

- If you want to find out about any additional supplements on the market for building muscle and/or weight loss, check out the National Institutes of Health: Office of Dietary Supplements.

Key Points

- Supplements can support—but not replace—training and nutrition: Products like protein powder, creatine, and pre-workout formulas may enhance resistance training outcomes when used properly, but they are not magic solutions and should complement, not replace, a balanced diet and structured program.
- Effectiveness and safety vary widely: Supplements are not strictly regulated, which can lead to misleading claims, poor product quality, and potential health risks such as kidney strain or hormonal imbalances.
- Whole foods are superior to most supplements: A balanced diet with whole foods is the safest and most effective way to meet nutritional needs, offering a wider range of nutrients without the additives often found in protein bars or shakes.
- Protein needs depend on activity level: The general recommendation is 0.36 grams of protein per pound of body weight for regularly active individuals, while highly trained athletes may need up to 1.0 gram per pound, emphasizing quality food sources over supplements.
- Performance-enhancing drugs pose serious health risks: Anabolic steroids may increase muscle size and strength but come with dangerous physical and mental side effects, often used for performance or financial gain despite long-term consequences.

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4.7: Comprehension Check

Summary

Muscle fitness, which includes muscle strength and endurance, is a key component of overall health and physical fitness. It is made up of four main elements: muscle force, endurance, strength, and power. These components help the body perform everyday tasks, support joint health, and reduce the risk of injury. Regular exercise, especially resistance and endurance training, improves muscle performance by triggering adaptations such as increased size, strength, and efficiency. Factors like age, biological sex, genetics, training, injuries, and nutrition all influence muscle fitness. While some of these, like age and genetics, are out of our control, training is a modifiable factor that can significantly improve muscle health. As people age, muscle mass naturally declines, but consistent physical activity can slow this process. Biological differences also play a role, with hormones like testosterone and estrogen affecting muscle development. Genetics determines traits like muscle fiber composition, which influence a person's potential for strength or endurance. Injuries can hinder muscle fitness, but proper rehabilitation can restore strength. Ultimately, a well-rounded training program that includes strength, endurance, and recovery practices is essential for long-term muscle fitness and overall well-being.

Test Your Understanding

1. What are the four main components of muscle fitness, and how do they differ from each other?
2. How does resistance training improve muscle strength and endurance?
3. Why is training considered a controllable factor in muscle fitness, and what are some benefits of regular strength training?
4. How do age and biological sex influence muscle fitness? Provide at least one example for each.
5. What are the factors that affect muscle fitness?

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Chapter 4 Glossary

- **Action Potential**: An electrical signal that travels along a neuron or muscle cell, triggered by a change in the cell's membrane potential. Action potentials are essential for nerve function, muscle movement, and various physiological processes.
- **Actin Myofilaments**: Thin protein filaments found in muscle fibers. Actin is also involved in maintaining the structure and shape of the muscle fiber.
- **Aerobic Metabolism**: Produces ATP using oxygen to break down glucose, fats, and proteins. It provides sustained energy for endurance activities and produces carbon dioxide and water as byproducts.
- **Agonist**: An agonist is the muscle that contracts to produce a specific movement.
- **Anabolic Steroids**: Synthetic substances that mimic testosterone, promoting muscle growth and performance. They can cause hormonal imbalances, liver damage, and cardiovascular issues and are illegal without a prescription.
- **Anaerobically**: Refers to activities that occur without oxygen, like weightlifting or sprinting, relying on stored energy sources and producing lactic acid.
- **Antagonist**: A muscle that opposes the action of the agonist.
- **Appetite Suppressants**: Reduce hunger and cravings, aiding weight management by affecting hormones, digestion, or neurotransmitters.
- **ATP Molecules**: The primary energy carrier in cells, fueling muscle contractions, metabolism, and cellular functions. ATP is regenerated through aerobic and anaerobic pathways, supporting physical activity and biological processes.
- **Atrophy**: The loss of muscle or tissue mass due to disuse, aging, injury, or disease. It occurs when muscle fibers shrink, but can be slowed with exercise and nutrition.
- **Axon**: The long, cable-like extension of a motor neuron that carries electrical impulses (action potentials) away from the cell body toward muscle fibers.
- **Beta-Alanine**: A non-essential amino acid that boosts carnosine levels, delaying muscle fatigue and enhancing endurance and performance.
- **Blood Vessels**: Transport blood, oxygen, and nutrients throughout the body. They include arteries (carry blood away from the heart), veins (return blood to the heart), and capillaries (exchange gases and nutrients).
- **Branched-Chain Amino Acids (BCAAs)**: Support muscle growth, recovery, and energy. They enhance protein synthesis, reduce muscle breakdown, and fight fatigue, making them popular in sports nutrition.
- **Caffeine**: Caffeine is a natural stimulant that blocks adenosine, increasing alertness, focus, and energy.
- **Cardiac Muscle**: A specialized, involuntary muscle found in the heart, responsible for pumping blood throughout the body. It has striated fibers, like skeletal muscle, but functions autonomously, controlled by the autonomic nervous system and pacemaker cells. It is highly fatigue-resistant and works continuously to maintain circulation.
- **Concentric Contraction**: When a muscle shortens while generating force, as in lifting a weight. It builds strength, power, and muscle growth in resistance training.
- **Conjugated Linoleic Acid (CLA)**: An omega-6 fatty acid found in meat and dairy, often used for fat loss, muscle retention, and metabolic support. It may aid body composition and has anti-inflammatory properties.
- **Creatine**: A natural compound in muscles that helps regenerate ATP, boosting strength, power, and recovery. Commonly supplemented as creatine monohydrate, it enhances performance and muscle growth.
- **Cross-Education**: When training one limb increases strength in the untrained limb due to neural adaptations. It aids injury recovery, neuromuscular efficiency, and rehabilitation.
- **Duration**: The length of time a muscle contraction or exercise bout is sustained, influencing energy system use and fatigue development.
- **Dystrophy**: The degeneration or weakening of tissue, often due to genetic, metabolic, or nutritional disorders.
- **Dynamic Constant Training (DCT)**: Lifting a constant load throughout a movement, as seen in free weights and machines. It improves strength, muscle mass, and coordination, making it effective for all fitness levels.
- **Dynamic Contraction**: A muscle contraction with movement, including concentric (shortening) and eccentric (lengthening) actions. It enhances strength, power, and muscle control in resistance training.
- **Dynamic Progressive Training (DPT)**: Gradually increases resistance, weight, or reps to promote strength, muscle growth, and endurance. It follows progressive overload, preventing plateaus and ensuring continuous improvement.
- **Dynamic Variable Training (DVT)**: Adjusts resistance throughout a movement using bands, chains, or machines to match strength curves. It enhances strength, muscle activation, and power, reducing sticking points in lifts.
- **Eccentric Contraction**: When a muscle lengthens under tension, controlling movement and absorbing force. Examples include lowering a weight or descending in a squat. They enhance strength, muscle growth, and injury prevention.
- **Endomysium**: A thin connective tissue layer that surrounds individual muscle fibers within a fascicle. It provides structural support, facilitates nutrient and oxygen exchange, and helps transmit force during muscle contractions.

- **Epimysium**: The outermost connective tissue layer that surrounds an entire skeletal muscle, providing structural support and protection.
- **External Lamina**: The external lamina is a thin layer of connective tissue surrounding individual muscle fibers. It is composed primarily of collagen and glycoproteins and provides structural support, protection, and a scaffold for muscle regeneration by facilitating satellite cell activity.
- **Fascicles**: Bundles of muscle fibers grouped together within a skeletal muscle, surrounded by perimysium. They contribute to muscle strength, flexibility, and function, with their arrangement affecting force production and movement efficiency.
- **Fasciculus**: A bundle of muscle fibers surrounded by perimysium, a connective tissue layer.
- **Fat Blockers**: Supplements that inhibit fat absorption by blocking lipase enzymes, reducing calorie intake.
- **Fiber Recruitment**: The process by which the nervous system activates muscle fibers to generate force. Efficient fiber recruitment enhances strength, power, and endurance, and is improved through progressive overload and neuromuscular training.
- **Fiber Supplements**: Products designed to increase dietary fiber intake, aiding in digestion, gut health, and regularity. Commonly used for constipation relief, blood sugar control, and weight management.
- **FITT Principle**: Guides exercise programming with four key factors: frequency, intensity, time, and type.
- **Fixators**: Stabilizing muscles that prevent unwanted movement, providing a stable base for prime movers. They aid in balance, posture, and injury prevention.
- **Force**: The amount of tension produced by a muscle during contraction; it depends on motor unit recruitment, firing rate, and muscle cross-sectional area.
- **Frequency**: Frequency refers to how often a muscle group or exercise is trained within a given period, typically measured in workouts per week. Frequency should be balanced with intensity, volume, and recovery to maximize strength gains while preventing over-training.
- **Glycogen**: A stored form of glucose found primarily in the liver and muscles, serving as a key energy reserve for the body. Glycogen is replenished through carbohydrate consumption after depletion.
- **Green Tea Extract**: A concentrated form of bioactive compounds from green tea leaves, rich in antioxidants, especially catechins like EGCG (epigallocatechin gallate). It is known for its benefits in metabolism, fat oxidation, heart health, and cognitive function.
- **Insertion**: The movable attachment of a muscle, where force is applied to create movement. It is typically distal to the origin and moves toward it during contraction.
- **Intensity**: Refers to the amount of resistance or load used during an exercise. It determines the level of muscular effort and adaptation. Proper intensity management is crucial for progressive overload, maximizing gains, and preventing over-training.
- **Isokinetic Training (IKT)**: A type of resistance training where muscle contractions occur at a constant speed throughout the range of motion, regardless of the force applied.
- **Isometric Contraction**: A type of muscle contraction where the muscle generates tension without changing length or causing joint movement. It helps build strength, endurance, and stability by maintaining a static position.
- **Isometric Training (IMT)**: A resistance training method where muscles generate force without changing length or causing joint movement. It enhances strength, endurance, and stability by maintaining static muscle contractions.
- **Isotonic Contraction**: A type of muscle contraction where the muscle changes length while generating constant tension.
- **Isotonic Training**: A type of resistance exercise where muscles generate force while changing length, maintaining constant tension throughout the movement.
- **Lactic Acid**: A byproduct of anaerobic metabolism, produced when the body breaks down glucose for energy in low-oxygen conditions, such as intense exercise.
- **L-Carnitine**: Naturally occurring amino acid derivative that plays a crucial role in fat metabolism and energy production. It transports fatty acids into mitochondria, where they are converted into ATP through beta-oxidation.
- **L-Glutamine**: Conditionally essential amino acid involved in muscle recovery, immune function, and gut health. It serves as a key fuel source for rapidly dividing cells, including immune and intestinal cells. It also supports protein synthesis, nitrogen balance, and energy production.
- **Mitochondria**: Membrane-bound organelles known as the powerhouses of the cell, responsible for producing ATP (adenosine triphosphate) through aerobic respiration. They play a key role in energy metabolism, especially in muscle cells, which require high energy for contraction. Mitochondria also contribute to cell signaling, apoptosis (cell death), and oxidative stress regulation.
- **Motor Neuron**: A nerve cell that originates in the central nervous system and sends signals to muscle fibers, causing them to contract. A single motor neuron and all the muscle fibers it innervates form a motor unit.
- **Motor Unit**: Consists of a motor neuron and all the muscle fibers it innervates. It functions as a single unit to produce muscle contractions.
- **Muscle Endurance**: the ability of a muscle or group of muscles to sustain repeated contractions or to maintain a submaximal contraction over an extended period of time without fatigue.
- **Muscle Fibers**: Muscle fibers are elongated muscle cells responsible for contraction. They contain myofibrils with actin and

myosin filaments.

- **Muscle Force**: The amount of tension or strength a muscle generates when it contracts to move or stabilize a body part. It is influenced by factors such as muscle size, fiber type, neural activation, and the type of contraction (isometric, concentric, or eccentric). Muscle force is essential for all physical movements, from simple daily tasks to high-intensity athletic performance.
- **Muscle Hyperplasia**: The increase in muscle mass due to the formation of new muscle fibers (cells), rather than the enlargement of existing ones (as in hypertrophy).
- **Muscle Hypertrophy**: The increase in muscle size due to the growth of muscle fibers, primarily from resistance training or mechanical overload. Hypertrophy is driven by progressive overload, adequate nutrition (especially protein intake), and recovery.
- **Muscle Learning**: The process by which repeated practice improves coordination, timing, and efficiency of muscle activation patterns.
- **Muscle Power**: The ability of a muscle or group of muscles to exert force rapidly, combining both strength and speed. It reflects how quickly muscular force can be generated to perform an action.
- **Muscle Strength**: the maximum amount of force a muscle or muscle group can generate against a resistance in a single effort.
- **Musculotendinous Junction**: The transition area where a muscle connects to a tendon. This region is crucial for force transmission from muscle contractions to the skeletal system, enabling movement.
- **Myofibrils**: Long, threadlike structures within muscle fibers (muscle cells) composed of repeating units called sarcomeres, which are the functional units of muscle contraction. They are essential for muscle function and are responsible for the striated appearance of skeletal and cardiac muscle.
- **Myoglobin**: An oxygen-binding protein found in muscle tissue that stores and transports oxygen to muscle cells, facilitating aerobic respiration and energy production. It is structurally similar to hemoglobin but has a higher oxygen affinity, allowing muscles to sustain activity, especially during prolonged or intense exercise.
- **Myopathies**: A group of neuromuscular disorders characterized by muscle weakness, dysfunction, or degeneration due to abnormalities in muscle fibers. Symptoms often include muscle weakness, fatigue, and, in some cases, pain or stiffness.
- **Myosin Myofilaments**: Thick protein filaments in muscle fibers that play a key role in muscle contraction. They are composed of myosin proteins, which have heads that attach to actin filaments to form cross-bridges, generating force through the sliding filament mechanism.
- **Neuromuscular Adaptation**: Early improvements in strength and performance resulting from changes in the nervous system, such as increased motor unit recruitment, firing frequency, synchronization, and reduced inhibitory signaling, rather than muscle hypertrophy.
- **Neuromuscular Junctions**: The specialized synapse where the axon terminal of a motor neuron meets a muscle fiber. At this junction, the neurotransmitter acetylcholine is released, triggering the muscle fiber to contract.
- **Origin**: The fixed, proximal attachment of a muscle to a bone, typically the more stable and less movable part during contraction. It serves as the anchor point from which the muscle pulls to create movement at its insertion.
- **Perimysium**: Is the connective tissue sheath that surrounds and groups muscle fibers into bundles called fascicles. It provides structural support, allows the passage of nerves and blood vessels, and helps distribute force during muscle contraction.
- **Periodization**: A structured training approach that cycles intensity, volume, and focus to optimize performance and recovery while preventing over-training. Common types include linear (gradual intensity increase), undulating (frequent variations), and block (specific goal-focused phases).
- **Prime Mover**: The primary muscle responsible for generating a specific movement. It works with synergists (assistive muscles) and against antagonists (opposing muscles) for controlled motion.
- **Protein Powder**: A dietary supplement made from various protein sources, such as whey, casein, soy, pea, or hemp, designed to support muscle growth, recovery, and overall protein intake. It is commonly used by athletes, bodybuilders, and individuals with increased protein needs. Protein powders come in different forms, including concentrates, isolates, and hydrolysates, each varying in protein content and digestion speed.
- **Repetition (Rep)**: Refers to one complete movement of an exercise, including both the lifting (concentric) and lowering (eccentric) phases. Multiple reps make up a set, and the number of reps performed influences strength, endurance, and muscle growth.
- **Repetition Maximum (RM)**: The maximum number of repetitions a person can perform of a given exercise at a specific weight before reaching failure. For example, a 1RM (one-rep max) is the heaviest weight that can be lifted once with proper form, while a 10RM is the heaviest weight that can be lifted 10 times before failure.
- **Sarcomere**: A sarcomere is the basic contractile unit of striated muscle fibers, composed of actin (thin) and myosin (thick) filaments arranged in a repeating pattern.
- **Sarcolemma**: the specialized cell membrane that surrounds a muscle fiber (muscle cell). It plays a crucial role in conducting electrical signals (action potentials) and in regulating the exchange of ions, which are essential for muscle contraction.

- **Sarcopenia**: Age-related loss of muscle mass, strength, and function due to factors like reduced physical activity, hormonal changes, and decreased protein synthesis. It can lead to weakness, impaired mobility, and a higher risk of falls.
- **Set**: A group of consecutive repetitions (reps) of an exercise performed without rest. Multiple sets are typically performed with short rest periods in between to improve strength, endurance, or muscle growth.
- **Skeletal Muscle**: A type of striated, voluntary muscle attached to bones via tendons, enabling movement, posture, and stability. It contracts through signals from the nervous system and functions using the sliding filament mechanism. Skeletal muscles also play a role in metabolism and heat production.
- **Sliding Filament Theory**: Explains muscle contraction as actin filaments sliding past myosin filaments, shortening the sarcomere. This process, powered by ATP and regulated by calcium, generates muscle force through cross-bridge cycling.
- **Smooth Muscle Tone**: Refers to the continuous, low-level contraction of smooth muscle tissue, which helps maintain organ function and blood vessel diameter. Smooth muscle remains partially contracted even at rest, allowing for sustained control over processes such as blood pressure regulation, digestion, and airway constriction. This tone is regulated by the autonomic nervous system, hormones, and local physiological conditions.
- **Synergist**: A muscle that assists the primary mover (agonist) in performing a movement by providing additional force or stabilizing the joint. Synergists help refine motion, reduce unnecessary movement, and enhance overall efficiency.
- **Tendons**: Strong, fibrous connective tissues that attach muscles to bones, enabling movement by transmitting the force generated by muscles. They are composed primarily of collagen, making them highly resistant to tension while maintaining flexibility. Tendons play a crucial role in stability, mobility, and overall musculoskeletal function.
- **Testosterone Boosters**: Supplements designed to naturally increase testosterone levels in the body. They typically contain ingredients like D-aspartic acid, fenugreek, ashwagandha, tribulus terrestris, and zinc, which may support hormone production, improve muscle growth, enhance libido, and boost energy levels.
- **Thermogenic Blends**: Formulations of ingredients designed to increase the body's metabolism, enhance fat oxidation, and promote heat production (thermogenesis). These blends often include stimulants like caffeine, green tea extract, capsaicin, and other metabolism-boosting compounds. They are commonly found in weight loss supplements and pre-workout formulas to help improve energy expenditure and fat burning.
- **Time**: In the context of the FITT principle for weight training, TIME refers to the duration of each workout session or the amount of time spent performing the exercise.
- **Type**: In reference to the FITT principle, "type" identifies the mode or style of resistance used to develop muscular fitness. This refers to the form of resistance training chosen to improve muscular strength, endurance, or power, and the specific exercises selected to target desired muscle groups.
- **Type I Muscle Fibers**: Also known as slow-twitch fibers, are skeletal muscle fibers specialized for endurance and sustained, low-intensity activity. They contract slowly, generate less force, and resist fatigue due to their high mitochondrial density and reliance on aerobic metabolism. These fibers are well-suited for activities like long-distance running, cycling, and maintaining posture.
- **Type II Muscle Fibers**: Also known as fast-twitch fibers, are skeletal muscle fibers that contract quickly and generate high force but fatigue faster than Type I (slow-twitch) fibers. They are further divided into Type IIa (fast oxidative-glycolytic) and Type IIb (fast glycolytic) fibers. These fibers are essential for explosive movements like sprinting, jumping, and heavy lifting.
- **Type IIa Muscle Fibers**: Also known as fast-twitch oxidative-glycolytic fibers, are a hybrid between Type I (slow-twitch) and Type IIb (fast-twitch) fibers. They contract quickly and generate moderate to high force but have greater endurance than Type IIb fibers due to their ability to use both aerobic and anaerobic metabolism. This makes them well-suited for activities requiring both power and endurance, such as middle-distance running and repeated resistance training.
- **Type IIb Muscle Fibers**: Also known as fast-twitch glycolytic fibers, are a type of skeletal muscle fiber that generate high force and contract rapidly but fatigue quickly. They rely primarily on anaerobic metabolism, using stored glycogen for energy, making them well-suited for short bursts of intense activity like sprinting or heavy lifting. However, they have low endurance due to limited oxygen efficiency and a high rate of lactic acid production.

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4.10: Detailed Accessible Description

Figure 4.2.8: Anterior Major Muscles (top diagram)

This labeled anatomical diagram displays the major muscles of the human body from an anterior (front-facing) perspective. The right side of the body (viewer's left) shows the superficial muscles, while the left side (viewer's right) displays deeper muscles.

Head and Neck

- The occipitofrontalis (frontal belly) is shown across the forehead, which is important for facial expressions.
- The sternocleidomastoid, a long muscle in the neck, is labeled on the superficial side and is responsible for rotating and flexing the head

Shoulder and Chest

- The deltoid muscle caps the shoulder and is involved in arm abduction.
- Pectoralis major, a large chest muscle, is labeled on both sides for pushing movements.
- Pectoralis minor, a smaller chest muscle beneath the major, is shown on the deep side.

Torso and Abdomen

- Rectus abdominis, the prominent "six-pack" muscle, runs vertically along the abdomen.
- Abdominal external oblique, located on the lateral abdomen, assists in trunk rotation and bending.

Upper Arm and Forearm

- Biceps brachii, on the front of the upper arm, is responsible for elbow flexion.
- Brachialis, located deeper under the biceps, and brachioradialis, extending into the forearm, are also labeled.
- Pronator teres and flexor carpi radialis are forearm muscles responsible for wrist and forearm movement.

Hip and Thigh

- The pectineus, adductor longus, sartorius, iliopsoas, and gracilis muscles are labeled, representing muscles responsible for hip flexion, thigh adduction, and leg rotation.
- The tensor fasciae latae, located on the lateral thigh, stabilizes the hip and knee.

Quadriceps (Front of Thigh)

- Rectus femoris, vastus lateralis, and vastus medialis are three of the four quadriceps muscles responsible for extending the knee.

Lower Leg

- Tibialis anterior, located on the shin, is involved in dorsiflexing the foot.
- Fibularis longus assists in foot eversion.
- The combined label soleus and gastrocnemius indicates two calf muscles responsible for plantar flexion of the foot.
- This diagram helps students visualize and identify the location and classification (superficial vs. deep) of major anterior skeletal muscles of the human body

Posterior Major Muscles (bottom diagram)

This anatomical diagram shows a labeled view of the major muscles on the back (posterior side) of the human body. The right side of the body (viewer's left) displays deep muscles, while the left side (viewer's right) shows superficial muscles.

Head and Neck

- Occipitofrontalis (occipital belly) and epicranial aponeurosis are labeled across the back of the head and skull, associated with scalp movement.
- Splenius capitis and levator scapulae are deep neck muscles involved in head and neck extension and shoulder elevation.

Shoulder and Upper Back

- Supraspinatus, infraspinatus, teres minor, and teres major are part of the rotator cuff group and shoulder stabilizers.
- The deltoid is a large superficial shoulder muscle responsible for lifting the arm.
- Trapezius, a broad, superficial upper back muscle, and rhomboids, located deeper, assist in scapular movement.
- Latissimus dorsi, a large muscle covering the lower back, is responsible for arm extension and adduction.

Arm and Forearm

- Triceps brachii, the major muscle on the back of the upper arm, enables elbow extension.
- Brachioradialis, extensor carpi radialis, extensor digitorum, extensor carpi ulnaris, and flexor carpi ulnarisare labeled in the forearm, controlling wrist and finger movements.

Torso and Hips

- Serratus posterior inferior and external oblique support trunk rotation and respiration.

The gluteal region includes:

- Gluteus maximus (dissected to show deeper layers),
- Gluteus medius (also dissected), and
- Gluteus minimus, the smallest and deepest of the three, all involved in hip extension and stabilization.
- Gemellus muscles, small deep muscles near the hip, are involved in the lateral rotation of the thigh.

Thigh and Hamstrings

- Biceps femoris, semitendinosus, and semimembranosus make up the hamstring group, responsible for knee flexion and hip extension.
- Gracilis, a long thin muscle on the inner thigh, aids in hip adduction.

Lower Leg

- Peroneus longus (fibularis longus) and tibialis posterior are labeled in the calf region and are involved in foot movement and stability.
- Gastrocnemius (partially dissected) and soleus muscles together form the calf muscle group, essential for plantar flexion (pushing the foot downward during walking or running).

These diagrams help students learn the anatomical locations and layering (superficial vs. deep) of key muscles on the posterior side of the human body and understand how these muscles contribute to movement and posture.

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5: FLEXIBILITY, MOBILITY, AND LOW-BACK WELLNESS



Figure 5.1: This man is demonstrating his flexibility and mobility. (Man jumping on road during golden hour; Harry Quan via Unsplash)

Introduction to Flexibility, Mobility, and Low-Back Wellness

Functional movement includes mobility, flexibility, and stability of the human body. Flexibility, mobility, and stability are fundamental components of human movement and physical performance. While flexibility refers to the ability of a muscle or joint to move through its full range of motion, mobility encompasses the broader capacity of a joint to move freely while being supported by surrounding muscles and connective tissues. Stability, on the other hand, ensures control and balance in movement, preventing excessive or uncontrolled motion that could lead to injury. Together, these three elements contribute to efficient movement patterns, injury prevention, and overall physical well-being. This chapter will explore the interrelationship between flexibility, mobility, and stability, their role in different types of movement, and practical strategies for assessment and improvement.

Learning Objectives

- Define flexibility
- Examine the benefits of flexibility
- Identify ways to increase flexibility
- Create an effective stretching program
- Assess your own flexibility
- Students will be able to explain the concept of flexibility, distinguish between static and dynamic flexibility, and describe their importance in overall fitness and daily movement.
- Students will be able to identify factors that influence individual flexibility and demonstrate how incorporating flexibility training into a fitness routine supports injury prevention, joint health, and functional mobility.

5.1: Introduction to Flexibility

5.2: The Benefits of Flexibility and Stretching

5.3: Factors Affecting Flexibility

5.4: Creating an Effective Flexibility Program

5.5: Sample Flexibility Plan
5.6: Low Back Fitness
5.7: Prevention and Management of Low-Back Pain
5.8: Comprehension Check
5.9: Glossary
5.10: References

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- 4: Muscular Strength and Endurance by Scott Flynn, Jonathan Howard, Lisa Jellum, and Althea Moser is licensed CC BY-NC-SA 4.0. Original source: https://oer.galileo.usg.edu/health-textbooks/4/.

5.1: Introduction to Flexibility



Figure 5.1.1: This woman is demonstrating a yoga position called the "Dancer Pose." (Dancer pose; Wesley Tingey via Unsplash)

Introduction

One of the five health-related components of fitness is flexibility. Flexibility is a crucial component of overall fitness, enabling the body to move freely and efficiently. It refers to the ability of joints and muscles to move through their full range of motion (ROM) without pain or restriction. Good flexibility can enhance performance in physical activities, reduce injury risk, and improve posture and mobility. By incorporating stretching exercises and maintaining a regular flexibility routine, individuals can support their overall health, movement, and quality of life.

Flexibility

Flexibility is the ability of a muscle or group of muscles to stretch and move through a **range of motion (ROM)** without restriction or discomfort. It is influenced by factors such as muscle length, joint structure, and the nervous system. Flexibility is important for everyday movements, athletic performance, and injury prevention. However, too much or too little flexibility can affect how well the body moves and maintains stability. The ideal level of flexibility depends on the individual and the physical activities they perform.

Question

- What does it mean to you to be "flexible"?

Types of Flexibility

Flexibility is categorized into two main types: static and dynamic. **Static flexibility** refers to the maximum range of motion a joint can achieve. It is typically measured by stretching a joint to its limit and holding the position while using a measuring instrument to quantify the range. Achieving this maximum range requires **passive forces**, which are applied by an external source rather than the individual's own muscles. In contrast, **dynamic flexibility** assesses joint stiffness during movement and relies on active force production through muscle contraction. Because stiffness is challenging to measure objectively, dynamic flexibility is often evaluated based on ease of movement in daily activities, such as swinging a tennis racket, climbing stairs, or getting in and out of a car. An effective stretching program aims to improve both static and dynamic flexibility to ensure a normal range of

motion (ROM) (American College of Sports Medicine, 2021). [1] The concept of “normal” is based on population studies that have measured joint movement across various body areas to establish an average range of motion for different joints. These averages take into account population groups (such as sedentary individuals versus athletes), age, gender, and joint specificity (Bohannon et al, 2016). [5]

Factors Affecting Flexibility

Just as flexibility relates to the ability of a joint to move through its full range of motion (ROM), every person also has an individualized range dependent on various factors. It is not necessary to be extremely flexible to be healthy and fit. It is more important to be able to move the joints through their range of motion without pain or discomfort, which can be indicated by moving through daily living activities comfortably. It is possible to be either too flexible or not flexible enough to be able to move the body comfortably (Kenney et al, 2019). [19]

Many factors affect one's individual flexibility, some of which can be controlled through training and some of which cannot be controlled. To develop a comprehensive fitness program, it is essential to incorporate stretching into your routine. For example, what cannot be controlled are factors such as genetics, which determine joint structure, gender, and age (Kenney et al, 2019). [19] Factors that can be controlled are things such as muscle length and elasticity, which can be changed through flexibility training (American College of Sports Medicine, 2016). [2] Here is a basic overview.

Joint Structure

- Different joints have different ranges of motion. For example, the shoulder joint has more mobility than the knee joint.
- The shape of bones and how they articulate limit potential movement.

Muscle Length and Elasticity

- Muscles and their surrounding connective tissues (e.g., fascia) must be extensible to allow for full ROM.
- Tight or shortened muscles reduce flexibility.

Tendon and Ligament Elasticity

- Tendons and ligaments support joints and contribute to movement.
- If they are too tight or inflexible, they restrict motion.

Nervous System Regulation

- The stretch reflex protects muscles from overstretching, but it can limit flexibility if overactive.
- Techniques like static stretching or proprioceptive neuromuscular facilitation (PNF) can help retrain this response (Hindle et al, 2012). [17]

Age

- Flexibility typically decreases with age due to reduced elasticity in muscles and connective tissues.
- However, regular stretching can slow this decline.

Question

- Will I get less flexible as I get older?

Sex

- Women generally tend to have greater flexibility than men, especially in the hips and lower back, due to hormonal and anatomical differences.
- Men tend to have higher muscle mass and tendon stiffness, which can limit the range of motion compared to women. Larger muscles can limit movement and can prevent some range of motion around the joints.

Genetics

- Genetic traits such as **hypermobility** can cause excessive flexibility. Hypermobility can also be referred to as being "double-jointed". For example, someone with hypermobility can bend their knee in both directions. Conversely, others will inherit tighter joints or connective tissues that resist stretching more.
- Types of muscle tissue
- Genetics influences the composition of collagen and elastin in tendons and ligaments. These proteins affect how stretchy or stiff soft tissues are, which impacts flexibility.
- Types of muscle tissue, such as slow-twitch or fast-twitch, are also largely genetic and can influence flexibility (Kenney et al, 2019). [19]

Injury and Disease

- Damage to muscles, tendons, or ligaments, such as strains, sprains, or tears, can lead to scar tissue formation and joint stiffness, reducing overall flexibility and range of motion.
- Conditions like arthritis, muscular dystrophy, or neurological disorders can cause joint inflammation, muscle rigidity, or nerve dysfunction, all of which negatively impact flexibility.

Physical Activity and Training

- Regular stretching and movement maintain or improve flexibility.
- Sedentary lifestyles contribute to muscle tightness and reduced ROM (American College of Sports Medicine, 2021). [1]

Temperature

- Warmer muscles are more pliable. Flexibility tends to improve after a proper warm-up (Baechle et al, 2016). [3]

Question

- Why are some people more flexible than me? Do they stretch all the time?

Why Flexibility is Important

Regular stretching plays a key role in improving range of motion (ROM) and overall flexibility. When performed consistently, stretching helps lengthen muscles and tendons, which allows joints to move more freely through their full range. This increased flexibility can enhance movement efficiency and reduce stiffness, making daily activities and physical exercise easier and safer. Additionally, by improving muscle elasticity and joint mobility, regular stretching can lower the risk of injuries such as muscle strains or ligament sprains. It also helps maintain proper posture and muscle balance, which further supports joint health and reduces stress on the body during movement (American College of Sports Medicine, 2021). [1]

Key Points

- Flexibility is a key component of fitness, essential for efficient movement, injury prevention, and overall health.
- Flexibility refers to the ability of joints and muscles to move through their full range of motion (ROM) without pain or

restriction.
- There are two types: static (passive stretching) and dynamic (active movement), both important for functional mobility.
- Flexibility varies by individual and is influenced by factors like joint structure, muscle length, age, and training.
- Regular flexibility training is often neglected, but it supports daily movement, reduces muscle tension, and improves physical performance.

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5.2: The Benefits of Flexibility and Stretching



Figure 5.2.1: This man is resting his hands on yoga blocks to stabilize himself in Pigeon Pose, which stretches the hips. (A woman in a black tank top sitting on a wooden table; Logan Weaver via Unsplash)

Introduction

Flexibility is a vital yet often overlooked component of physical fitness that plays a crucial role in overall health and well-being. It refers to the ability of joints to move through their full range of motion, which is influenced by muscle elasticity, joint structure, and nervous system function. Regular flexibility training, such as stretching exercises, can enhance mobility, improve posture, reduce muscle tension, and lower the risk of injuries. Additionally, maintaining flexibility contributes to better physical performance and can promote relaxation and stress relief. This section will explore the various benefits of flexibility, emphasizing its importance in both athletic performance and daily activities. There are many benefits to regular stretching, with the most important of those being simple: being flexible will help a person to move freely and complete activities with greater ease.

Improved Performance

Improving flexibility is an important part of enhancing performance in both sports and everyday physical activity. Flexibility allows joints to move through their full range of motion, which supports smooth and efficient movement. Athletes benefit from greater flexibility because it enables better technique and reduces the risk of injuries caused by muscle tightness or joint stiffness. For example, a soccer player with flexible hips and hamstrings may have a more powerful and controlled kick, while a tennis player with greater shoulder mobility can swing more freely and with less strain.

In sports, flexibility contributes to movement efficiency and coordination. When muscles and joints are more mobile, the body is better able to perform complex actions with less restriction. Most athletes develop an optimal range of motion for their sport when they participate in regular flexibility training. However, it is also important to recognize that stretching, especially static stretching performed right before activity, can temporarily reduce muscle force and power. A study by Haddad, et al. demonstrates that a single session of prolonged static stretching may significantly reduce explosive performance, even when performed up to 24 hours before competition (Haddad et al, 2014). [10] This effect is most noticeable in sports that require explosive strength, such as sprinting, jumping, or heavy lifting. For these activities, dynamic warm-ups are often preferred because they prepare the muscles for high-intensity efforts without compromising performance.

Although the word "performance" is often considered to pertain to sport and athletics, flexibility also supports daily physical tasks like reaching, bending, and walking. Day-to-day tasks become easier and more efficient for those who maintain a normal range of motion in their joints. As people age or spend more time being sedentary, their flexibility naturally declines, which can make

everyday movements more difficult and increase the risk of injury. Regular stretching can help maintain joint function, improve posture and balance, and reduce muscle tension that contributes to discomfort or limited mobility (Vilardon et al, 2024). [33]

Overall, flexibility is a key component of physical fitness that enhances both athletic performance and functional movement. While increased flexibility improves mobility and reduces injury risk, it should be balanced with strength and power training—especially for athletes involved in high-intensity sports. Using the right type of stretching at the right time can help individuals maintain flexibility without negatively affecting performance.

Healthy Joints and Pain Management

As many as 28% 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 (Zelaya et al, 2023). [37] 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 and discomfort in the body are not always the result of injury or disease; they can also arise from muscular imbalances caused by uneven flexibility and strength across muscle groups. When certain muscles become too tight, often due to inactivity, poor posture, or repetitive movements, they can exert excessive tension on the joints and skeletal structures to which they are attached.

For example, when the muscles at the front of the thighs (quadriceps) and hips (hip flexors) become excessively tight due to a lack of stretching or prolonged sitting, they may begin to pull the pelvis into a forward tilt. This altered pelvic alignment increases the lumbar curve of the spine, a condition known as lordosis or exaggerated lumbar sway. Over time, this postural distortion can contribute to pain and stiffness not only in the lower back, but also in the shoulders, neck, and other areas of the spine as the body attempts to compensate for the misalignment.

These imbalances can also affect movement efficiency, leading to faulty biomechanics and increasing the risk of overuse injuries. Fortunately, incorporating a regular flexibility routine that targets all major muscle groups and joint areas can help prevent or correct these imbalances. Stretching promotes muscular symmetry, supports proper postural alignment, and reduces unnecessary tension on joints and connective tissues. By maintaining balanced flexibility, individuals can move more freely, reduce the risk of chronic pain, and support overall musculoskeletal health.

Muscle Relaxation and Stress Relief

Daily life often involves extended periods of static posture, such as sitting at a desk, standing in place, or staring at a screen. In addition, repetitive movements, like typing, carrying bags, or using handheld devices, can place uneven strain on certain muscle groups (Harvard Health Publishing, 2021). [14] Over time, these stressors may lead to muscle stiffness, restricted range of motion, and the formation of myofascial trigger points, commonly referred to as “knots.” These are sensitive, tense areas within muscles that can cause discomfort locally or radiate pain to other areas of the body. Regular stretching is an effective strategy for relieving neuromuscular tension. Stretching not only physically lengthens muscles and improves flexibility, but it also activates the parasympathetic nervous system, promoting a state of relaxation. As a result, stretching can help reduce anxiety levels, lower blood pressure, and decrease respiratory rate, all of which contribute to the relaxation of muscles and the alleviation of tension-related aches and pains (Kendall et al, 2005). [18]

Flexibility training has also demonstrated therapeutic benefits beyond general relaxation. For example, stretching exercises have been prescribed as part of treatment plans for dysmenorrhea, or painful menstruation. Gentle, targeted stretching can reduce pelvic muscle tightness and ease cramping by improving circulation and decreasing localized muscular tension (Cramer et al, 2021). [6] Similarly, flexibility exercises are often used to help prevent or relieve exercise-induced muscle cramps, especially during athletic activities or intense physical exertion. By addressing both the physical and physiological components of muscle tension, regular flexibility training can play a valuable role in overall pain management, recovery, and stress reduction, making it a key component of a holistic approach to health and performance.

Other Benefits

In addition to the benefits listed above, many other benefits have been researched and characterized as good reasons to maintain a routine of stretching. Incorporating flexibility exercises into a regular fitness routine can yield these benefits, contributing to improved physical health and quality of life.

Increased Blood Flow

Blood serves as the primary transport system for essential nutrients and oxygen throughout the body, delivering these critical elements to muscles and tissues to support their function and repair. When muscles are stretched, blood flow to those specific areas increases, facilitating enhanced delivery of oxygen and nutrients. This improved circulation can aid in the muscle recovery process following exercise by helping to clear metabolic waste products, reduce muscle soreness, and promote tissue repair. Consequently, regular stretching can contribute to more efficient recovery and better overall muscle health (Kruse et al, 2016). [21]

Reduction of Future Lower Back Pain

While research on this topic remains ongoing and somewhat inconclusive, many experts agree that maintaining muscle fitness and flexibility through regular stretching exercises may help counteract the natural decline in elasticity of muscles and connective tissues that typically occurs with aging. This loss of elasticity can contribute to stiffness and reduced mobility, which are common factors linked to lower back pain. By preserving or improving the elasticity of these tissues, individuals may reduce their risk of experiencing lower-back discomfort or pain in the future. Thus, incorporating stretching into a regular fitness routine is often recommended as a preventive strategy to support spinal health and minimize the likelihood of developing lower-back pain (Rebelo et al, 2023). [27]

Improved Joint Range of Motion and Functional Mobility

Flexibility enhances the range of motion of joints, allowing them to move more freely and efficiently. This increased mobility not only supports better performance during physical activities and daily tasks but also helps reduce the risk of injuries caused by limited joint movement or muscle tightness. Improved joint flexibility contributes to better posture and balance, which are essential for maintaining overall functional independence, especially as individuals age. By promoting smoother and more coordinated movements, flexibility supports both athletic performance and everyday physical function (Rebelo et al, 2023). [27]

Enhanced Balance and Coordination

Flexibility exercises, particularly those that incorporate balance training, can improve neuromuscular control. This leads to better coordination and stability, reducing the likelihood of falls and enhancing overall movement efficiency. Activities like yoga and Pilates, which combine stretching with balance-focused movements, are especially effective in promoting these benefits. In a 2024 study by Vilardon et al., improved flexibility resulted in enhanced walking performance and balance, with measurable increases in gait speed among older adults (Vilardon et al, 2024). [33]

Reduced Muscle Tension and Stress

Stretching can alleviate muscle tightness and promote relaxation by reducing the levels of stress hormones in the body. Incorporating stretching into daily routines can help mitigate the physical and mental effects of stress, leading to improved overall well-being (Cramer et al, 2021). [6]

Improved Posture

Regular stretching helps maintain muscle balance and alignment, which is crucial for good posture. For example, stretching the chest and strengthening the upper back can counteract the effects of prolonged sitting and slouching, leading to better spinal alignment and reduced discomfort (Kendall et al, 2005). [18]

Flexibility and Aging

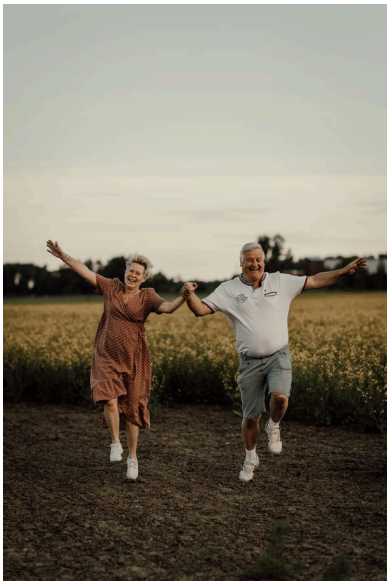


Figure 5.2.2: Maintaining flexibility through regular exercise is important as individuals age. (A man and woman jumping in the air; Isak Pettersson via Unsplash)

For many young adults, long-term flexibility is often taken for granted. Everyday movements—such as bending over to tie shoelaces, walking across campus with a backpack, or reaching for items on a shelf—are typically performed with ease and little discomfort. At this stage of life, joints and muscles generally function without significant limitation, making it easy to overlook the importance of maintaining flexibility.

However, as individuals age, the range of motion (ROM) naturally declines due to changes in joint structure, muscle elasticity, and connective tissue function. Once simple tasks like turning the head to look over the shoulder, stepping in and out of a car, or carrying grocery bags can become noticeably more difficult or even painful. These limitations can reduce independence, increase the risk of falls or injury, and ultimately lower one's quality of life.

Maintaining flexibility through regular stretching and mobility exercises can help slow the decline of ROM and preserve functional movement throughout the lifespan. In 2023, Meng found that there was a reduced risk of sarcopenia and a slower decline in muscle strength with higher baseline flexibility over time (Meng et al, 2023). [23] For these reasons, flexibility training should be viewed as a lifelong investment in health, comfort, and autonomy—not just a temporary concern during youth or athletic activity.

The Inactivity-Mobility Cycle

The **inactivity–mobility cycle** is a self-perpetuating pattern in which reduced physical activity leads to decreased joint mobility, and decreased mobility, in turn, makes physical activity more difficult, leading to further inactivity. This cycle can begin at any age but is especially common in individuals recovering from injury, living with chronic pain, or experiencing age-related declines in flexibility and strength (Warneke et al, 2022). [34]

When joint range of motion (ROM) is limited, due to factors like arthritis, injury, prolonged sitting, or muscular tightness, individuals often begin to move less to avoid discomfort or prevent further pain. However, reduced movement leads to physiological changes in muscles, tendons, and connective tissue. These tissues begin to shorten, tighten, and stiffen when they are not regularly stretched or challenged. As a result, joint stiffness increases, making once-simple movements like walking up stairs, reaching overhead, or standing up from a seated position more difficult and uncomfortable.

Over time, this limited movement can contribute to muscle atrophy, joint degeneration, and loss of balance and coordination. The person may become even less active in response to pain, instability, or fear of injury, which further restricts their mobility. This creates a vicious cycle in which physical inactivity and poor mobility continually reinforce one another.

The inactivity–mobility cycle is particularly concerning because it may remain unnoticed in its early stages, especially in populations who are otherwise healthy. Left unaddressed, it can lead to long-term consequences, including decreased

independence, reduced functional capacity, and lower quality of life.

Breaking the Cycle

Fortunately, this cycle can be interrupted. Regular flexibility training, such as static stretching, dynamic mobility exercises, yoga, or physical therapy, helps maintain or restore joint ROM and muscle elasticity. Even low-impact physical activity, like walking or swimming, contributes to joint lubrication and muscle engagement. By making movement more comfortable and efficient, these practices encourage individuals to be more active, which in turn supports further gains in mobility. Early awareness and consistent effort to preserve flexibility are key to preventing or reversing the inactivity–mobility cycle, especially as individuals age or recover from injury.

Individuals who have experienced injuries requiring joint immobilization often come to recognize the vital role mobility plays in overall health. When joint range of motion (ROM) becomes restricted, due to conditions such as arthritis or injury, physical activity typically declines. This reduction in activity can further limit ROM, creating a cycle of worsening immobility. However, incorporating a simple stretching program can help alleviate these limitations and interrupt the cycle of decline (Warneke et al, 2022). [34]

Question

- If research consistently shows that flexibility and stretching reduce injury risk and improve movement:
  - Why do you think many people still avoid stretching as part of their fitness routine?
  - What personal or social factors might contribute to this behavior?

Key Points

- Being flexible allows one to move freely and complete activities with greater ease.
- Flexibility is essential for overall health and function, supporting joint mobility, posture, physical performance, and the ability to move freely in daily life.
- Regular stretching can reduce pain and stiffness, especially in those with arthritis or muscular imbalances, by promoting joint health and muscular alignment.
- Stretching relieves stress and muscle tension, lowers blood pressure and anxiety, and may help with conditions like muscle cramps and menstrual pain.
- Flexibility helps prevent future injuries and lower back pain, improves circulation, and counteracts age-related declines in range of motion.
- Inactivity leads to decreased mobility, creating a cycle of reduced movement and joint stiffness—stretching can help break this cycle and maintain quality of life as people age.

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5.3: Factors Affecting Flexibility



Figure 5.3.1: (Women Carrying Baby On her Back Close Up; Annie Spratt via Unsplash)

Introduction

Flexibility, the ability of a joint or series of joints to move through an unrestricted, pain-free range of motion, is influenced by a variety of factors. These include anatomical elements such as muscle length, joint structure, and connective tissue elasticity, as well as lifestyle factors like physical activity level, age, and biological sex. Genetics also plays a role in determining an individual's baseline flexibility, while regular stretching and exercise can significantly enhance it over time. Additionally, injury and disease can negatively impact flexibility by causing pain, inflammation, or structural damage that limits movement. Understanding these factors is essential for developing effective fitness programs and maintaining overall musculoskeletal health.

Enhancing joint range of motion (ROM) is essential for maintaining flexibility, reducing injury risk, and improving overall movement efficiency. ROM can be increased through targeted training methods such as stretching, mobility exercises, and strength training, which help optimize joint function and muscle elasticity. Factors such as joint structure, muscle tension, and neuromuscular control all influence ROM, making it important to use a variety of techniques to address individual limitations.

Types of Joints

Joints are the points where two or more bones meet in the body. They allow movement and flexibility and provide support and stability to the skeleton. The human body has several types of joints, each allowing for different ranges and types of movement. They can be classified based on their structure and function. Each type of joint is specialized for specific movements, contributing to the body's flexibility, stability, and overall functionality. Each type of joint is specialized for specific movements, contributing to the body's flexibility, stability, and overall functionality. The main types of joints are **fibrous joints (synatrthroses)**, **cartilaginous joints (amphiarthroses)**, and **synovial joints (Diarthroses)**.

Question

- Why do some of my joints feel flexible while others don't feel flexible at all?

Fibrous Joints (Synarthroses)

Description: These joints are held together by dense connective tissue and allow little or no movement.

Examples:

- **Sutures (in the skull)**
- **Syndesmoses (between the radius and ulna)**
- **Gomphoses (**teeth in their sockets)

Description: These joints are connected by cartilage and allow limited movement.

Examples:

- **Synchondroses** (such as the epiphyseal plates in growing bones)
- **Symphyses** (such as the pubic symphysis of the pelvis and intervertebral discs)

Synovial Joints (Diarthroses)

Description: These joints are characterized by a synovial cavity filled with fluid that lubricates the joint, allowing for free movement. They are the most common and movable joints in the body. Figure 5.3.2 illustrates the main components of synovial joints.

Examples:

- **Ball-and-Socket Joints**: Allow movement in multiple directions (e.g., shoulder, hip).
- **Hinge Joints**: Permit movement in one direction (e.g., elbow, knee).
- **Pivot Joints**: Allow rotation around an axis (e.g., atlas and axis in the neck).
- **Condyloid Joints**: Allow movement in two directions (e.g., wrist joint).
- **Saddle Joints**: Allow movement in two planes. An example of a saddle joint is the thumb joint (the carpometacarpal joint of the thumb), which gives the thumb its wide range of motion and enables grasping and manipulation.
- **Plane (Gliding) Joints**: A type of synovial joint where the articulating surfaces are flat or nearly flat, allowing bones to slide past one another in any direction along the plane of the joint. These joints permit limited movement, typically in multiple directions, such as gliding or sliding motions. Examples include the joints between the small bones of the wrist (carpals) and the ankles (tarsals), as well as the joints between the vertebrae.

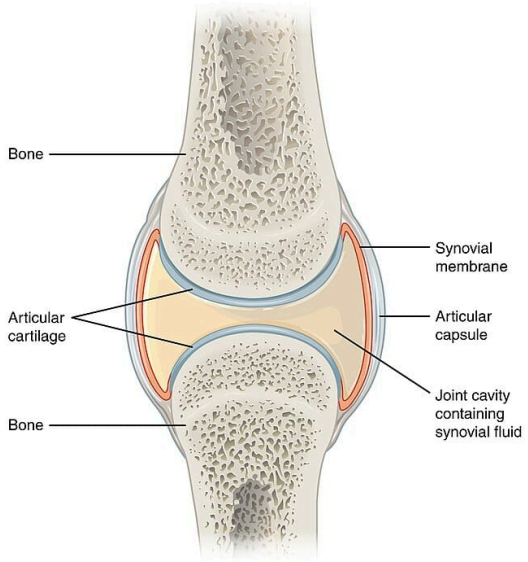


Figure 5.3.2: This diagram shows the structure of a synovial joint, discussed below.
(CC BY 3.0 by OpenStax College via Wikimedia Commons)

Figure 5.3.2 is a labeled anatomical illustration of a synovial joint, specifically showing the ends of two long bones where they meet at a joint. The image is a cross-sectional side view that highlights the key internal structures of the joint. At the top and bottom of the image, two bones are shown and labeled "bones", each with a porous, spongy interior that represents cancellous (trabecular) bone tissue. The ends of these bones are covered in a smooth, white layer labeled "Articular cartilage", which cushions the bones and reduces friction during movement. Surrounding the joint is the labeled "Articular capsule", a tough, fibrous envelope that encloses the entire joint structure. Inside the capsule, a thin lining labeled "Synovial membrane" produces synovial fluid. The space between the bones is labeled "Joint cavity containing synovial fluid". This fluid-filled cavity lubricates the joint, nourishes the cartilage, and allows for smooth, pain-free movement. The images of synovial joints illustrate the complex structure that enables smooth and flexible movement between bones. Key features include articular cartilage covering the bone ends, a synovial cavity filled with lubricating fluid, and a surrounding joint capsule lined with a synovial membrane. Additional supporting structures, like ligaments and sometimes bursae or menisci, provide stability and reduce friction during motion. Each structure is clearly labeled with lines pointing to the respective part, helping to visually demonstrate how the components of a synovial joint fit and function together.

Joint Structure

A **joint** is a location on the body in which two or more bones intersect and interact. **Joint structure** refers to the physical components and anatomical features that make up a joint, allowing it to connect two or more bones and enable movement. The structure of the various

Cartilage is a firm, flexible connective tissue found throughout the body. It provides structure and support while allowing some flexibility and movement. Unlike bone, cartilage is avascular (lacks blood vessels), so it heals more slowly. It is not as hard as bone but is more rigid than muscle. Cartilage is found in many areas of the body, including joints, the ears and the nose, and parts of the rib cage. The **cartilage of a joint** is a smooth, flexible connective tissue that covers the ends of bones where they meet in a joint. Its main function is to reduce friction, absorb shock, and allow bones to glide over each other smoothly during movement. In synovial joints, this cartilage is known as **articular cartilage**, and it plays a crucial role in protecting the bones and maintaining joint health.

Additional Anatomy of a Joint

Articular Surfaces: The smooth, cartilage-covered areas of the bones that come into contact within the joint, allowing for smooth movement.

Joint Capsule: A fibrous tissue surrounding the joint, which holds the bones together and contains synovial fluid to lubricate the joint.

Synovial Fluid: A thick, slippery liquid found inside the cavities of synovial joints, such as the knee, shoulder, and elbow.

Ligaments: Strong bands of connective tissue that attach bone to bone, providing stability and limiting excessive movement.

Connective Tissue: A type of biological tissue in the body that supports, connects, or separates different types of tissues and organs. It can provide structural support, such as bones and cartilage, a role in binding and connecting other tissues like tendons and ligaments, protecting and insulating organs (i.e., fat tissue), and transporting substances like blood (which is a fluid connective tissue).

Collagen: The most abundant protein in the human body and a key component of connective tissue. It provides strength, structure, and flexibility to tissues such as skin, tendons, ligaments, cartilage, and bones. Collagen fibers form a supportive framework that

Joint Range of Motion (ROM)

Range of motion is closely linked to the structure of each joint, and flexibility exercises must be tailored to specific joints. This means that stretching one part of the body, such as the hamstrings, will not improve flexibility in a different area, like the shoulders. Similarly, it is possible to have good flexibility in one joint, such as the shoulder, while experiencing limited mobility in others, like the fingers or ankles.[22] Therefore, an effective flexibility program should include a variety of stretches that target all major joints in the body.

Each joint in the body has a unique structure, function, and range of motion, which means it responds differently to flexibility training. For example, ball-and-socket joints like the hips and shoulders allow for wide movement in many directions, while hinge joints like the knees and elbows move primarily in one plane. Because of these differences, a well-rounded flexibility routine should target all major joints, using both dynamic and static stretches suited to each area. Ignoring certain joints can lead to muscular imbalances, reduced mobility, and a higher risk of injury during physical activities. By addressing the flexibility needs of the whole body, individuals can improve overall movement quality, posture, and functional performance.

For example, the elbow is a hinge joint, which is a type of synovial joint. It primarily allows for movement in one direction, similar to the way a door hinge operates. In the case of the elbow, this movement is flexion (bending) and extension (straightening). 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 as depicted in Figure 5.3.3.

Question

- What does it really take to become more flexible?
- Can I really change my range of motion by stretching?

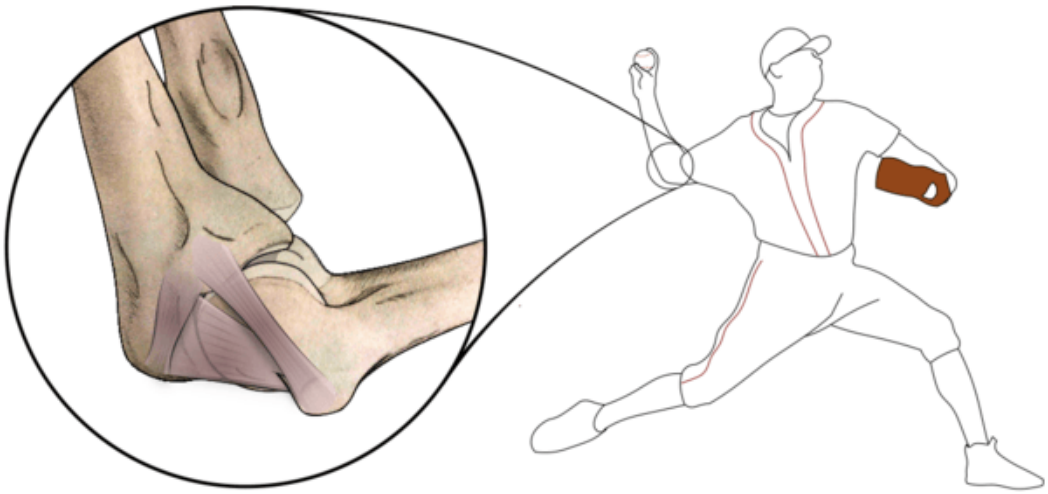


Figure 5.3.3: This diagram shows how the elbow joint might move in a throwing motion. (CC BY-SA 4.0; R.J. Molenaars via Wikimedia Commons)

Conversely, the shoulder joint, which is structurally a ball-and-socket joint, can rotate in multiple directions. In other words, it has a wide range of motion as illustrated in Figure 5.3.4.

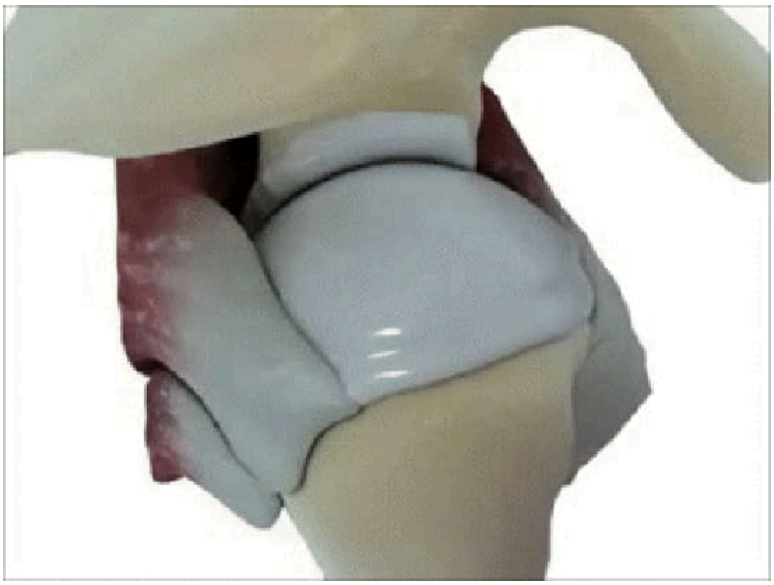


Figure 5.3.4: The shoulder joint with muscular attachment points and joint interfaces clearly shown. (CC BY 3.0; Young Lae, Moon M.D. via Wikimedia Commons)

However, the knee joint is a modified hinge joint that 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.

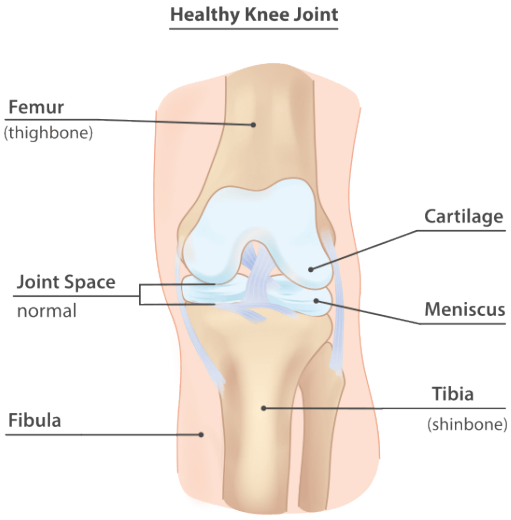


Figure 5.3.5: This image illustrates a healthy knee joint, showing key components such as the femur (thighbone), tibia (shinbone), fibula, cartilage, meniscus, and normal joint space. The cartilage and meniscus cushion the bones and allow smooth, pain-free movement, while the joint space indicates proper alignment and lack of inflammation. (CC BY-SA 4.0; InjuryMap via Wikimedia Commons)

Figure 5.3.5 is a labeled anatomical illustration of a healthy human knee joint, shown in a frontal cross-sectional view that highlights the bones and soft tissues involved in joint structure and function. At the top of the image is the "Femur (thighbone)", which extends downward to form the upper part of the knee joint. It appears thick and strong, tapering as it connects to the joint. At the bottom, the "Tibia (shinbone)" is shown, forming the lower half of the joint. Beside it, on the outside of the lower leg, is the "Fibula", a thinner bone that runs parallel to the tibia. Between the femur and tibia is a clear "Joint space", labeled as “Joint space normal,” indicating a healthy gap that allows for smooth movement and absorbs shock. This space is filled with cartilage and synovial fluid in a living joint. A smooth, light blue layer covering the ends of the femur and tibia is labeled "Cartilage". This tissue cushions the bones and reduces friction during movement. A crescent-shaped structure between the femur and tibia is labeled "Meniscus". It acts as a shock absorber and stabilizer within the knee joint, distributing weight and reducing wear on the cartilage.

The overall depiction emphasizes the anatomical relationships in a normal, healthy knee, with all components well-aligned and sufficient joint spacing maintained for proper function.

Connective and Muscle Tissue

Flexibility improves by increasing the range of motion (ROM) in a joint. Joints are surrounded and connected by muscles, tendons, ligaments, and skin, and it appears that it is the changes in this connective tissue that support this increased range of motion. 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 and in place. In addition, muscle tissue is surrounded by 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 are 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 are equipped with central computers and various sensors that help monitor and diagnose problems. For example, sensors in the engine detect temperature, wheel sensors monitor tire pressure, and sensors in the gas tank indicate when fuel is low. Similarly, the human body contains specialized sensors called **proprioceptors** that help regulate movement and protect against injury.

Within muscles, there are two main types of proprioceptors: **muscle spindles** and **Golgi tendon organs (GTOs)**. These structures monitor the length and tension of muscles and communicate with the central nervous system (CNS) to coordinate appropriate responses. Muscle spindles are located parallel to the muscle fibers and detect changes in muscle length. When a muscle is stretched, the muscle spindle sends a signal to the CNS, triggering the stretched muscle to contract—a protective response known as the **stretch reflex** or **myotatic reflex**. At the same time, the opposing muscle (the antagonist) is signaled to relax, a process known as **reciprocal inhibition**. For example, when the quadriceps are stretched, the hamstrings (the antagonist muscles) relax to allow for smoother movement.

Golgi tendon organs (GTOs) are found near the junction where muscle fibers meet tendons. They detect tension in the muscle and, when activated, especially during a prolonged stretch, send signals to the CNS that inhibit muscle contraction. This response is known as **autogenic inhibition** or the **inverse myotatic reflex**. It causes the stretched muscle to relax, but this only happens after the muscle has been under tension for about five seconds or more. This is why effective stretching requires holding a position for an extended period—short, quick stretches do not allow the body enough time to engage this protective response.

In both cases, the neuromuscular system plays a critical role in managing muscle function, helping to prevent injury by controlling when muscles contract and when they relax.



Figure 5.3.6: A man stretching his left hamstring on a fence. He is holding his toes with both hands and is folding his torso towards the top of his thigh. (A man in white tank top and black shorts doing pushup during daytime; Michael DeMoya via Unsplash)

Age

As individuals age, their flexibility tends to decrease due to natural physiological changes in the body. One of the primary reasons for this decline is the gradual loss of elasticity in muscles, tendons, and ligaments. Over time, collagen fibers within connective tissues become stiffer, reducing the range of motion around joints (Knudson, 2006). [20] Additionally, the production of synovial fluid, which lubricates joints and helps them move smoothly, diminishes with age, leading to increased joint stiffness and discomfort. These changes make it more challenging for older adults to perform movements that were once easy and pain-free in their youth.

Moreover, age-related decreases in physical activity can further contribute to the loss of flexibility. Many older adults lead more sedentary lifestyles, which can cause muscles and joints to become less mobile and more prone to tightness or injury. Conditions commonly associated with aging, such as arthritis or osteoporosis, may also restrict movement and flexibility due to joint pain or structural changes (Neogi, 2013). [24] However, engaging in regular stretching, mobility exercises, and strength training can help counteract these effects and maintain or even improve flexibility well into older age.

Question

- Why is it important to maintain flexibility as you get older?
- Why does flexibility impact quality of life?

Genetics

Genetics plays a significant role in determining an individual's baseline flexibility, which refers to the natural range of motion a person has without any training or conditioning. Some people are born with a higher degree of flexibility due to inherited traits that affect the structure and composition of their muscles, tendons, and joints. For example, the length of muscles and tendons, the shape of bones, and the elasticity of connective tissues are all influenced by genetic factors (Kenney et al, 2019). [19] These inherited traits set the foundation for how flexible a person is from a young age and how their body responds to stretching or mobility training over time.

One notable genetic trait that influences flexibility is **hypermobility**, a condition where joints move beyond the normal range of motion. Hypermobility is often inherited and is caused by variations in the structure of collagen, a protein that provides strength and elasticity to connective tissues. People with hypermobility tend to have looser ligaments and more pliable joints, which can make them naturally more flexible. While this can be advantageous in activities such as dance, gymnastics, or yoga, it can also

increase the risk of joint instability, pain, and injury if not properly managed.

It's important to note that while genetics influence baseline flexibility, they do not limit a person's ability to improve flexibility through consistent effort. With regular stretching, proper technique, and targeted exercises, individuals can enhance their range of motion regardless of their genetic starting point. However, understanding one's genetic predisposition, whether it's limited flexibility or hypermobility, can help guide safe and effective flexibility training tailored to their unique needs.

Biological Sex

Biological sex is another factor that influences flexibility, with research generally showing that females tend to be more flexible than males. This difference is partly due to hormonal variations, particularly the presence of estrogen, which contributes to greater elasticity in muscles and connective tissues. Women also typically have a wider pelvis and different joint structures, such as a greater angle at the hips (known as the Q-angle), which can enhance flexibility in certain areas of the body, especially the lower back and hips (Fujikawa et al, 2023). [8]

In contrast, males often have greater muscle mass and tighter connective tissues, which can limit their range of motion compared to females. Testosterone, the primary male sex hormone, contributes to increased muscle density and stiffness, which may reduce joint flexibility. Additionally, social and cultural factors may influence flexibility between the sexes, with activities promoting flexibility (such as dance or gymnastics) more commonly encouraged for females from a young age (Fujikawa et al, 2023). [8]

Despite these general trends, it's important to note that flexibility can vary widely among individuals regardless of sex. With consistent stretching and mobility training, both males and females can improve their flexibility significantly. Recognizing these biological differences simply helps in designing appropriate and effective flexibility programs tailored to an individual's body structure and needs.

Question

- Which gender is more flexible - women or men? Or is there any difference at all?
- Can these differences be equalized through training?

Injury and Disease

Injury and disease can significantly impact flexibility by altering the structure and function of joints, muscles, and connective tissues. When an injury occurs, such as a muscle strain, ligament sprain, or joint dislocation, it often results in inflammation, pain, and reduced mobility in the affected area. To protect the injured region, the body may limit movement, leading to stiffness and decreased range of motion over time. Scar tissue can also form during the healing process, which may restrict flexibility if not properly managed through rehabilitation exercises and stretching. Regular stretching can also be used to relieve exercise-related muscle cramps (Kenney et al, 2019). [19]

Chronic diseases, particularly those affecting the musculoskeletal system, can further limit flexibility. Conditions like **osteoarthritis**, for instance, involve the gradual breakdown of cartilage in joints, leading to pain, swelling, and stiffness (Neogi, 2013). [24] As the joint becomes less cushioned and more inflamed, its range of motion often decreases, making daily movements more difficult and uncomfortable. Similarly, **rheumatoid arthritis**, an autoimmune disease, can cause joint deformities and long-term stiffness, severely restricting flexibility (Zelaya et al, 2023). [37] While these conditions cannot always be reversed, targeted physical therapy, regular gentle stretching, and appropriate medical treatment can help manage symptoms and maintain as much flexibility and mobility as possible.

Question

- Can you safely regain flexibility in a joint after an injury without risking further damage?
- Can stretching help mobility after an injury?

Physical Activity

Engaging in an active flexibility program can significantly improve an individual's range of motion, joint health, and overall movement efficiency. Regular stretching and mobility exercises help maintain the elasticity of muscles and connective tissues, reducing stiffness and enhancing the body's ability to perform daily activities and physical tasks with ease. Consistent flexibility training also promotes better posture and may reduce the risk of musculoskeletal injuries by allowing muscles and joints to move more freely and adaptively. In contrast, a sedentary lifestyle can lead to shortened muscles, reduced joint mobility, and increased stiffness. Prolonged periods of inactivity can cause connective tissues to become less pliable and contribute to postural imbalances, making movement less efficient and potentially increasing the risk of strains or injuries when activity is resumed. Therefore, maintaining an active flexibility routine is essential for preserving functional movement and overall physical health (American College of Sports Medicine, 2021). [1]

Physical activity without dedicated stretching can still influence flexibility, but the effects depend on the type and intensity of the activity. Dynamic activities such as swimming, dance, or martial arts often involve movements through a full range of motion, which can help maintain or even improve flexibility over time. Strength training with proper technique, especially through a full range of motion, can also support joint mobility and muscular balance (Baechle et al, 2016). [3] However, if physical activity is repetitive or limited in movement patterns (e.g., running or cycling), it may lead to tightness in specific muscle groups. Without regular stretching, this can result in muscle imbalances, reduced range of motion, and increased risk of injury. Over time, the lack of flexibility at work may limit performance and make recovery more difficult, emphasizing the importance of including stretching in a well-rounded fitness routine.

Key Points

- Flexibility refers to a joint's ability to move through a full, pain-free range of motion and is influenced by anatomical, lifestyle, and genetic factors.
- Types of joints, fibrous (immovable), cartilaginous (slightly movable), and synovial (freely movable), affect how much flexibility each joint can achieve.
- Synovial joints, like ball-and-socket and hinge joints, allow for the greatest movement and are supported by structures like cartilage, ligaments, synovial fluid, and joint capsules.
- Range of motion (ROM) varies by joint type and can be improved through stretching, strength training, and mobility exercises tailored to specific joints.
- Connective tissue elasticity (especially collagen and elastin) plays a major role in flexibility, responding to both short-term (elastic) and long-term (plastic) stretching.
- Neuromuscular control involves proprioceptors like muscle spindles and Golgi tendon organs that regulate stretch reflexes and help protect muscles during stretching.
- Age reduces flexibility due to decreased collagen elasticity, reduced synovial fluid production, and lower physical activity levels, but it can be managed with regular exercise.
- Genetics influence baseline flexibility through inherited traits like joint structure, muscle length, and connective tissue elasticity; hypermobility is one genetic trait.
- Biological sex affects flexibility, with females typically more flexible due to hormonal and structural differences like greater connective tissue elasticity and joint angles.
- Injury and disease (e.g., arthritis, strains, or dislocations) can limit flexibility through pain, inflammation, scar tissue formation, and structural damage, often requiring rehabilitation.

Attributions

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5.4: Creating an Effective Flexibility Program



Figure 5.4.1: This straddle stretch targets the hamstring muscle. (Man in White Sleeveless Top; Alora Griffiths via Unsplash)

Introduction

A well-rounded flexibility program offers numerous benefits, including improved posture, enhanced physical performance, reduced risk of injury, and greater relaxation and recovery. Whether an individual is an athlete aiming to increase mobility or someone simply striving to move more comfortably in daily life, establishing a personalized flexibility routine is essential. The first step in this process is assessing current flexibility levels. From there, creating an effective program requires an understanding of the different types of flexibility, the various stretching techniques available, and how to adapt these exercises to meet specific needs and goals. This section provides a clear framework for building a safe, balanced, and sustainable flexibility program that contributes to overall fitness and long-term wellness.

Assessing Individual Flexibility

Just as there are many types of joints, there are several methods available to assess an individual's flexibility, ranging from simple field tests to more advanced clinical assessments. Flexibility is assessed in multiple ways because no single test can assess overall flexibility due to different types of joints (Riebe et al, 2018). [28] One of the most common and accessible tests is the **sit-and-reach test**, which evaluates the flexibility of the lower back and hamstrings. In this test, the individual sits on the floor with legs extended and reaches forward toward their toes as far as possible, with the distance reached indicating their level of flexibility. Other common field tests include the **shoulder flexibility test**, which assesses the upper body range of motion, and the **trunk rotation test**, which evaluates the ability to twist the upper torso. The **straight leg test (SLT)** measures the flexibility of the hamstrings and hip flexion.

For more precise measurements, especially in clinical or rehabilitation settings, professionals may use tools like **goniometers** or **inclinometers**. These instruments measure the exact angle of a joint's range of motion, providing detailed data that can be tracked over time. These tools are particularly useful when evaluating flexibility after an injury or surgery, allowing for careful monitoring of progress during physical therapy. Additionally, some facilities use digital motion analysis systems or apps to assess flexibility in real-time, offering a more comprehensive view of body movement patterns.

The choice of flexibility assessment depends on the individual's needs, health status, and available resources. While simple tests are effective for general fitness evaluations, more advanced tools offer precise insights that can guide rehabilitation or athletic training programs. Regardless of the method, regular flexibility assessments help identify imbalances or limitations, inform exercise plans, and track improvements over time.

Factors Affecting Flexibility Tests

Warming up before completing a flexibility assessment is crucial for ensuring both safety and accuracy. A proper warm-up increases blood flow to the muscles, raises body temperature, and enhances the elasticity of connective tissues, all of which help prepare the body for movement. This reduces the risk of muscle strains or injuries during stretching and allows for a more accurate measurement of an individual's true flexibility. Without a warm-up, muscles are colder and stiffer, which can limit the range of motion and lead to misleading assessment results. A good warm-up typically includes light aerobic activity, such as brisk walking or gentle cycling, followed by dynamic stretches to activate the muscles and joints involved in the flexibility test (Nieman, 2010). [25]

Other factors include:

- **Time of Day** - Generally, people are more flexible in the afternoon than in the morning.
- **Temperature** - "Warmer" muscles tend to be more flexible. This can be from a warm-up or a warm room or both.
- **Ability to Relax** - Relaxing during a flexibility test helps reduce muscle tension, allowing for a greater range of motion and potentially leading to a better overall score.
- **Soreness or Injury** - Injury or soreness can limit movement and cause discomfort, leading to a reduced range of motion and lower flexibility. It can also potentially aggravate an injury.
- **Personality** - Someone who has a competitive nature may have the tendency to push harder or may have a more developed tolerance for pain.

Flexibility Training Techniques

Various stretching techniques have been shown to be effective in improving the range of motion (ROM). While each technique may differ in its approach, all can generally be performed using one of two basic modes: active or passive. **Active stretching**, also known as unassisted stretching, involves performing the stretch independently, without the help of an external force. In contrast, **passive stretching,** also referred to as assisted stretching, requires the support of an outside force, such as a partner, a strap, or gravity, to help achieve the stretch. Both modes offer unique benefits and can be incorporated into a well-rounded flexibility program depending on individual needs and goals.

Question

- There are so many different ways to stretch. What is the best way to stretch to improve my flexibility?

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 of static stretching are 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 (American College of Sports Medicine, 2021). [1]

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 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 targets and improves 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 apply to certain populations.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching

Proprioceptive Neuromuscular Facilitation (PNF) Stretching is an advanced form of flexibility training that involves both stretching and contracting the targeted muscle group. 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 the contract-relax stretching method because of the sequence of movements involved (Hindle et al, 2012). [17] Other types of PNF stretching involve contract-relax-antagonist contraction, also describing the sequence of movements involved, but adding a step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the range of motion 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 (Knudson, 2006). [20] Some disadvantages to PNF are that it generally requires a knowledgeable partner, it's somewhat complicated, and it can cause some soreness from the contractions.

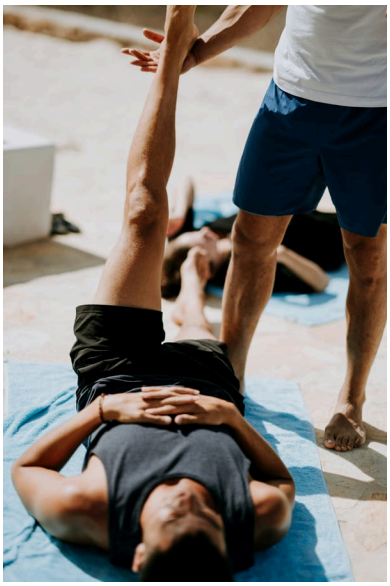


Figure 5.4.2: A partner stretch targeting the hamstring. (Man Lying on Floor Near Man Standing Holding His Leg; Annie Spratt via Unsplash)

Table 5.4.1: A Comparison of Stretching Techniques.

Factor	Slow Static	Ballistic	Dynamic	PNF
Risk of Injury	Low	High	Medium	Medium
Degree of Pain	Low	Medium	Medium	High
Resistance to Stretch	Low	High	Medium	Medium
Practicality (Time and Assistance Needed)	Excellent	Good	Excellent	Poor
Efficiency (Energy Consumption)	Excellent	Poor	Good	Poor
Effective for Increasing Range of Motion	Good	Good	Good	Excellent

TABLE 5.4.1 compares the risk of injury, the degree of pain, resistance ot stretch, the practicality, efficiency, and how effective different methods of stretching are. The different stretching techniques include slow static, ballistic, dynamic, and PNF (Heyward, 2018). [16] For example, the risk of injury for slow static stretching is low, while the risk of injury when practicing ballistic stretching is high.

Putting Together a Flexibility Program

Creating a flexibility program involves identifying specific muscle groups that need attention and selecting appropriate stretching techniques, such as static, dynamic, or proprioceptive neuromuscular facilitation (PNF). The program should include stretches that are performed consistently, and it's important to tailor the program to the individual's goals, activity level, and any limitations to ensure safety and effectiveness.

Set Goals

After figuring out which areas of the body are more or less flexible, a person should set realistic goals to either improve or maintain their range of motion (ROM). When setting goals, it's important to be specific. Instead of saying, "I want to become more flexible," it's better to focus on a particular part of the body that needs improvement. Goals should also be measurable so that progress can be tracked. For example, a clearer and more useful goal might be, "I will improve my sit-and-reach score by 4 cm by the end of the semester." This goal works well because it names a specific area, includes a way to measure progress, and sets a deadline. Setting goals this way can help increase the chances of actually reaching them.

Question?

- Do I have to stretch every day?

Apply the FITT-VP Principle

As previously noted, the American College of Sports Medicine (ACSM) provides guidelines for developing a flexibility program using the FITT Principle - Frequency, Intensity, Time, and Type. When selecting areas to stretch, individuals should aim to include a variety of exercises that target all major joints, such as the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles (American College of Sports Medicine, 2021). [1] Once appropriate exercises have been chosen, the following recommendations should be followed to ensure a safe and effective flexibility 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. It is important to note that because flexibility is specific to each joint, the body has a pain response for a reason. Pain indicates that the stretch is too intense or may be in a bad form.

Time (or duration of each stretch): Hold the stretch for 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. Note: For older adults, 30-60 seconds may be more effective.

Type (mode): Select from either of the above techniques mentioned that best suit your circumstances (Static, Dynamic, Ballistic, or Proprioceptive Neuromuscular Facilitation).

Volume: A total of 60 seconds per flexibility exercise (For example, 2 sets of 30 seconds or 4 sets of 15 seconds)

Pattern: Repeat each stretch 2-4 times. Stretch major muscle-tendon units, including those of the neck, shoulders, chest, trunk, lower back, hips, legs, and ankles.

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 (American College of Sports Medicine, 2016). [2] Recent studies have provided evidence against stretching before exercise session suggesting that stretching will compromise the force-producing capabilities of muscles (Knudson, 2006). [20] Therefore, it is recommended that stretching take place only after the body temperature and the muscles have 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.

Question

- Does it matter when I stretch?

Flexibility and Training Principles

Understanding the principles of training is essential for developing an effective and safe flexibility program. These principles provide a foundation for how the body responds to stretching and how to structure a routine for long-term progress. In flexibility training, key principles such as specificity, overload, progression, and reversibility help guide the selection and performance of exercises to improve or maintain the range of motion. By applying these concepts correctly, individuals can create a well-rounded program that meets their goals, prevents injury, and promotes overall mobility and functional movement. This section will explore each training principle and its role in flexibility development based on recommendations by the ACSM (Riebe et al, 2018). [28]

A proper warm-up is important before stretching or flexibility training because it increases blood flow, raises muscle temperature, and helps prepare the body for movement, reducing the risk of injury. Warm muscles are more elastic and responsive, which allows for a greater range of motion during stretching. Similarly, a cool-down after flexibility training helps gradually lower the heart rate and relax the muscles, aiding in recovery and reducing post-exercise stiffness. Often, flexibility training is used after an aerobic or strength training session, which can be used to cool down from those activities. Including both warm-up and cool-down phases enhances the effectiveness and safety of a flexibility routine.

Specificity

Specificity in a flexibility or stretching program means that improvements in flexibility are specific to the joints and muscles being stretched. For example, stretching the hamstrings will increase flexibility in the back of the legs but won't significantly affect the shoulders or hips. This principle is important because each individual has unique flexibility needs based on their lifestyle, activities, or areas of tightness. A well-designed program should focus on the specific muscles and joints that are most relevant to the individual's goals, whether for athletic performance, injury prevention, or daily movement.

Overload

Overload in a flexibility or stretching program refers to the need to gently push the muscles and joints beyond their usual range of motion in order to see improvement. This means holding stretches for longer durations or gradually increasing the intensity or depth of a stretch over time. For different individuals, overload should be applied based on their current flexibility level—beginners may start with shorter, less intense stretches, while more advanced individuals can safely challenge their range of motion further. The key is to apply overload progressively and carefully to avoid injury while encouraging continued flexibility gains.

Progressive Overload

Progressive overload in a flexibility or stretching program means gradually increasing the challenge placed on the muscles and joints to continue improving range of motion over time. This can be done by holding stretches for longer periods, increasing the number of repetitions, or deepening the stretch slightly as flexibility improves. For each individual, progressive overload should be applied according to their starting level and goals—ensuring the body is consistently challenged without causing pain or injury. By applying this principle, individuals can make steady progress and avoid hitting a plateau in their flexibility training.

Reversibility

The principle of reversibility in a flexibility or stretching program refers to the concept that flexibility gains can be lost over time if regular stretching is not maintained. When individuals stop stretching for an extended period, muscles and connective tissues may become tighter, leading to a decrease in range of motion. This principle applies to everyone, regardless of fitness level—consistent practice is essential to preserve the benefits of flexibility training. For individuals returning after a break, it may be necessary to ease back into stretching gradually to safely regain lost mobility.

Individual Differences

The principle of individual differences recognizes that each person responds differently to flexibility and stretching programs due to factors such as genetics, age, sex, activity level, and previous injuries. Some individuals may naturally have a greater range of motion, while others may require more time and effort to see progress. This means flexibility programs should be personalized to match an individual's specific needs, limitations, and goals. By tailoring stretches and routines appropriately, individuals can improve their flexibility safely and effectively.

Stretching Safely

In addition to warming up the muscles before performing stretching exercises, other important practices help make a flexibility routine safe and effective. When muscles are stretched too quickly or forcefully, the stretch reflex may be triggered, causing the muscles to contract while being stretched. This added tension increases the risk of strain or injury. For this reason, ballistic stretching—fast, bouncing movements—is not suitable for everyone. To reduce this risk, stretches should be performed slowly, in a controlled manner, and held for at least 10 seconds or more.

Some stretches are also considered contraindicated, meaning they are not recommended due to the potential for harm. Research has shown that certain stretching exercises may offer little benefit or even increase the chance of injury. While lists of contraindicated and safer alternative stretches are available, they are not always comprehensive. Individuals need to understand their own physical limitations and pay close attention to how their bodies respond during each stretch to prevent discomfort or injury.

Question

- Are there really stretches I should avoid?

Contraindicated Stretches

Contraindicated stretches are those that have been found to pose a higher risk of injury, especially when performed incorrectly or by individuals with certain physical limitations (Liguori & Carroll-Cobb, 2021). [22] These stretches can place excessive stress on joints, ligaments, or muscles and may not offer significant benefits. Here are some common examples of contraindicated stretches:

Hurdler's Stretch (traditional style)

- **Why it's risky**: Involves sitting with one leg straight in front and the other bent behind at the knee. This places strain on the knee joint and ligaments.

- **Safer alternative**: Modified hurdler's stretch with the back leg bent in front instead of behind, or use a hamstring stretch with both legs in front.

Neck Circles (Full head circles)

- **Why it's risky**: Rolling the head in a full circle, especially backward, can compress cervical vertebrae and cause strain.
- **Safer alternative**: Gentle side-to-side or forward-backward neck tilts.

- **Why it's risky**: Bending forward with straight knees can overstretch the lower back and hamstrings and put pressure on the spine.
- **Safer alternative**: Seated hamstring stretch with a neutral spine and knees slightly bent.



Figure 5.4.3: This forward bend with locked knees can be risky for some people. (Man doing a headstand; GMB Fitness via Unsplash)

Back Bends or Bridge (unsupported)

- **Why it's risky**: Deep spinal hyperextension can place stress on the lower back, especially for individuals without adequate strength or flexibility.
- **Safer alternative**: Gentle cobra or sphinx stretch done on the stomach.

Deep Forward Lunge

- **Why it's risky**: It can cause knee overextension. If the front knee extends beyond the toes, it increases pressure on the knee joint and can strain the ligaments.
- **Safer alternative**: A shallow or modified lunge, where the front knee stays directly above the ankle, and the back knee remains slightly bent, can reduce these risks. Using support (like a wall or chair) or practicing dynamic lunges with a smaller range of motion can also help build strength and flexibility safely.

- **Why it's risky**: Involves lying on the back and bringing the legs overhead to the floor, which can compress the neck and spine.
- **Safer alternative**: Reclined hamstring stretch or supported legs-up-the-wall pose.



Figure 5.4.4: The Plow Pose could compress the neck and spine and is considered risky for some people. (A woman doing a Yoga pose on a blue mat; Shivam Tiwari via Unsplash)

It's important to note that what is contraindicated for one person might be safe for another with proper form, supervision, and conditioning. Always consider individual flexibility, strength, joint health, and injury history when choosing stretches.

Key Points

- A well-rounded flexibility program improves posture, enhances performance, reduces injury risk, and promotes relaxation and recovery.
- Flexibility assessments, like the sit-and-reach and shoulder flexibility tests, help identify areas of tightness and track progress.
- Flexibility is influenced by factors such as warm-up, time of day, temperature, relaxation level, and existing injuries or soreness.
- Stretching techniques include static, dynamic, ballistic, and PNF, each with unique benefits depending on goals and fitness levels.
- Active stretching is done independently, while passive stretching involves an external force like a partner or gravity.
- Goal setting should be specific, measurable, and time-bound to effectively improve flexibility.
- The FITT Principle (Frequency, Intensity, Time, Type) guides safe and effective flexibility routines.
- Key training principles—specificity, overload, progression, and reversibility—ensure long-term flexibility gains.
- Warm-ups enhance muscle elasticity, and cool-downs aid recovery and reduce stiffness.
- Contraindicated stretches should be avoided or modified to prevent injury, especially for individuals with limited flexibility or joint issues

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5.5: Sample Flexibility Plan



Figure 5.5.1: A woman in lotus pose twisting her torso. (Woman Performing Yoga; Dane Wetton via Unsplash)

Introduction

Starting a new flexibility program can be an exciting and rewarding journey toward improved mobility, reduced muscle tension, and overall physical well-being. Whether an individual aims to enhance athletic performance, recover from an injury, or simply maintain a healthy range of motion, a well-structured flexibility routine is essential. This section will guide the reader through the key principles and steps involved in beginning a flexibility program, including setting realistic goals, choosing appropriate stretches, and incorporating safe practices to ensure long-term success. By understanding the body's needs and gradually progressing, one can build a sustainable flexibility routine that supports overall fitness and health goals.

Stretching the body's muscles provides freedom of movement to do the things you need to do and the things you like to do. Stretching can improve your flexibility, although it will not improve your endurance or strength.

Apply the FITT Principle

Stretching should be done after regularly scheduled strength and aerobic activities and is recommended on a daily basis. For individuals who are unable to perform endurance or strength exercises, stretching alone can still be beneficial and should be done at least three times per week, with each session lasting at least 20 minutes. Each stretching exercise should be performed at least four times per session. The individual should slowly move into the stretch as far as possible without causing pain, hold the position for 15 to 60 seconds, then relax and repeat, aiming to stretch slightly farther each time. Breathing should be steady and continuous during the stretch, and counting out loud can help ensure proper breathing technique.

Question

- When should I stretch? How much should I stretch? How often?

Safety

- Individuals who have had a hip or knee replacement should consult with their surgeon before engaging in lower-body exercises. It is important to always begin with a warm-up before performing stretching exercises. For instance, stretching

can be done after endurance or strength training, or, if only stretching is planned for the day, a brief session of light walking and arm-pumping can serve as an appropriate warm-up.
- Stretching should never result in pain, particularly joint pain. If pain is experienced, the stretch is likely too intense and should be reduced to a level that is comfortable. A mild pulling sensation or slight discomfort is normal. Stretches should be performed using slow, steady movements—never with bouncing or jerking motions, as these can cause muscles to tighten and increase the risk of injury.
- Joints should not be “locked” into place when straightening the limbs during stretches. While arms and legs should be extended, a slight bend should always be maintained at the joints to avoid strain.
- Some exercises may require lying on the floor. Individuals who are concerned about getting back up should consider working out with a partner, using a chair, or exercising in a pool. A chair can also be kept nearby for support when getting up. All stretches can be modified as needed.

Question

- What are some of the strategies you can use to prevent injury or to avoid "pulling" a muscle when beginning your stretching regimen?

Getting Started

Stretching exercises are typically performed at a low intensity. Progression is possible over time, but it is important to recognize personal limits—stretching should never cause pain. A slight feeling of discomfort is normal, but the sensation should not be painful. Individuals should aim to gently increase their range of motion, pushing a bit farther as flexibility improves, while avoiding movements that lead to pain. The following exercises should be performed in the order presented and as described in Table 5.5.1 .

For individuals not currently engaged in aerobic or strength activities, flexibility and stretching exercises should be performed at least three times per week, with each session lasting a minimum of 20 minutes.

Sample Stretching Session

Flexibility Exercise/Stretch	# of repetitions per set	
Standing Single leg stretch (regular or modified) or alternative hamstring stretch	2 – 4 per side	
Standing quad stretch	2- 4 per side	
Standing Side Lunge	2 – 4 per side	
Wall stretch for Calf	2 – 4 per side	
Across the Body Shoulder Stretch	2 – 4 per side	
Triceps Stretch with Prop or Overhead Triceps Stretch.	2 – 4 per side	

Flexibility Exercise/Stretch	# of repetitions per set	
Wall Stretch for Chest	2 – 4 per side	
Wrist Stretch	2 – 4 per side	
Modified Hurdlers Stretch or Seated Forward Bend	2 – 4 per side	
Hip and Trunk Rotation	2 – 4 per side	
Neck Rotation	2 – 4 per side	
Knees to Chest Stretch	2 – 4 per side	
Double Hip Rotation	2 – 4 per side	
Single Leg Extension	2 – 4 per side	
Single Overhead Reach and Lateral Stretch	2 – 4 per side	
Groin Stretch (Butterfly)	2 – 4 per side	

Table 5.5.1: Sample Stretching Session by Danielle Altman is licensed CC BY-NC 4.0

Standing Exercises

There are a variety of joints and muscle groups to target for an effective flexibility program.

Standing Single Leg Stretch

Stretches hamstrings (back of the thigh), calves, and erector spinea (lower back)



Figure 5.5.2: A standing hamstring stretch. (Man is dancing in living room; Vitaly Gariev via Unsplash)

Instructions

1. From a standing position, lift one leg and place the heel on the chair or bench.
2. Keep one leg stretched out on the chair, straight, toes pointing up.
3. Keep the other leg off the bench, with the foot flat on the floor.
4. Straighten back.
5. If you feel a stretch at this point, hold the position for 15–60 seconds.
6. If you don't feel a stretch, lean forward from the hips (not waist) until you feel stretching in the leg on the bench, keeping back and shoulders straight.
7. Hold position for 10–60 seconds.
8. Repeat with the other leg.
9. Complete 2-4 repetitions on each side.

Modified Single Leg Stretch

Stretches hamstrings (back of the thigh), calves, and erector spinea (lower back)

Instructions

1. From a seated position, extend one leg straight out, putting some weight on the heel.
2. Keep the other leg bent, with the foot flat on the floor
3. If you don't feel a stretch, lean forward from the hips (not waist) until you feel stretching in the straight leg, keeping back and shoulders straight.
4. Hold position for 10–60 seconds.
5. Repeat with the other leg.
6. Complete 2-4 repetitions on each side.

Alternative Hamstrings Stretch

Stretches hamstrings (back of the thigh), calves, and erector spinea (lower back)

Instructions

1. Stand behind the chair, holding on with both hands.

2. Bend forward from the hips (not waist), keeping back and shoulders straight at all times.
3. When the upper body is parallel to the floor, hold the position for 10–60 seconds. You should feel a stretch in the backs of your thighs.
4. Complete 2-4 repetitions on each side.

Standing Quad Stretch

Stretches the quadriceps (front of the thigh)



Figure 5.5.3: A standing quad stretch. (Woman in a green sports bra top; Joshua Díaz via Unsplash)

Instructions

1. In a standing position, hold the back of a chair or wall with the right hand.
2. Reach back with your left hand while you slowly bend the left leg upward.
3. Grab the foot with the left hand and gently pull the heel towards your buttocks until you feel mild tension in the front of the thigh and hips.
4. Hold the stretch for 10–60 seconds.
5. Repeat on the opposite side.
6. Complete 2-4 repetitions on each side.

Standing Side Lunge Stretch

Stretches the hip adductors (inner thigh)

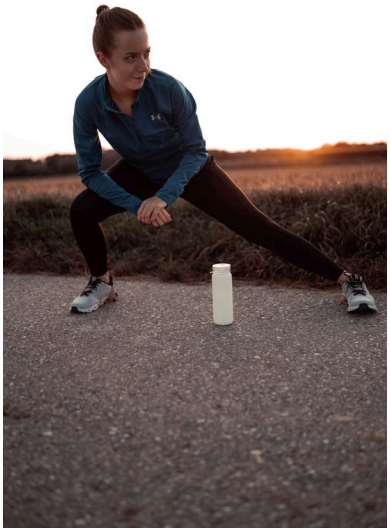


Figure 5.5.4: A standing side lunge. (Person Kneeling on Ground; Bluewater Sweden via Unsplash)

Instructions

1. Stand in a wide straddle with legs turned slightly outward.
2. With your hands on your thighs (for more balance) or clasped in front of your chest, lunge to one side by bending one knee.
3. Keep the knee directly over the ankle and avoid letting it extend past your foot (this protects your knee joint)
4. Lunge to the point of mild tension in the inner thigh.
5. Hold the stretch for 10–60 seconds.
6. Repeat on the opposite side.
7. Complete 2-4 repetitions on each side.

Wall Stretch for Calf

Stretches lower leg muscles.

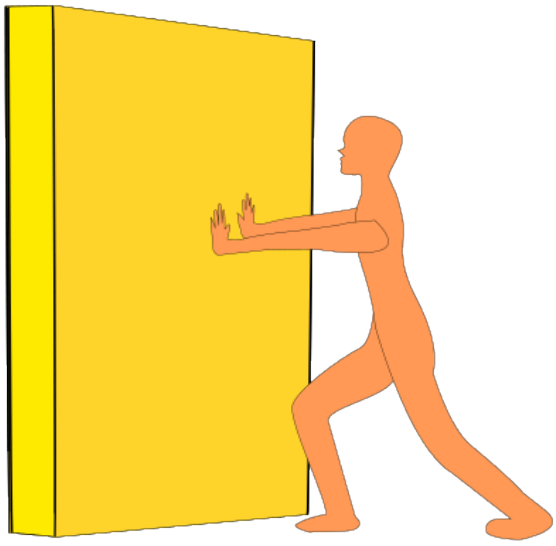


Figure 5.5.5: A wall stretch. (CC BY-SA 4.0; Pk001 via Wikimedia Commons)

Instructions

1. Stand with hands against the wall, arms outstretched and elbows straight.
2. Keeping your left knee slightly bent, toes of right foot slightly turned inward, step back 1–2 feet with right leg, heel, and foot flat on the floor. You should feel a stretch in your calf muscle, but you shouldn't feel uncomfortable. If you don't feel a stretch, move your foot farther back until you do.
3. Hold position for 15–60 seconds.
4. Bend the knee of the right leg, keeping the heel and foot flat on the floor.
5. Hold the stretch for 10–60 seconds.
6. Repeat on the opposite side.
7. Complete 2-4 repetitions on each side.

Ankle Stretch

Stretches the front ankle muscles

Instructions

1. Remove your shoes. Sit toward the front edge of a chair and lean back, using pillows to support your back.
2. Stretch your legs out in front of you.
3. With your heels still on the floor, bend your ankles to point your feet toward you.
4. Next, bend your ankles to point your feet away from you.
5. If you don't feel the stretch, repeat with your feet slightly off the floor.
6. Hold the stretch for 10–60 seconds.
7. Repeat on the opposite side.
8. Complete 2-4 repetitions on each side.

Across the Body Shoulder Stretch

Stretches the deltoid (shoulder)



Figure 5.5.6: A shoulder stretch. (A shirtless man flexing; Farkas Mario via Unsplash)

Instructions

1. In a standing or seated position, keep your back straight and torso facing forward.
2. Bring your right arm across in front of your body towards your left shoulder.

3. Grab the elbow with your left hand or press your upper arm with your left forearm.
4. Gently push your right arm towards your body until you feel mild tension in the shoulder.
5. Hold the stretch for 10–60 seconds.
6. Repeat on the opposite side.
7. Complete 2-4 repetitions on each side.

Triceps Stretch with Prop

Stretches muscles in the back of the upper arm



Figure 5.5.7: A triceps stretch using a prop. (CC BY-SA 4.0; Danielle Altman)

Instructions

1. Hold one end of a towel or yoga strap in the left hand.
2. Raise and bend the left arm to drape the towel down the back. Keep your left arm in this position, and continue holding onto the towel/strap.
3. Reach behind the lower back and grasp the bottom end of the towel with the right hand.
4. Climb the left hand progressively higher up the towel, which also pulls your right arm down. Continue until your hands touch, or as close to that as you can comfortably go.
5. Hold the stretch for 10–60 seconds.
6. Repeat on the opposite side.
7. Complete 2-4 repetitions on each side.

Overhead Triceps Stretch

Stretches Muscles in the back of the upper arm

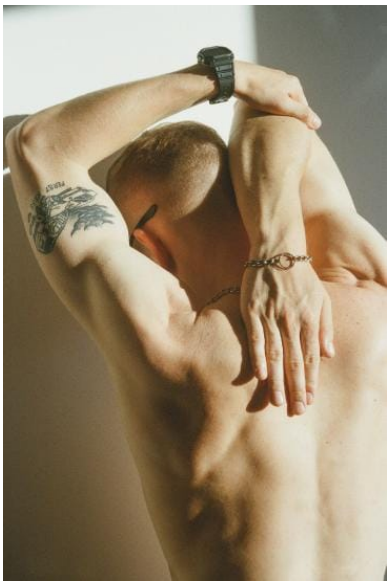


Figure 5.5.8: An overhead triceps stretch. (Topless Man with a tattoo; Sasha Lebedeva via Unsplash)

Instructions

- From a sitting or standing position, raise one arm directly overhead, bending the arm at the elbow to reach towards your back in the middle of the shoulders.
- With the opposite arm, reach across the back of your head and grasp the elbow of the first arm.
- Gently push up and back on your elbow until you feel mild tension.
- Hold the stretch for 10–60 seconds.
- Repeat on the opposite side.
- Complete 2-4 repetitions on each side.

Wall Stretch for the Chest

Stretches the pectoralis major and pectoralis minor (chest)



Figure 5.5.9: A wall stretch for the shoulder and chest. (CC By-SA 4.0; Danielle Altman)

Instructions

- Stand in front of a wall and extend one arm out directly against the wall.
- Keep your feet facing forward, turn away from the wall until you feel a stretch in the chest and upper arm.
- Hold the stretch for 10–60 seconds.
- Repeat on the opposite side.
- Complete 2-4 repetitions on each side.

Wrist Stretch

Stretches the wrist joint.



Figure 5.5.10: The Namaste pose stretches the wrists. (Woman wearing black sports bra; Madison Laverne via Unsplash)

Instructions

1. Place your hands together in a praying position.
2. Slowly raise elbows so arms are parallel to the floor, keeping hands flat against each other.
3. Hold the stretch for 10–60 seconds.
4. Complete 2-4 repetitions.

Floor Exercises

There are a variety of floor exercises. Ideally, completing these using a mat or on carpet can keep the body more comfortable during the stretch.

Tips for Performing Floor Exercises

To get into a lying position:

1. Stand next to a very sturdy chair that won't tip over (put the chair against the wall for support if you need to).
2. Put your hands on the seat of the chair.
3. Lower yourself down on one knee.
4. Bring the other knee down.
5. Put your left hand on the floor and lean on it as you bring your left hip to the floor.
6. Your weight is now on your left hip.
7. Straighten your legs out.

8. Lie on your right and left sides.
9. Roll onto your back.

To get up from a lying position:

1. Roll onto your right or left side.
2. Use your right hand, placed on the floor at about the level of your ribs, to push your shoulders off the floor.
3. Your weight is on your left hip.
4. Roll forward, onto your knees, leaning on your hands for support. Lean your hands on the seat of the chair you used to lie down.
5. Lift one of your knees so that one leg is bent, foot flat on the floor.
6. Leaning your hands on the seat of the chair for support, rise from this position.

Modified Hurdlers Stretch

Stretches the hamstrings, spinal extensors, and calves.

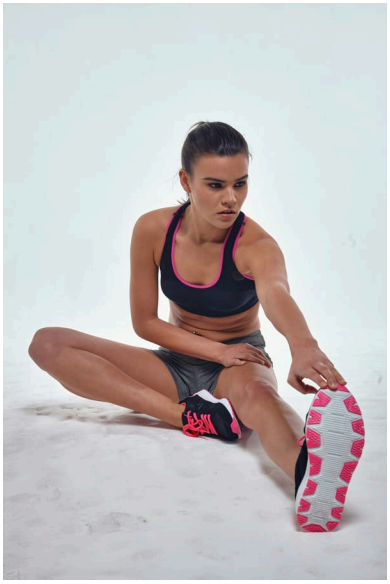


Figure 5.5.11: A modified hurdlers stretch. (Woman in blue tank top; Clem Onojeghuo via Unsplash)

Instructions

1. Sit on the floor and gently extend the right leg.
2. Press the sole of the left foot against the inner right thigh or knee.
3. Keeping your back straight, lean forward at the hips (not waist) and reach forward towards your right foot until you feel mild tension in the straight leg and the lower back.
4. Hold the thigh, shin, or foot with the right hand to maintain the stretch for 15-60 seconds.
5. Repeat on the left side.
6. Complete 2-4 repetitions on each side.

Seated Forward Bend

Stretches hamstrings (back of thighs), calves, and erector spinea (lower back).



Figure 5.5.12: A seated hamstring stretch. (A shirtless man sitting on the floor; GMB Fitness via Unsplash)

Instructions

1. Sit on the floor and extend both legs straight in front of the torso.
   - NOTE: If your lower back is hunched, place a rolled towel or blanket beneath the buttocks to allow the legs to be on a downward slope.
2. Keeping your back straight, lean forward at the hips (not waist) and reach forward towards your feet until you feel mild tension in the back of your legs and your lower back.
3. Hold the thigh, shin, or foot with the right hand to maintain the stretch for 15-60 seconds.
4. Repeat on the left side.
5. Complete 2-4 repetitions on each side.

Hip and Trunk Rotation

Stretches the internal and external obliques, piriformis (hip flexor), erector spinae (lower back), and the gluteals (buttocks).



Figure 5.5.13: A seated twist. (Margaret Young; A woman is sitting on a yoga mat via Unsplash)

Instructions

1. Sit comfortably on the floor with your legs and gently extend the right leg.
2. Bend or left knee and place the heel near your inner thigh with the foot flat on the floor or cross it over your right leg, placing your left ankle against the outside of your right knee.
3. Place your left hand on the floor next to your left hip or slightly behind your left hip.
4. Rotate your trunk to the left (towards the bent leg) using your right elbow to aid in the stretch by placing it on the outside of your left knee (the bent leg).
5. Continue the rotation by taking your gaze behind you if possible.
6. Hold the stretch for 15-60 seconds.
7. Repeat on the left side.
8. Complete 2-4 repetitions on each side.

Neck Rotation

Stretches neck muscles

1. Lie on the floor with a phone book or other thick book under your head.
2. Slowly turn your head from side-to-side, holding the position each time for 10–60 seconds on each side. Your head should not be tipped forward or backward, but should be in a comfortable position. You can keep your knees bent to keep your back comfortable during this exercise.
3. Complete 2-4 repetitions on each side.

Knees to Chest Stretch

Stretches lower back (spinal extensors)

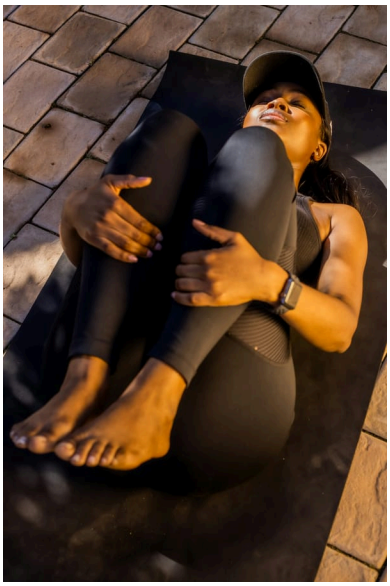


Figure 5.5.14: A knees to chest stretch. (A woman sitting on ground; Mpho Maponyane via Unsplash)

Instructions

1. Lie on the floor on your back, knees bent and feet flat on the floor.
2. Relax your chin slightly towards your chest to maintain a neutral spine.
3. Keep your shoulders on the floor at all times.
4. Keeping knees bent and together, hold the front of your shins or the back of your thighs with your hands.
5. Gently lift the tops of the legs and bring both bent legs as close to the abdomen as possible.
6. Relax your spine and gently allow your back to press into the ground.
7. Hold the stretch for 10–60 seconds.

8. Complete 2-4 repetitions.

- Optional: Rock knees side to side as lower back stays connected to the ground.

Note: From this position, you can transition into the double hip rotation or the single leg extension stretch.

Double Hip Rotation

Stretches the outer muscles of the hips and thighs. If you've had a hip replacement, check with your physician before doing this stretch.

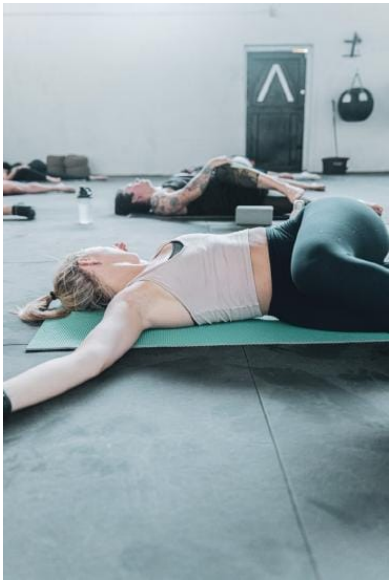


Figure 5.5.15: A lying side stretch, which is a double hip rotation. (Women in white sports bra and black shorts; Logan Weaver by Unsplash)

Instructions

1. Lie on the floor on your back, knees bent and feet flat on the floor.
2. Keep your shoulders on the floor at all times.
3. Keeping knees bent and together, gently lower legs to one side as far as possible without forcing them.
4. Hold position for 10–60 seconds.
5. Return legs to upright position.
6. Repeat toward the other side.
7. Complete 2-4 repetitions on each side.

Single Leg Extension Stretch

Stretches the hip flexors in the front of the thigh.



Figure 5.5.16: A leg extension stretch. (Woman in black tank top and leggings; LittPro Inc via Unsplash)

Instructions

1. Lie on your back with both legs extended straight.
2. Gently bend your right leg and grasp it behind your knee at the back of the thigh, keeping your left leg flat on the ground.
3. While continuing to hold the back of the thigh, slowly extend the right leg straighter overhead.
4. Pull your right leg towards the chest from the back of the thigh until you feel mild tension, the shin, or the foot - depending on your level of flexibility.
5. Hold the stretch for 10-60 seconds.
6. Repeat on the left side.
7. Complete 2-4 repetitions on each side.

Stretches the muscles of the pelvis and inner thigh. If you've had a hip replacement, check with your physician before doing this stretch.

1. Lie on your back on the floor, knees bent and feet flat on the floor.
2. Keep your shoulders on the floor throughout the exercise.
3. Lower one knee slowly to the side, keeping the other leg and your pelvis in place.
4. Hold position for 10–60 seconds.
5. Bring the knee back up slowly.
6. Repeat with the other knee.
7. Complete 2-4 repetitions on each side.

Seated Overhead Reach and Lateral Stretch

Stretches the lateral muscles in the back, internal and external obliques, and spinal extensors.



Figure 5.5.17: A seated side stretch. (Woman in white tank and black pants; Alex Shaw via Unsplash)

Instructions

1. Start in a comfortable seated position with legs crossed or with feet touching in front of the pelvis in a "butterfly" position.
   - Note: If you have knee pain, you can also do this stretch standing.
2. Starting with the torso centered over the pelvis, with both hands touching the ground by your side.
3. Slowly reach one arm up overhead, keeping it in line with your ear, and lean on the opposite arm.
4. Reach the raised arm as far over your head as you can, trying to feel a stretch coming from your hip to your fingertips.
5. Hold position for 10–60 seconds.
6. Gently lower the raised arm to the starting position.
7. Repeat on the opposite side.
8. Complete 2-4 repetitions on each side.

Groin Stretch (Butterfly)

Stretches the hip adductors (inner thigh) and abductors (outer thigh)

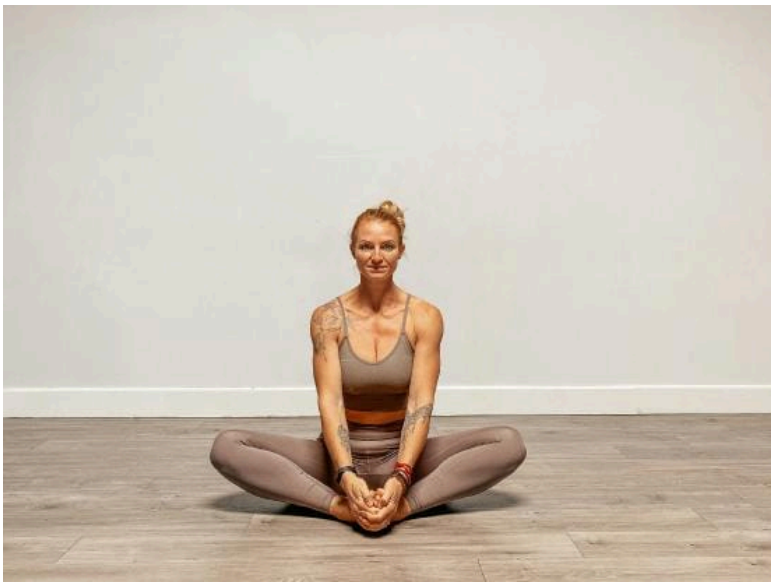


Figure 5.5.18: A butterfly stretch. (A woman sitting on the floor in yoga pose; Heather Jacoby via Unsplash)

Instructions

1. Start in a comfortable seated position with feet touching in front of the pelvis in a "butterfly" position as close to the body as possible. Note: to focus the stretch on your outer thigh, move the feet further from the body and complete the same steps.
2. Keep the back straight and shoulders back.
3. Reach forward and grasp your feet with both hands.
4. Slowly lean forward while bending the elbows, hinging at your hips (avoid arching your back).
5. Press the elbows onto your thighs and bend forward to the point of mild tension in your inner and outer thighs.
6. Hold position for 10–60 seconds.
7. Complete 2-4 repetitions on each side.

Sample "Healthy Back" Exercise Session

Exercise	# of Repetitions	Duration of Exercise	# of Sessions per Week
Cat-Cow Sequence	5-10 cycles	~ 10 seconds per cycle	2 – 3 times
Bird-Dog Hip Extension	5-10 (movement) 2-4 (static)	~ 30- 60 seconds per cycle	2 – 3 times
Glute Bridge	5 times	20 seconds per repetition	2 – 3 times
Side Plank	5 times	20 seconds per repetition	2 – 3 times
Wall Sit (Squat)	5 times	10 – 60 seconds per repetition	2 – 3 times

Table 5.5.2: Sample Stretching Session by Danielle Altman is licensed CC BY-NC 4.0

Exercises for Lower Back

These exercises are designed to strengthen, stretch, and improve the range of motion in the core area to promote a healthier lower back.

Cat-Cow Sequence

This is a movement to improve the range of motion throughout the cervical spine (neck), back, spine and hips.



Figure 5.5.19: The Cat Position in Yoga.



Figure 5.5.20: The Cow Position in Yoga.

Figure 5.5.18 and Figure 5.5.19: (CC BY-SA 4.0; Danielle Altman)

Figure 5.5.19 depicts a woman demonstrating the cat pose position. Her hands and knees are on the ground, shoulder-width apart. Her back is rounded, elongating her spine. Her head is tucked between her shoulders, in the direction of her legs. Figure 5.5.20 depicts a woman demonstrating the cow pose position. Her hands and knees are on the ground, shoulder-width apart. Her chest is lifting while she arches her back and lifts her head.

Instructions

1. Kneel on your hands and knees with the body aligned so that the shoulders are directly above the wrists and the hips are in line with the knees.
2. Begin by pushing your back upward, pulling in your abdomen, and rounding the spine as far as you can comfortably. Try to exhale slowly during this movement.
3. Continue the movement, allowing your head to drop between your shoulders and tucking your pelvis down and under your body.
4. Next, slowly lower your back, shift your pelvis up, and lift your chin slightly until your back is flexed (arched). Try to inhale slowly during this movement.
5. NOTE: In the cow position, make sure to STOP if you feel any pain or discomfort in the back.
6. Complete 5-10 cycles of the back extension and flexion, keeping the movement in a comfortable range of motion.

Bird-Dog Hip Extension

Elongates and builds endurance in the erector spinea (lower back), the multifidus spinae (Upper back), and the abdominals.



Figure 5.5.21: The bird-dog exercise. (CC By-SA 4.0; Tz drunk poet via Wikimedia)

Instructions

1. Kneel on your hands and knees with the body aligned so that the shoulders are directly above the wrists and the hips are in line with the knees.
2. Slowly extend one arm out in front, keeping it at shoulder level. Hold to ensure your body feels balanced.
3. Next, lift the opposite leg straight, keeping your back straight and pulling in your abdominal muscles towards your spine.
4. Hold this position for 5-10 seconds, then alternate to the opposite side (movement series). Complete 5-10 repetitions on each side.
5. Hold 10-60 seconds (static extension), then alternate to the opposite side. Complete 2-4 repetitions on each side.

Glute bridge

Builds strength and endurance in the gluteus maximus (buttocks), erector spinae (lower back), and hamstrings (back of legs)

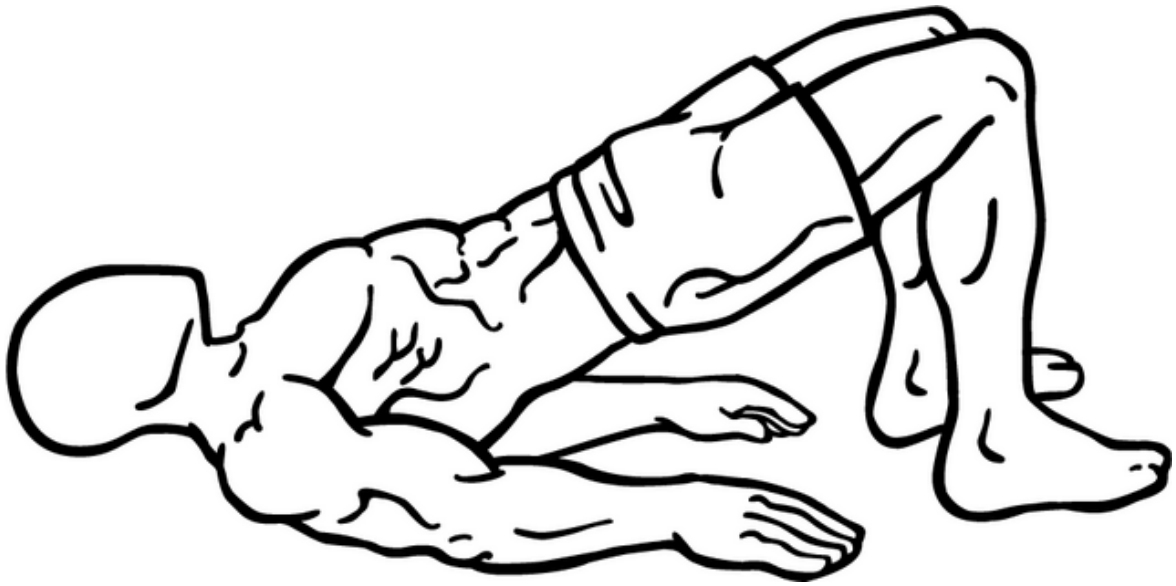


Figure 5.5.22: The glute bridge exercise. (CC BY-SA 3.0; Everkinetic via Wikimedia Commons)

Instructions

1. Lie on the floor on your back with your arms extended along your side and your knees bent with your feet flat on the floor.
2. Keep your spine long, with the chin tucked slightly forward to avoid any arch in the neck.
3. Tuck your pelvis in and tighten your buttocks.
4. Raise your hips so your body weight is supported by the head, shoulders and feet.
5. Hold this position for 10-15 seconds.
6. Repeat 5 times.
7. As you gain strength, increase the hold to 60 seconds or increase the repetitions.

Side Plank

Builds endurance in the hips and abdominal obliques.

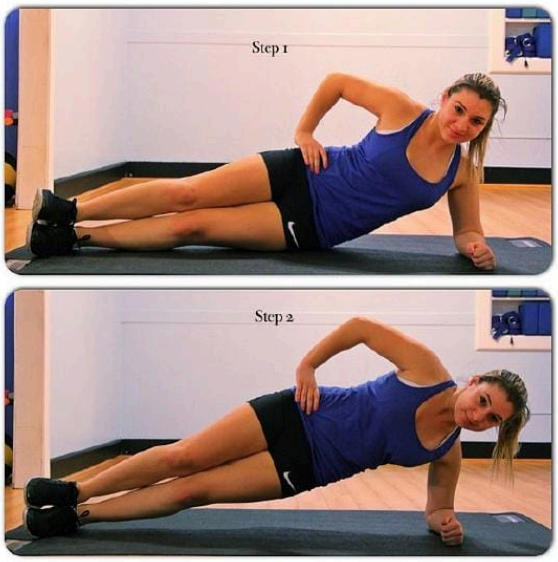


Figure 5.5.23: A woman is demonstrating the side plank. In step one, the left hip rests on the mat; in step two, she pulls her hip up to rest all her weight on her left arm. (CC BY-SA 3.0; Jaykafit via Wikimedia Commons)

Figure 5.5.23 depicts a woman demonstrating the proper form for a forearm side plank. In step 1, she is lying on her side with her top arm on her hip, and her bottom arm has the elbow in line with the shoulder and her forearm extended flat on the mat. Her feet are stacked. In Step 2, she lifts her hips off the ground, maintaining the side body position with her feet, legs, hips, torso, and head aligned.

Instructions

1. Start lying on the floor on your side.
2. Place your top arm alongside your body, across your chest, or on your top hip;
3. Align your elbow with the shoulder of your bottom arm, extending the forearm out in front so there is a 90-degree angle at your elbow joint.
4. Lift your hips so that your weight is supported by your forearm and your feet.
5. To modify, keep the knees on the ground as you lift your hips.
6. Hold the position for 10-15 seconds and lower your hips to the ground.
7. Repeat the exercise 5 times.
8. As you gain strength, increase the time you keep the hips up.

Wall Sit (Squat)

Builds endurance of the quadriceps (front of thighs), hamstrings (back of thighs), gluteus maximus (buttocks), and rectus abdominis (abs).



Figure 5.5.24: A wall squat. (CC BY-SA 4.0; Danielle Altman)

Instructions

1. Stand in front of a wall and lean against it with your back.
2. Walk your feet out a few steps and then bend at your knees and slide down the wall with your torso until you are in a squat position.
3. Keep the knees aligned with the ankles and avoid letting the knees extend past your feet.
4. Body position is similar to sitting in a chair, but lower only to the point you can hold the squat for 10-15 seconds.
5. Hold the position for 10-60 seconds.
6. Repeat 5 times.
7. As you gain strength, increase the time you hold the squats or increase the repetitions.

Key Points

- To create a flexibility program, apply the FITT-VP principle.
- Always warm up before stretching, use slow and controlled movements, and avoid pain—stretching should feel mildly uncomfortable but never hurt.
- Individuals with joint replacements should consult their surgeon before lower-body exercises, and modifications or support (e.g., a chair or partner) can be used as needed.
- The best stretching program uses a variety of muscles, including hamstrings, quadriceps, adductors, abductors, calves, ankles, triceps, and wrists.
- For a healthy lower back, it is important to build endurance in the core muscles - hips, abdominals, and erector spinae.

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5.6: Low Back Fitness

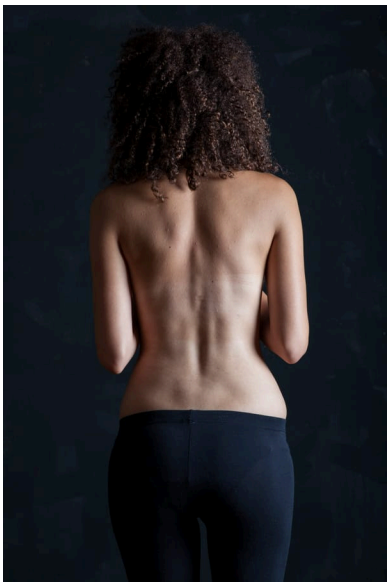


Figure 5.6.1: (Topless women in black skirt; Engin Akyurt via Unsplash)

Introduction

The lower back plays a vital role in supporting posture, enabling movement, and protecting the spinal cord and surrounding structures. Maintaining low-back fitness is essential for overall functional health, especially as it contributes to core stability, balance, and injury prevention. Poor posture, prolonged sitting, and lack of physical activity can all lead to weakness and discomfort in the lower back, which may affect daily activities and long-term well-being. This section will explore the importance of low-back fitness, common risk factors for low-back pain, and effective strategies for strengthening and maintaining a healthy lower back.

Structure and Function of the Spine

The spine, also known as the vertebral column, is a central part of the human skeleton that supports the body and protects the spinal cord. It comprises 33 individual bones called **vertebrae**, which are stacked on top of each other and separated by intervertebral discs that act as cushions. The spine is divided into five regions: cervical, thoracic, lumbar, sacral, and coccygeal. In addition to providing structure and stability, the spine allows for a wide range of movements such as bending, twisting, and rotating. Understanding the structure and function of the spine is important for maintaining posture, preventing injury, and promoting overall musculoskeletal health.

Question

- Does it really matter if I sit up straight?
- What does hunching do to my spine?

- The **cervical**, or neck, has 7 vertebrae.
- The **thoracic**, or upper back, has 12 vertebrae.
- The **lumbar**, or lower back, has 5 vertebrae.
- The **sacrum** is made up of 5 fused vertebrae.
- The **coccyx**, or tailbone, is made up of 4 fused vertebrae.

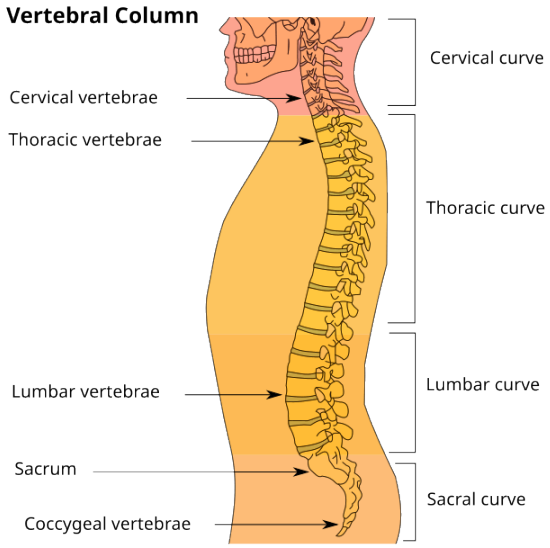


Figure 5.6.2: The human spine, or vertebral column, has five distinct regions: cervical, thoracic, lumbar, sacral, and coccygeal. Each vertebra is stacked in alignment, with intervertebral discs visible between them, providing cushioning and flexibility. (Public Domain by Arcadian via Wikimedia Commons)

A healthy spine looks straight from behind, but as seen in Figure 5.6.2:, it has a natural curve when viewed from the side. The curvature of the spine helps distribute weight evenly and supports movement and posture. Ligaments and muscles envelop the spine both for support and to help the body move. At the top are the cervical vertebrae (7 total), located in the neck. These are the smallest and allow for a wide range of head and neck movement. Below them are the thoracic vertebrae (12 total), which connect to the ribs and help form the upper back and chest. The lumbar vertebrae (5 total) are larger and more robust, located in the lower back, where they support much of the body's weight and allow for bending and twisting. Beneath the lumbar region are the sacral vertebrae (5 fused), forming the sacrum, which connects the spine to the pelvis. Finally, at the base of the spine are the coccygeal vertebrae (usually 4 fused), commonly known as the coccyx or tailbone. Each region plays a unique role in supporting movement, balance, and protection of the spinal cord.

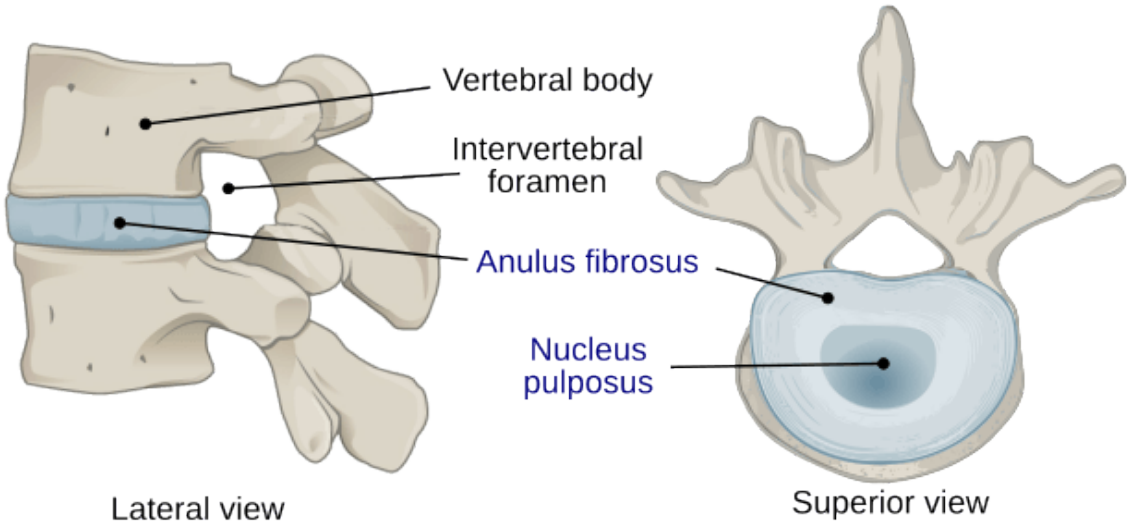


Figure 5.6.3: The lateral and superior view of the vertebral body. (CC BY-SA 3.0; Jmarchn via Wikimedia Commons)

Intervertebral discs lie between the vertebrae as can be seen in Figure 5.6.3. Intervertebral discs are soft, cushion-like structures located between the vertebrae of the spine. Each disc is made up of a tough outer layer called the **annulus fibrosus** and a gel-like inner core called the **nucleus pulposus**. These discs act as shock absorbers, helping to reduce impact during movement, and they also allow for flexibility and slight movement between the vertebrae.

The processes of the spine are bony projections that extend from each vertebra and serve important roles in movement, muscle attachment, and protection of the spinal cord. There are three main types:

1. Spinous process – This is the single, pointed projection that extends backward from the center of each vertebra. It can often be felt through the skin and serves as an attachment point for muscles and ligaments that help control posture and movement.
2. Transverse processes – These are two projections that extend outward from either side of the vertebra. They also provide sites for muscle and ligament attachment and play a role in spinal movement and stability.
3. Articular processes – These include both superior and inferior articular processes, which connect one vertebra to the next. They form facet joints that help guide and limit the movement of the spine while providing additional support.

Together, these processes help maintain spinal structure, enable movement, and allow the spine to bear loads while staying flexible and protected. The processes of the spine, specifically the superior and inferior articular processes, are directly involved in forming synovial joints, known as facet joints or zygapophyseal joints. These joints occur where the inferior articular process of one vertebra meets the superior articular process of the vertebra below it.

Facet joints are synovial joints, meaning they have a joint capsule, synovial fluid, and smooth cartilage surfaces that allow for controlled movement. These joints help guide and limit the movement of the spine—such as bending, twisting, and extension—while providing stability and helping to bear weight. The orientation and condition of these joints influence how much and in which directions the spine can move.

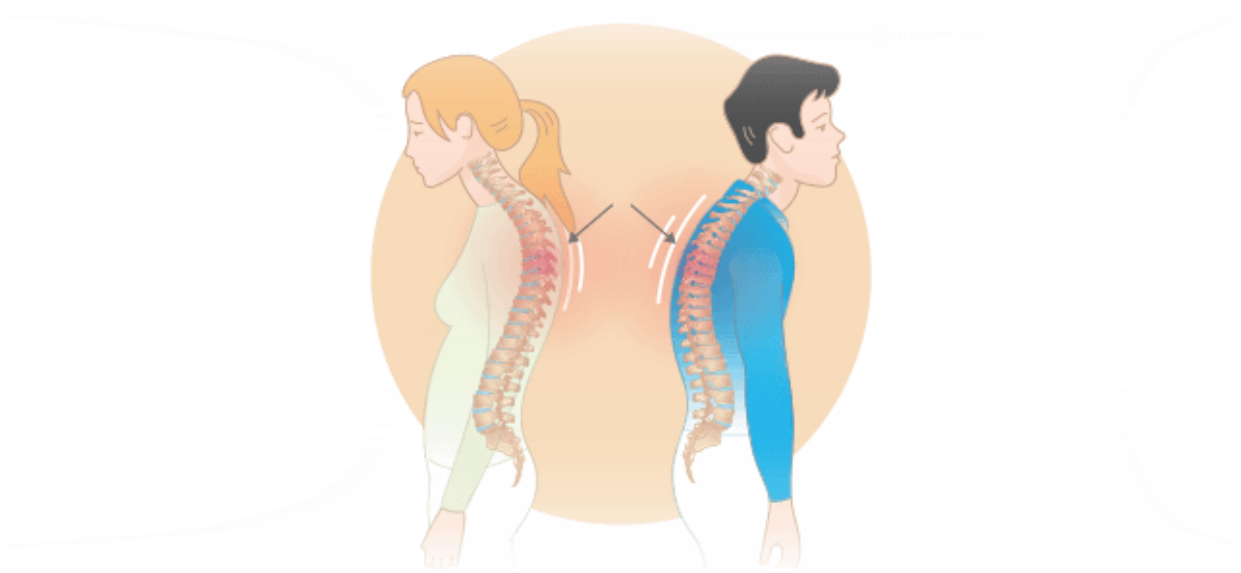


Figure 5.6.4: Slouching can cause back pain. The curve of the spine is affected by poor posture. (CC BY-SA 4.0; InjuryMap via Wikimedia Commons)

Understanding the Anatomy of the Back

There are many different structures in the anatomy of the back that work together to support your body. Problems with any one of these structures can cause back pain.

- There are four regions of the spine:
  - Cervical spine.
  - Thoracic spine.
  - Lumbar spine.
  - Sacrum and coccyx.
- Parts of the spine and back include:
  - Vertebrae – small bones stacked on top of one another, which protect the spinal cord.
  - Spinal cord – a long bundle of nerves that runs down the back through a canal in the vertebrae.
  - Intervertebral discs – cushion-like pads between the vertebrae that act like shock absorbers and spacers for the spine.
  - Ligaments – short bands of tough, flexible tissue that hold the vertebrae in place.

- Tendons – a cord of tissue that connects muscle to bone.
- Muscles – a bundle of dynamic fibers that support your spine and upper body and help you move.

Key Points

- The lower back is essential for posture, movement, and protection of the spinal cord and related structures.
- Maintaining low-back fitness supports core stability and balance, and reduces the risk of injury.
- Common causes of low-back pain include poor posture, prolonged sitting, and inactivity.
- The spine consists of 33 vertebrae divided into five regions: cervical, thoracic, lumbar, sacral, and coccygeal.
- Intervertebral discs between vertebrae act as shock absorbers and allow for spinal flexibility.
- Bony projections on each vertebra—spinous, transverse, and articular processes—support movement and muscle attachment.
- Facet joints, formed by articular processes, are synovial joints that guide and limit spinal movement.
- The spine is supported by a complex system of bones, discs, ligaments, tendons, and muscles working together to enable movement and prevent injury.

Attributions

Betts, J.G., Young, J.A., Johnson, E., et al. *Anatomy and Physiology*. (2013) OpenStax. Houston, TX.

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5.7: Prevention and Management of Low-Back Pain

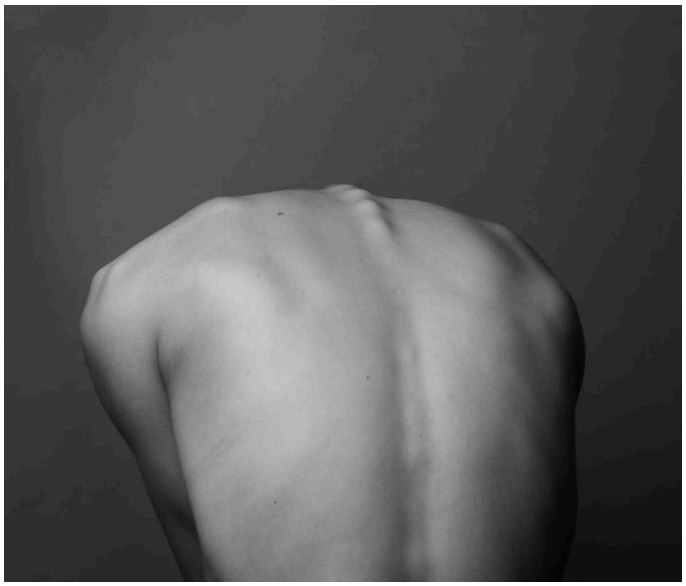


Figure 5.7.1: (Grayscale Photo of Persons Back; Inge Poelman via Unsplash)

Introduction

Back pain is one of the most common medical problems in the United States. It can range from a dull, constant ache to a sudden, sharp pain that may shoot down the leg. Sometimes it can come on suddenly – from an accident, a fall, or lifting something heavy, or it can develop slowly because of age-related degenerative changes in the spine. In some cases, inflammatory arthritis disorders or other medical conditions cause back pain.

Treatment varies depending on the cause and symptoms, and often there are several contributing factors. However, there are steps you can take to improve your health and lower your chance of developing chronic or long-lasting back pain.

Anyone can have back pain, and almost everyone will experience back pain at some point in their life (World Health Organization, 2023). [35] Most people have back pain at some point in their lives. It's one of the most common reasons people visit the doctor or nurse. Many people hurt their backs at work when they lift, push, or pull something too heavy. People are more likely to experience back pain as they get older (Urits et al, 2019). [31] Several factors increase your risk of developing back pain, including:

- **Fitness level:** Back pain is more common among people who are not physically fit. For example, weak back and stomach muscles may not properly support the spine (core strength). Back pain is also more likely if you exercise too strenuously after being inactive for a while (overdoing it).
- **Weight gain:** A diet high in calories and fat, combined with an inactive lifestyle, can lead to obesity. This can put stress on the back.
- **Job-related risk factors:** Jobs that require heavy lifting, pushing, pulling, or twisting can injure the back. A desk job may also play a role, especially if you have poor posture or sit all day in an uncomfortable chair.
- **Stress level:** If you chronically have poor sleep, depression, or anxiety, back pain can be more frequent and more severe.
- **Age:** Back pain becomes more common with age, particularly after the age of 45.
- **Heredity:** Genetics play a role in some disorders that cause back pain.
- **Poor posture**: How you stand, sit, and walk affects the health of the spine. The risk of an injury increases if one doesn't stand and sit up straight.
- **Injury**: Falling or having an accident
- **Health problem**: that causes back pain (like arthritis or cancer)
- **Smoking**

Question

- I exercise and stretch regularly. Am I at risk of having back pain?

There are different kinds of back pain. Back pain varies greatly and can feel like a dull, constant ache or a sudden, sharp pain. Back pain can often get better on its own.



Figure 5.7.2: Back pain can be debilitating. (CC BY 4.0; InjuryMap via Wikimedia Commons)

Doctors and researchers describe the types of back pain in the following ways: Edit section

- **Acute back pain** happens suddenly and usually lasts a few days to a few weeks.
- **Subacute back pain** can come on suddenly or over time and lasts 4 to 12 weeks.
- **Chronic back pain** may come on quickly or slowly, last longer than 12 weeks, and occur daily.

What is the difference between acute and chronic back pain?

- **Acute back pain** is pain that lasts from a few days to a few weeks. It's often caused by an accident, a fall, or lifting something too heavy. Acute back pain usually gets better without any treatment.
- **Chronic back pain** is pain that lasts for more than 3 months. It is much less common than acute back pain. Most chronic back pain can be treated without surgery.

Back pain can range from local pain in a specific spot to generalized pain spreading all over the back. Sometimes the pain radiates away from the back to other areas of your body, such as the buttocks, legs, or abdomen. The intensity of back pain varies for each person (Urits et al, 2019). [31] Depending on the type, causes, and location of your back pain, you may experience:

- Increasing pain with lifting and bending.
- Worsening pain when resting, sitting, or standing.
- Back pain that comes and goes.
- Stiffness in the morning when awakening and lessened back pain with activity.
- Pain that radiates away from the back into the buttocks, leg, or hip.
- Numbness or weakness in your legs or feet.

Low Back Pain?

- I just hurt my back. Should I seek medical attention?

Find out when to call a doctor or nurse

Serious Symptoms:

- Numbness and tingling.
- Severe back pain that does not improve with medication (see Treatment section).
- Back pain after a fall or injury.
- Back pain along with:
  - Trouble urinating.
  - Weakness, pain, or numbness in your legs.
  - Fever.
  - Weight loss that you did not intend.

Back pain can be caused by many different factors, which may all be present at the same time and interact to result in chronic low back pain. These could include mechanical or structural problems with the spine, inflammatory conditions, and other medical conditions (World Health Organization 2023). [35] It is also possible that no specific cause can be identified for the start of back pain.



Figure 5.7.3: Posture during everyday activities that occupy much of our time plays an important role in long-term back health and the prevention of pain. (CC BY 2.0; Nenad Stojkovicvia Wikimedia Commons)

Back pain can happen when mechanical or structural problems develop in the spine, discs, muscles, ligaments, or tendons in the back, or compress a nerve (Urits et al, 2019).[31]

- **Sprain**: an injury to the ligaments that support the spine (which connect the different bones), often occurring from twisting or lifting improperly.
- **Strain**: an injury to a muscle or tendon.
- **Degenerative disc disease**: aging causes the discs between the vertebrae of the spine to break down. It is associated with other degenerative changes in the spine, such as arthritis or spinal stenosis.
- **Herniated or ruptured discs**: an event causing a disc to compress and irritate nearby nerves. This often occurs at the lumbar level but can be present in the cervical spine as well.
- **Spondylolisthesis**: a vertebra in the spine slips out of place or gradually moves out of alignment.
- **Spinal stenosis**: a narrowing of the spinal canal that puts pressure on the spinal cord and nerves.

- Fractured vertebrae.
- **Scoliosis** or other congenital changes to the spine.
- **Myofascial pain**: tightness and pain of the muscles supporting the spine due to damage to the muscles or a result of the nerve input to the muscles coming from the spine.
- **Sciatica**: is a type of back pain that occurs when the **sciatic nerve**—the largest nerve in the body—is compressed or irritated, typically in the lower spine. This condition often results from a herniated disc, spinal stenosis, or **bone spurs** that press on the nerve roots in the lumbar region. Sciatica is characterized by sharp, shooting pain that radiates from the lower back down through the buttocks and into one leg, sometimes reaching the foot. In addition to pain, individuals may experience numbness, tingling, or muscle weakness along the nerve pathway. Sciatica can range from mild to severe and may worsen with prolonged sitting, standing, or certain movements.

More to Explore

- Find out more about injuries and other mechanical and structural problems that can affect the spine such as sprains and strains, Spinal stenosis, Scoliosis, and medical conditions such as Ankylosing spondylitis, Osteoporosis, and Fibromyalgia.

Inflammatory Conditions Edit section

- Ankylosing spondylitis: A specific type of arthritis of the spine.
- Other types of inflammatory arthritis of the spine.

- **Osteoporosis:** A condition that can lead to painful fractures of the vertebrae. It is a medical condition characterized by a decrease in bone density and mass, leading to bones that are weak, brittle, and more prone to fractures. It occurs when the body loses too much bone, makes too little bone, or both, resulting in porous and fragile bone tissue. Osteoporosis is most common in older adults, particularly postmenopausal women, and can affect any bone in the body, though fractures are most common in the spine, hips, and wrists. The condition often progresses silently and painlessly until a fracture occurs, making early prevention and bone health maintenance essential.
- **Fibromyalgia:** A chronic condition characterized by widespread musculoskeletal pain, fatigue, and tenderness in specific areas of the body.
- **Endometriosis:** A is a chronic medical condition in which tissue similar to the lining of the uterus (called the endometrium) grows outside the uterus, often on the ovaries, fallopian tubes, and other pelvic organs.
- **Kidney stones or infections**
- **Infections that involve the bones of the spine or the discs between these bones** can cause back pain.
- **Tumors:** In some rare cases, they develop on the spine or other areas of the back.
- **Pregnancy**

Back pain caused by overuse or improper body mechanics may be preventable (Urits et al, 2019). [31] The following recommendations can support a healthy back and overall lifestyle:

- Engaging in regular exercise helps strengthen back muscles. Activities that improve balance and strength, such as tai chi, yoga, or other weight-bearing exercises that challenge stability, can reduce the risk of falls and back injuries. A proper warm-up is recommended before engaging in any physical activity.
- A nutritious diet that includes adequate calcium and vitamin D is important for maintaining spinal health.
- Maintaining a healthy weight can help reduce unnecessary strain on the back, lowering the risk of injury.
- Practicing good posture and providing proper support to the back while sitting or standing helps prevent back discomfort.
- Heavy lifting should be avoided when possible. When lifting is necessary, the legs and abdominal muscles should be used rather than the back to minimize the risk of strain or injury.

Question

- Are there specific exercises I can do to prevent back pain?Edit section

Wellness Strategies for the Low-Back

Taking care of the back is essential to avoid back pain, as prevention is often easier and more effective than treatment.

There are strategies individuals can use to strengthen their back and reduce the risk of back pain (Hayden et al, 2021). [15]

- Do back-strengthening and stretching exercises at least 2 or 3 times a week.
- Try a yoga class. It can help stretch and strengthen muscles and improve your posture.
- Stay active. Regular physical activity can help keep your back muscles strong. Aim for 2 hours and 30 minutes of moderate activity a week.

Individuals with health conditions can consult their doctor to determine the most suitable activities for their needs.

More to Exlpore

Do you have any health conditions that might be impacting your back health? Get tips on staying active with a disability.

Maintaining good posture can help prevent back pain (Hayden et al, 2021). [15] In general:

- Slouching should be avoided when standing or sitting.
- While seated, the back should rest against the chair with feet flat on the floor and knees positioned slightly higher than the hips.
- When standing, individuals should keep their head up and shoulders back to promote proper alignment.

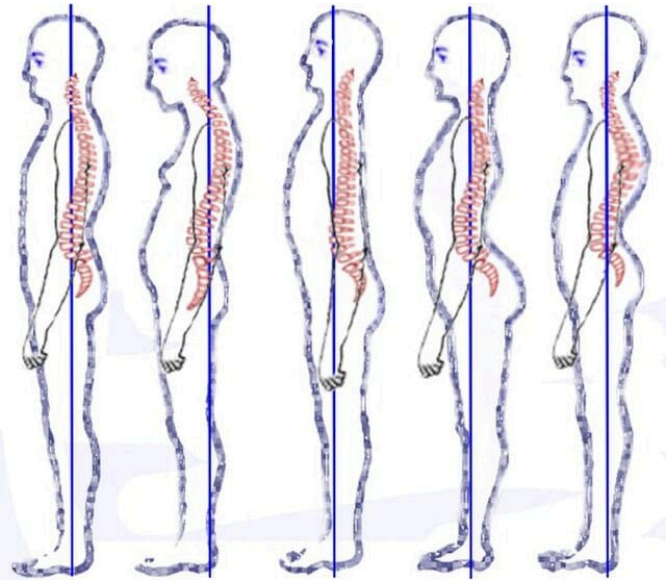


Figure 5.7.4: This image shows five different types of spinal posture, ranging from poor to ideal alignment. The figure on the far left represents good posture, where the ears, shoulders, hips, knees, and ankles align vertically, and the natural curves of the spine are maintained. The other figures illustrate various postural deviations such as forward head posture, exaggerated lumbar or thoracic curves, and slouched alignment. Good posture helps reduce strain on the spine, supports muscle balance, and can prevent back pain and fatigue. (Public Domain by V-Ugnivenko via Wikimedia Commons)

Slouching places extra pressure on the spine, particularly in the lower back and neck, which can lead to muscle strain, poor spinal alignment, and long-term discomfort or pain. It often occurs unconsciously, especially during prolonged sitting, working at a computer, or using mobile devices. Because it's easier to let the body relax into a slouched position than to maintain an upright posture, slouching can quickly become a habitual source of back problems.

Question

- What can I do to improve my posture?

Standing

Maintaining good posture while standing helps keep the spine properly aligned, reducing strain on muscles, ligaments, and joints. It also supports balance, reduces fatigue, and can help prevent back and neck pain (Harvard Health Publishing, 2018). [13]

- Hold the head up, keeping the neck straight and the chin neutral.
- By keeping the earlobes in line with the middle of the shoulder, shoulder blades back, chest forward, and abdomen pulled in.
- The pelvis should be straight, without being tilted forward or backward.
- Maintain a "neutral spine": Strive to keep the spine's natural curve in the upper and lower back.

Walking

Walking with poor posture, such as slouching or leaning forward, can disrupt spinal alignment and place uneven stress on the muscles and joints of the back. Over time, this may lead to muscle fatigue, lower back pain, and reduced mobility (Harvard Health Publishing, 2021). [12]

- Maintain good standing posture while walking
- Keep your head up: Gaze forward (not down) about 10–20 feet ahead to maintain neutral neck alignment.
- Engage your core: Lightly activate your abdominal muscles to support your spine and reduce sway in your lower back.
- Relax your shoulders: Keep them down and slightly back—avoid hunching or rounding forward.
- Swing your arms naturally: Let your arms move with the opposite leg in a relaxed, rhythmic motion—elbows bent around 90 degrees.
- Align your spine: Imagine a straight line from the top of your head down through your spine—avoid excessive leaning forward or arching backward.
- Step with purpose: Roll from heel to toe with each step; avoid stomping or shuffling.
- Distribute your weight evenly: Avoid favoring one side—balance your stride and foot pressure.
- Wear supportive shoes: Choose shoes with good arch support and cushioning to promote healthy walking mechanics

Sitting

Prolonged sitting, especially with poor posture, increases pressure on the intervertebral discs and can lead to spinal misalignment, muscle imbalances, and lower back pain. Over time, it may contribute to the degeneration of spinal structures and reduced flexibility (UCLA, n.d.). [32]

- Sit all the way back in your chair: Your back should be fully supported by the backrest, especially the lumbar region
- Keep feet flat on the floor: Avoid crossing your legs. Your knees should be at or just below hip level.
- Align ears, shoulders, and hips: These should be in a straight vertical line to avoid forward head posture or slouching.
- Use a small cushion or lumbar roll: Placing support at the lower back helps maintain the spine's natural curve.
- Relax your shoulders: Keep them down and back, not hunched or elevated.
- Adjust your screen height: The top of your computer screen should be at or slightly below eye level to prevent neck strain.
- Keep forearms parallel to the floor: Your elbows should rest close to your body at a 90–120 degree angle.
- Take regular breaks: Stand up and stretch or walk every 30–60 minutes to reduce muscular fatigue and improve circulation.

Lifting

Improper lifting, such as bending at the waist or twisting while carrying a load, places excessive stress on the spine and can strain or damage muscles, ligaments, and intervertebral discs. This increases the risk of acute injuries like herniated discs and chronic lower back pain (Stanford Environmental Health & Safety, n.d.). [29]

- Maintain good posture while lifting.

- Plan the lift before starting: Check the object's weight, remove obstacles, and determine your path.
- Get close to the object: Stand with your feet shoulder-width apart, as close to the object as possible to reduce leverage on the spine.
- Keep a straight back and neutral spine: Avoid rounding the back; maintain the natural curve of your spine throughout the lift.
- Bend at the hips and knees—not the waist: Use your legs to squat down to the object rather than bending over.
- Tighten your core muscles: Engage your abdominal and back muscles to support the spine during the lift.
- Lift with your legs: Straighten your knees and hips as you rise, keeping your back upright and the load close to your body.
- Avoid twisting or turning: Pivot with your feet instead of twisting your spine while holding the object.
- Hold the object close to your body: Keep it at about waist height to reduce strain on your arms and back.
- Use assistive devices or ask for help when needed: If the load is too heavy or awkward, use tools or get assistance.

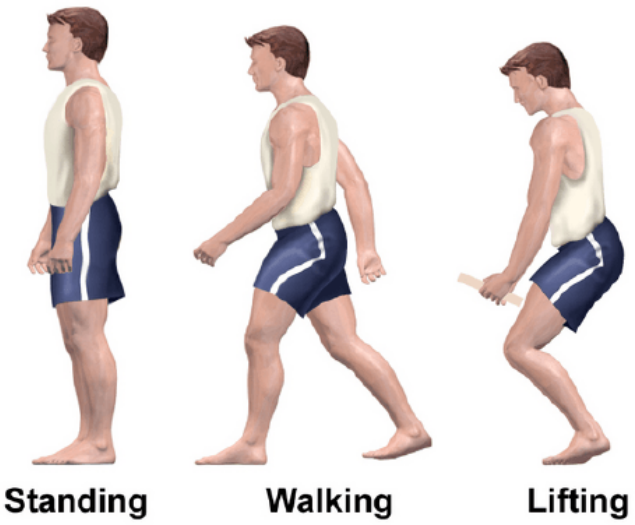


Figure 5.7.5: Examples of good posture. (CC BY-SA 4.0; BruceBlaus via Wikimedia Commons)

Objects should be lifted using the legs rather than the back. The back should remain straight while bending at the knees or hips, as demonstrated in Figure 5.7.5. As can be seen in Figure 5.7.6, the improper way of lifting puts stress on the spine, rather than using the legs to take the primary load. Remember, assistance should be sought if the load is too heavy to lift alone.



Figure 5.7.6: There is a right way, and a wrong way, to lift heavy objects. (Public Domain via Wikimedia Commons)

Smarter Smartphone Use

Using a cell phone for prolonged periods can negatively affect the spine, particularly the cervical (neck) region. When individuals tilt their heads forward to look at a screen, often referred to as “text neck,” it increases the load on the cervical spine significantly. Research has shown that a head tilted at a 60-degree angle can place as much as 60 pounds of force on the neck (Hansraj, 2014). [11] Over time, this poor posture can lead to muscle strain, disc compression, and even long-term spinal misalignment or degeneration. In addition to neck pain, users may also experience upper back and shoulder discomfort, emphasizing the importance of maintaining good posture and taking regular breaks during device use (Elvan et al, 2024). [7]

- Raise the device to eye level to avoid tilting your head downward, which can strain the neck and upper back (known as “text neck”).
- Keep shoulders relaxed and not hunched; maintain a neutral shoulder position to avoid muscle tension.
- Use both hands to hold the phone and type with both thumbs to distribute movement evenly and reduce overuse injuries.
- Take frequent breaks (every 20–30 minutes) to stretch and reset posture.
- Engage your core and sit upright if using the phone while seated—avoid slumping or leaning back excessively.
- Avoid prolonged use while lying down to prevent neck twisting or awkward spinal alignment.

Question?

- Why does using your cell phone affect your posture?
- How can you maintain proper posture while using your cell phone?

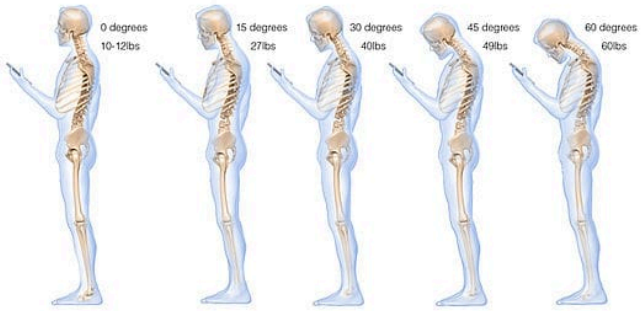


Figure 5.7.7: This image illustrates how poor posture, often associated with texting or mobile phone use, can significantly strain the neck and upper back. (CC BY-SA 3.0 by Dr. Kenneth Hansraj via Wikimedia)

This illustration compares five side-view skeletal figures, each holding a phone in the same raised position, but with the head and neck tilted forward at a different angle — 0, 15, 30, 45, and 60 degrees. As the tilt increases, you can see the cervical spine curve progressively more forward in each figure. Alongside each angle is the corresponding load that the tilt places on the neck: at 0 degrees, with the head balanced upright, it carries its normal weight of about 10 to 12 pounds. But at just 15 degrees of forward tilt, that effective load jumps to 27 pounds. At 30 degrees it’s 40 pounds, at 45 degrees it’s 49 pounds, and by 60 degrees — a fairly extreme downward tilt — the neck is effectively supporting 60 pounds, roughly five times the head’s actual weight. The image is a visual way of showing how “text neck” posture dramatically increases strain on the cervical spine the further forward the head drops.

Dr. Kenneth Hansraj conducted a study titled *Assessment of Stresses in the Cervical Spine Caused by Posture and Position of the Head*, which examined how different head positions affect the pressure on the neck. His findings showed that when the head is aligned upright in proper posture, it exerts about 10 pounds of force on the cervical spine. However, when the head is tilted forward at a 60-degree angle—such as when looking down at a phone—the effective weight on the neck increases dramatically to

approximately 60 pounds (Hansraj, 2014). [11]

Prevent back injuries when working at a desk

Having proper ergonomics when working at a desk on a computer can be essential for preventing back pain. Back injuries are the most common type of workplace injury. Figure 5.7.8 depicts proper ergonomics for sitting at a desk and working on a computer. Proper ergonomics at a desk or computer workstation is essential for preventing strain and promoting long-term musculoskeletal health. An ergonomic setup should ensure that the monitor is at eye level, approximately an arm's length away, to prevent neck strain. The chair should support the natural curve of the spine, with feet flat on the floor and knees at a 90-degree angle. Wrists should remain in a neutral position while typing, with forearms parallel to the floor. Regular breaks to stand, stretch, or walk can also help reduce the risk of repetitive strain injuries and improve circulation. Maintaining good posture and an ergonomically sound workspace can significantly enhance comfort and productivity throughout the workday (Harvard Health Publishing, 2021). [14]



Figure 5.7.8: This setup supports good posture and can help prevent repetitive stress injuries and discomfort during prolonged periods of sitting and typing. Note that the individual is seated with her back supported, arms and legs forming 90-degree angles, and feet flat on the floor, which helps reduce strain on joints and muscles. The monitor is positioned 24 to 30 inches away at eye level, minimizing neck strain and promoting a neutral head and spine position. (CC BY-SA 4.0; onlinetyping.org via Wikimedia Commons)

Sleeping

There are a variety of ways to sleep to help prevent back pain. Sleeping in a position that supports the natural curve of the spine is important for managing and preventing back pain. For many people, sleeping on their backs with a pillow under the knees helps maintain proper spinal alignment by reducing pressure on the lower back. Side sleepers can benefit from placing a pillow between their knees to keep the hips, pelvis, and spine aligned. It's generally recommended to avoid sleeping on the stomach, as this position can strain the neck and lower back. Using a supportive mattress and pillow that keeps the spine in a neutral position can also improve sleep quality and reduce discomfort. Establishing good sleep posture is a simple yet effective strategy for relieving back pain and promoting spinal health (Salamon, 2022). [30]

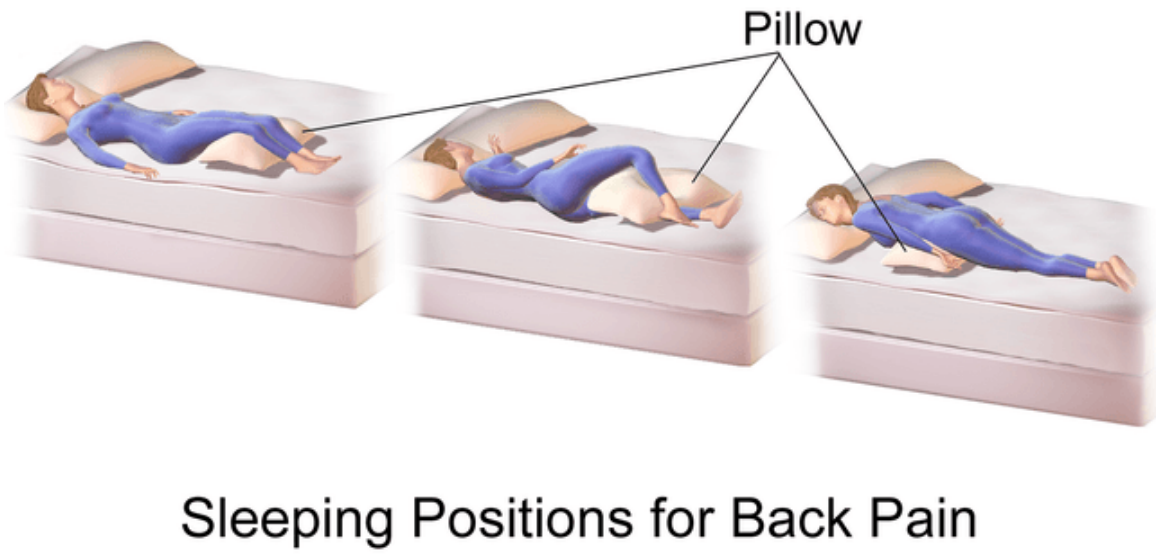


Figure 5.7.9: Support during sleep is important due to the length of exposure. Six to eight hours of sleep per night translates to 25-33% of our lives spent in bed. (CC BY-SA 4.0; BruseBlaus via Wikimedia Commons)

Maintain a healthy body weight

Having a healthy body weight can help reduce the strain on the back. Being overweight can significantly contribute to back pain by placing additional stress on the spine and supporting structures. Excess body weight, particularly around the abdomen, shifts the body's center of gravity forward, which can strain the lower back and lead to poor posture. This increased load on the spine can accelerate the wear and tear on intervertebral discs and joints, potentially leading to conditions such as herniated discs or osteoarthritis. Additionally, excess weight may contribute to inflammation and decreased physical activity, both of which can further exacerbate back discomfort. Maintaining a healthy weight through balanced nutrition and regular exercise is an important strategy for reducing the risk and severity of back pain.

Get enough calcium and vitamin D

Getting enough calcium and vitamin D plays a crucial role in maintaining strong bones and preventing back pain. Calcium is essential for building and preserving bone mass, while vitamin D helps the body absorb calcium effectively. Together, they support the structural integrity of the spine and reduce the risk of conditions like osteoporosis, which can lead to weakened vertebrae and increased susceptibility to fractures and chronic back pain. Spine fractures from osteoporosis are a leading cause of back pain. Adequate intake of these nutrients, through diet or supplements if needed, is particularly important as people age and bone density naturally declines. Supporting bone health through proper nutrition is a key component in the prevention and management of back-related issues.

Living with back pain can be challenging; however, most individuals experience relief within approximately six weeks (Urits et al, 2019). [31] It is important to follow the recommendations provided by healthcare professionals. The following strategies may help in managing pain and supporting recovery:

- Exercises should be introduced gradually, and individuals should consult their healthcare provider to determine which types are most appropriate, as some activities may need to be avoided.
- When sitting for extended periods, it is beneficial to stand up, move around, and change positions frequently.
- Wearing comfortable, low-heeled shoes can help reduce strain on the back.
- During long drives, using lumbar support and taking regular breaks to stand and walk can alleviate discomfort.
- Sleeping on the side with a small pillow between the knees is recommended. If sleeping on the back, a pillow under the knees may provide relief. Sleeping on the stomach is best avoided when possible.
- Limiting the weight of items carried can help reduce back strain; making multiple trips is preferable to carrying excessive loads at once.
- Reflecting on one's relationship with pain can be helpful—rather than letting pain take control, individuals can explore coping strategies, such as focusing on meaningful activities or finding ways to manage discomfort effectively.

Key Points

- Back pain is extremely common, affecting nearly everyone at some point, and is a leading reason for doctor visits in the U.S.
- Causes of back pain vary, including injuries, poor posture, lack of fitness, aging, stress, inflammatory diseases, and other medical conditions like arthritis, osteoporosis, and fibromyalgia.
- Risk factors include low physical fitness, excess body weight, job-related strain, stress, smoking, poor posture, and aging.
- Types of back pain are classified as acute (lasting a few days to weeks), subacute (4–12 weeks), and chronic (lasting longer than 12 weeks).
- Symptoms range widely, from dull aches to sharp, radiating pain; they can include numbness, stiffness, and worsened pain with certain activities or positions.
- Serious signs include pain with fever, weight loss, numbness, or difficulty urinating, and should be evaluated by a doctor.
- Structural causes include sprains, strains, herniated discs, spinal stenosis, scoliosis, and conditions like sciatica.
- Inflammatory and medical conditions, such as ankylosing spondylitis, infections, tumors, or endometriosis, can also lead to back pain.
- Prevention strategies include regular exercise, good posture, weight management, proper lifting techniques, and adequate intake of calcium and vitamin D.
- Managing back pain involves gradual exercise, ergonomic support, posture correction, comfortable footwear, good sleep habits, and emotional coping strategies.

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5.8: Comprehension Check

Summary

Flexibility, one of the five health-related components of fitness, refers to the ability of muscles and joints to move through their full range of motion (ROM) without pain or restriction. It is essential for everyday movement, athletic performance, injury prevention, and overall physical health. Flexibility can be categorized into static (measured while holding a stretch with passive force) and dynamic (measured during movement using active muscle contractions). While flexibility levels vary by individual and are influenced by both controllable and uncontrollable factors, maintaining a healthy ROM is more important than being extremely flexible. Incorporating regular stretching into a fitness routine helps support mobility, reduce muscle tension, and enhance quality of life.

The benefits of flexibility are wide-ranging. Improved flexibility enhances joint mobility, helps prevent injuries, and reduces muscle soreness after physical activity. It also promotes better posture and balance, supports efficient movement patterns, and can contribute to stress relief and relaxation. Incorporating regular stretching into a fitness routine can help individuals move more freely and comfortably throughout their day.

Several factors affect flexibility, including age, gender, genetics, physical activity, and muscle temperature. Flexibility tends to decrease with age, but regular stretching can slow or reverse this process. People who are inactive or who perform repetitive movements may develop muscle tightness and imbalances. Warming up before stretching, maintaining a healthy weight, and staying active all contribute to improved flexibility.

It is important to create an effective stretching program. A well-designed program includes warm-up exercises, static and dynamic stretches targeting major muscle groups, and consistency in practice. The routine should be tailored to individual needs and fitness levels, ensuring that stretches are performed safely and gradually. With commitment and proper technique, flexibility training can improve quality of life and physical function.

Low-back fitness is especially important because the lower back plays a central role in supporting posture, enabling movement, and protecting the spine. Weakness, poor posture, and prolonged sitting can lead to discomfort and injury in the lower back. Strengthening the core muscles, maintaining spinal alignment, and engaging in regular physical activity can help reduce the risk of low-back pain. To prevent and manage low-back pain and improve flexibility, there are many strategies, such as maintaining good posture while sitting, standing, walking, lifting, and sleeping. Good ergonomics is also essential both when working on a computer and using a cell phone.

Test Your Understanding

1. Define flexibility and describe the benefits of increased flexibility.
2. Identify the factors that can affect flexibility. Which factors can be controlled and how?
3. Identify the basic functions of the spine.
4. Explain the exercise prescription recommendations for a basic flexibility program.
5. What is low-back fitness and why is it important?
6. Identify t3 factors that can help prevent low-back pain.

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Chapter 5 Glossary

- **Active Stretching**: A type of stretching where the individual uses their own muscles to hold a stretch without the assistance of an external force.
- **Annulus Fibrosus**: The tough outer layer of an intervertebral disc that surrounds the nucleus pulposus and provides structural integrity.
- **Arthritis**: A condition involving inflammation of the joints, leading to pain, stiffness, and reduced mobility.
- **Articular Cartilage**: Smooth cartilage that covers the ends of bones at synovial joints to allow for smooth movement and reduce friction.
- **Articular Surfaces**: The surfaces of bones that come into contact at a joint.
- **Autogenic Inhibition**: A reflex relaxation of the muscle in response to high tension, often activated during stretching.
- **Ball-and-Socket Joints**: Joints that allow movement in all directions, such as the shoulder and hip.
- **Ballistic Stretching**: A type of stretching that uses bouncing or jerking movements to increase range of motion.
- **Cartilage**: A flexible connective tissue found in joints, providing cushioning and reducing friction between bones.
- **Cartilage of a Joint**: Refers to the specific cartilage (often articular) within a joint that helps absorb shock and enable smooth movement.
- **Cartilaginous Joints (Amphiarthroses)**: Joints connected entirely by cartilage, allowing limited movement.
- **Cervical**: Relating to the neck region of the spine, which includes seven vertebrae.
- **Coccygeal**: Pertaining to the coccyx or tailbone, the lowest part of the vertebral column.
- **Coccyx**: The small, triangular bone at the base of the spine, commonly referred to as the tailbone.
- **Collagen:** The main protein found in the body's connective tissues, giving strength, structure, and flexibility to the skin, bones, tendons, ligaments, and cartilage.
- **Condyloid Joints**: Joints that allow movement in two planes without rotation, such as the wrist joint.
- **Connective tissue:** A type of tissue that supports, connects, or separates parts of the body. It includes ligaments, tendons, cartilage, bone, fat, and blood, and provides structure, protection, and flexibility through proteins like collagen and elastin.
- **Contraindicated stretches:** Stretching exercises that are considered unsafe or potentially harmful, especially when performed incorrectly or by individuals with certain limitations. These stretches may place excessive stress on joints, muscles, or ligaments and increase the risk of injury.
- **Degenerative Disc Disease**: A condition where intervertebral discs lose flexibility and cushioning, often causing pain.
- **Dynamic Flexibility**: The ability to move joints through their full range of motion during active movements.
- **Dynamic Stretching**: A form of stretching involving movement to increase flexibility and warm up muscles.
- **Endometriosis**: A disorder in which tissue similar to the lining of the uterus grows outside the uterus, often causing pelvic pain.
- **Ergonomics**: The study and design of work environments to promote efficiency and reduce strain on the body.
- **Fibromyalgia**: A chronic condition characterized by widespread musculoskeletal pain, fatigue, and tender points.
- **Fibrous Joints (Synarthroses)**: Joints connected by dense connective tissue, allowing little or no movement.
- **Flexibility**: The ability of a joint or group of joints to move through their full range of motion (ROM) without pain, discomfort, or restriction. It depends on the length and elasticity of muscles, tendons, and ligaments, as well as joint structure and nervous system function. Flexibility is essential for efficient movement, injury prevention, and overall physical function.
- **Goniometers**: Instruments used to measure the range of motion in a joint.
- **Golgi Tendon Organs (GTOs)**: Sensory receptors in tendons that detect changes in muscle tension and help prevent injury.
- **Herniated or Ruptured Discs**: A condition where the inner nucleus pulposus protrudes through the outer annulus fibrosus, potentially compressing spinal nerves.
- **Hinge Joint**: A joint that permits movement in one direction, such as the elbow or knee.
- **Hypermobility**: A condition where joints move beyond the normal range of motion, often due to genetic factors.
- **Inactivity-Mobility Cycle** is a self-reinforcing pattern in which reduced physical activity leads to decreased joint mobility and flexibility, which in turn makes movement more difficult and uncomfortable. As mobility declines, individuals tend to become even less active, further worsening mobility. This cycle can contribute to muscle stiffness, joint pain, and a decline in overall physical function and quality of life.
- **Inclinometers**: Devices used to measure the angle of joint movement or spinal curvature.
- **Individual Differences, Principle of**: The concept that flexibility programs should be tailored to an individual's unique body structure, capabilities, and needs.
- **Intervertebral Discs**: Cushion-like pads between the vertebrae that absorb shock and allow movement in the spine.
- **Inverse Myotatic Reflex**: A protective reflex that causes a muscle to relax when there is excessive tension, often mediated by the Golgi tendon organs.

- **Joint**: A location where two or more bones meet, allowing for varying degrees of movement.
- **Joint Capsule**: A fibrous tissue envelope that encloses a synovial joint, providing stability while allowing movement.
- **Joint Structure**: The anatomical features of a joint, including bones, cartilage, ligaments, and the joint capsule, that influence movement and flexibility.
- **Ligaments**: Strong bands of connective tissue that connect bones at joints and provide stability.
- **Lumbar**: Refers to the lower back region of the spine, consisting of five vertebrae.
- **Muscle Spindles**: Sensory receptors within muscles that detect changes in length and help regulate muscle contraction.
- **Myofascial Pain**: Pain that originates from the muscle and connective tissue (fascia), often due to trigger points.
- **Neutral Spine**: A posture where the natural curves of the cervical, thoracic, and lumbar spine are maintained in proper alignment.
- **Nucleus Pulposus**: The soft, gel-like center of an intervertebral disc that helps absorb compressive forces.
- **Osteoarthritis**: A degenerative joint disease characterized by the breakdown of cartilage, leading to pain and stiffness.
- **Osteoporosis**: A condition where bones become weak and brittle due to low bone mass and density.
- **Passive Forces**: External forces that assist in stretching a muscle, such as gravity, a partner, or equipment.
- **Passive Stretching**: A type of stretching in which an external force is used to help stretch the muscle.
- **Pivot Joints**: Joints that allow rotation around a single axis, such as the joint between the first and second cervical vertebrae.
- **Plane (Gliding) Joints**: Joints that allow sliding or gliding movements, typically found in the wrists and ankles.
- **Proprioceptors**: Sensory receptors that provide information about body position and movement.
- **Proprioceptive Neuromuscular Facilitation (PNF) Stretching**: An advanced form of flexibility training involving both stretching and contracting the muscle being targeted.
- **Range of Motion (ROM)**: The full movement potential of a joint, usually its range of flexion and extension.
- **Reciprocal Inhibition**: A neuromuscular response where the contraction of one muscle leads to the relaxation of its opposing muscle.
- **Rheumatoid Arthritis**: An autoimmune disorder causing chronic inflammation of joints, leading to pain and potential joint deformity.
- **Sacral**: Pertaining to the sacrum, the triangular bone at the base of the spine, formed by five fused vertebrae.
- **Sacrum**: A large, triangular bone at the base of the spine that connects to the pelvis.
- **Saddle Joints:** A type of synovial joint where the articulating surfaces of the bones are shaped like a saddle—concave in one direction and convex in the other. This unique structure allows movement in two planes: flexion/extension and abduction/adduction, making the joint biaxial.
- **Sciatica**: Pain that radiates along the sciatic nerve, typically from the lower back through the hip and down the leg, often caused by nerve compression.
- **Shoulder Flexibility Test**: An assessment that measures the range of motion in the shoulders.
- **Sit-and-Reach Test**: A common test to measure flexibility in the hamstrings and lower back.
- **Skeletal Muscle**: Muscle attached to bones that allows voluntary movement and is involved in posture and stability.
- **Scoliosis**: A lateral curvature of the spine that can lead to imbalance and back pain.
- **Spine**: Also called the vertebral column or backbone, is the central support structure of the body. It is made up of 33 individual bones called vertebrae, which are stacked in a column and separated by intervertebral discs. The spine protects the spinal cord, supports the head and torso, and allows for a wide range of movement while maintaining stability.
- **Spinal Stenosis**: A narrowing of the spinal canal that can compress nerves, leading to pain, numbness, or weakness.
- **Spondylolisthesis**: A condition in which one vertebra slips forward over the vertebra below it, often causing back pain.
- **Sprain**: An injury to a ligament caused by overstretching or tearing.
- **Straight Leg Test (SLT)** is a flexibility assessment used to measure the flexibility of the hamstring muscles (the muscles located at the back of the thigh).
- **Static Flexibility**: The ability to hold a stretch at the end of a joint's range of motion.
- **Static Stretch**: A stretch that is held in a challenging but comfortable position for a period of time.
- **Stretch Reflex or Myotatic Reflex**: An automatic muscle contraction in response to stretching within the muscle.
- **Synovial Fluid**: A thick, slippery fluid found within synovial joints. It is produced by the synovial membrane and serves several important functions: lubricating the joint to reduce friction between the articulating bones, supplying nutrients to the cartilage, and acting as a shock absorber to protect the joint during movement. This fluid is essential for maintaining healthy, pain-free joint motion.
- **Synovial joints (Diarthroses):** The most common and most movable type of joint in the human body. These joints are characterized by a fluid-filled joint cavity enclosed by a joint capsule, which allows for smooth movement between the articulating bones. The synovial fluid within the cavity reduces friction, nourishes the cartilage, and absorbs shock. Examples of synovial joints include the knee, shoulder, elbow, and hip, each allowing varying types and ranges of motion depending on their structure.
- **Strain**: An injury to a muscle or tendon caused by overstretching or tearing.
- **Thoracic**: Pertaining to the middle section of the spine, consisting of twelve vertebrae connected to the ribs.

- **Trunk Rotation Test**: A test used to assess the rotational flexibility of the torso and spine.
- **Vertebrae**: The individual bones that make up the spinal column.
- **Vertebral Column**: Also known as the spine or spinal column, is a series of interconnected bones called vertebrae that extend from the base of the skull to the pelvis. It supports the body's weight, protects the spinal cord, and allows for flexible movement. The vertebral column is divided into five regions: cervical, thoracic, lumbar, sacral, and coccygeal.

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6: BODY COMPOSITION



Figure 6.1: Body composition can vary greatly between human beings. (CC BY-SA 4.0; Buggas beauty care via Wikimedia Commons)

Introduction to Body Composition

Body composition is the relative amounts of fat mass, muscle, bone, and other tissues in the body, and it is a key indicator of health and physical fitness. While body weight alone is often used to assess health, it does not reveal how much of that weight comes from fat versus lean tissue. Two individuals may weigh the same, but if one has a higher proportion of muscle and the other a higher proportion of fat, their health risks and physical performance can differ significantly.

Maintaining a healthy weight and body composition is essential for overall health, as it helps reduce the risk of chronic diseases such as diabetes, heart disease, and cancer. Excess body fat, especially when accumulated in certain areas, can negatively affect vital functions, while an appropriate balance of fat supports overall well-being. Achieving and sustaining a healthy weight involves more than just dietary changes; it requires personalized goals, balanced physical activity, and evidence-based strategies like behavior change techniques and SMART goals.

Understanding body composition is a tool for promoting lifelong health and well-being. By studying the factors that influence body composition, including genetics, nutrition, physical activity, and environment, one can gain insight into assessing, maintaining, and improving health in oneself and others. This chapter explores the science of body composition, the health risks of imbalance, and strategies for achieving a healthy balance of fat and lean mass.

Learning Objectives

- Explain the difference between body weight and body composition, including fat mass, lean tissue, and fat-free mass.
- Identify types and functions of body fat and describe how fat distribution (android vs. gynoid) affects health and performance.
- Interpret body composition measurements and ratios (body fat %, waist circumference, waist-to-hip) to assess health risks.
- Analyze biological, genetic, hormonal, and age- or sex-related factors influencing body composition.
- Evaluate lifestyle and environmental factors, including nutrition, exercise, sleep, and stress, in shaping body composition.
- Compare and contrast the use of BMI and Body Composition measurements.
- Explain the health risks associated with excess or insufficient body fat and low lean mass.
- Describe the prevalence and negative health consequences of obesity and being overweight.
- Apply strategies, including diet, exercise, and clinical interventions, to optimize body composition and reduce disease risk.
- Analyze the impact of body image, societal pressures, and support systems on emotional, social, and occupational wellness.
- Integrate knowledge of body composition to support overall wellness, functional health, and long-term quality of life.

6.1: The Basics of Body Composition

6.2: Factors Affecting Body Composition
6.3: Body Composition for Health
6.4: Body Composition for Wellness
6.5: Assessing Body Composition
6.6: Strategies for Change
6.7: Comprehension Check
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6.1: The Basics of Body Composition



Figure 6.1.1: (CC BY-SA 2.0; Australian Human Rights Commission via Wikimedia Commons)

Introduction

Understanding body composition is essential for assessing overall health and fitness. Body weight refers to the total mass of an individual and is commonly measured in pounds or kilograms. Body composition, on the other hand, refers to the proportions of fat, muscle, bone, and other tissues that make up a person's total body weight. Unlike body weight alone, body composition provides more meaningful insight into how much of the body is composed of fat versus lean tissue. This section explores the basic types of fat found in the body, such as essential fat and storage fat, and explains the significance of body fat percentage as a health indicator. It also introduces the fundamentals of metabolism, the process by which the body converts food into energy. Additionally, the differences between being overweight and being obese will be outlined, clarifying how each condition is defined and measured. Together, these concepts provide a foundation for understanding how body composition influences health and disease risk.

Body Composition

Body composition refers to the percentages of fat, bone, water, and lean muscle in the human body. It is a more detailed indicator of health than body weight alone, as it distinguishes between 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. Understanding body composition helps assess fitness levels, monitor progress in health programs, and evaluate risks for certain diseases related to excess body fat.

Tracking weight can be helpful, but body composition measurements help separate a person's actual weight from the weight that could be unhealthy. For adults of all ages, the proportion of FM is most commonly measured by **percent body fat**. For example, an individual who weighs 200 pounds and has 8% percent 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 percent body fat of 20% carries 40 pounds of FM. Weight alone, in this case, does not distinguish between FFM and FM and would suggest that both individuals have similar health. Too much or too little percent body fat affects the potential for various adverse effects on health. Percent body fat is a key measure of body composition, which is one of the five major health-related components of physical fitness. Maintaining a healthy body fat percentage is important for overall health, physical performance, and reducing the risk of chronic diseases, but it is not the only way to define underweight, overweight, and obesity. For example, in older adults, the weight and density of bone tissue are important indicators of health, as age-related loss of bone mass, known as osteoporosis, can increase the risk of fractures (Schorr et al, 2018). [79]

Table 6.1.1: Comparison of Body Composition of Biological Females and Males

Type of Tissue	Biological Females	Biological Males
Essential Fat	12%	3%
Storage Fat	15%	12%
Bone	12%	15%
Muscle	36%	45%
Other	25%	25%

Question

- How might focusing on body composition rather than just weight influence the way you approach your personal fitness or health goals?
- What impact could this have on your long-term well-being?

Types of Fat

Fat storage in the body consists of two types of fat: essential and nonessential fat. **Essential fat** refers to the minimum amount of fat required by the body to maintain normal physiological function and overall health. It is crucial for a range of bodily processes, including cell membrane integrity, nerve conduction, hormone production (especially sex hormones like estrogen and testosterone), and the absorption of fat-soluble vitamins (A, D, E, and K). Essential fat is stored in small amounts in organs such as the heart, lungs, liver, spleen, kidneys, intestines, and bone marrow, where it cushions and protects these structures. In women, essential fat also supports reproductive health by aiding in the regulation of menstrual cycles and supporting potential pregnancy. In women, essential fat is stored in the breasts, pelvis, hips, and thighs. The average essential fat percentage is about 3–5% of total body weight for men and approximately 10–13% for women, reflecting the additional fat required for reproductive health. Unlike storage fat, essential fat is not available for energy use and should not be reduced through weight loss efforts, as doing so can impair critical biological functions.



Figure 6.1.2: Body composition and fat concentrations can be affected in different places on the body depending on genetics and gender. (CC BY-SA 4.0; chormail153750 via Wikimedia Commons)

Non-essential fat, also known as **storage fat** or adipose tissue, refers to the body fat that accumulates in adipose tissue and is not necessary for basic physiological function. This type of fat serves several important purposes, including energy storage, insulation, and cushioning of internal organs. It is typically found around an internal organ called **visceral fat** and beneath the skin, known as **subcutaneous fat.** Visceral fat protects vital organs such as the kidneys and intestines. Subcutaneous fat is the fat that can

often be seen or felt. It can be found in many parts of the body, but the largest fat deposits are typically in the abdomen, hips, buttocks, and thighs as depicted in Figure 6.1.3. It provides insulation for the body and helps to regulate temperature. In moderate amounts, non-essential fat supports temperature regulation and provides an energy reserve that the body can draw on during periods of calorie deficit or increased physical activity. However, when excess storage fat accumulates, especially visceral fat located around the abdominal organs, it can increase the risk of various chronic health conditions such as cardiovascular disease, type 2 diabetes, and certain cancers. Body composition assessments often aim to estimate the proportion of non-essential fat relative to lean tissue to determine an individual's overall health status. While some amount of storage fat is normal and healthy, maintaining a balanced level through proper nutrition and regular physical activity is key to reducing health risks associated with excess body fat (Doheny, 2009). [26]

Question

- Why is it important to maintain essential fat in the body, and what potential health risks might occur if essential fat levels drop too low?
- How does understanding the difference between essential fat and storage fat change the way you think about body fat, health, and weight management?

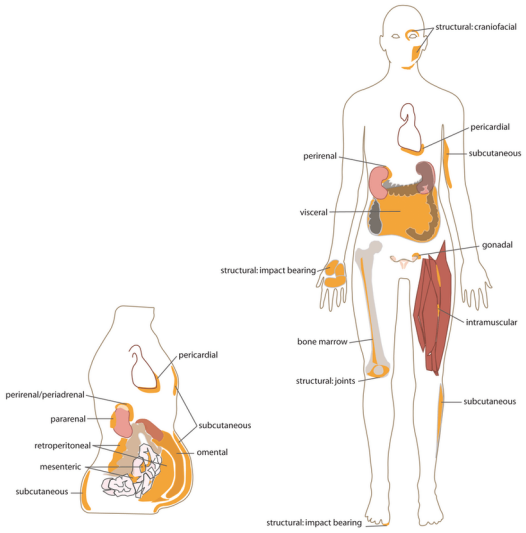


Figure 6.1.3: White adipose falls under two major classifications: visceral, or surrounding organs, and subcutaneous, under the skin. Fat is distributed widely throughout the body and has different functions and growth properties depending on its location. (CC BY-SA 3.0; Cook, et al. via Wikimedia Commons)

Figure 6.1.3: This illustration provides a labeled anatomical illustration of where white adipose (fat) tissue is distributed in the human body. It includes two figures: a full-body outline of a human (right) and a cross-sectional view of the abdominal area (left). The diagram uses color coding to visually distinguish different types and locations of adipose tissue. This educational illustration highlights both visceral fat (fat stored around organs) and subcutaneous fat (fat stored under the skin), as well as specialized fat stores related to structure, organ protection, and energy storage.

Full-Body View Labels (Right)

- Structural Craniofacial: fat located in the head and face
- Pericardial: fat surrounding the heart
- Perirenal: fat around the kidneys
- Subcutaneous: fat beneath the skin, shown in the arms, thighs, and abdominal area
- Visceral: fat surrounding internal organs in the abdominal cavity.
- Gonadal: fat associated with the reproductive organs
- Intramuscular: fat located within muscles, illustrated in the thigh muscle
- Structural Impact bearing: fat in areas like the palms, soles, and buttocks that help absorb mechanical impact
- Bone marrow: fat stored in the central cavities of bones

- Structural Joints: fat found near joints, assisting in cushioning and function

Abdominal Cross-Section View Labels (Left)

- Pericardial: fat around the heart area
- Perirenal/Periadrenal: fat near the kidneys and adrenal glands.
- Pararenal: fat surrounding the kidneys but outside the renal fascia
- Retroperitoneal: fat behind the abdominal cavity lining
- Mesenteric: fat associated with the mesentery, the connective tissue holding the intestines.
- Omental: fat found in the omentum, a layer of fatty tissue that drapes over abdominal organs.
- Subcutaneous: fat under the skin around the abdominal area.

Body Weight and Body Size

Body weight and body size are commonly used to assess health, but they do not tell the full story when it comes to body composition. As previously addressed, body composition refers to the proportion of fat mass and fat-free mass in the body. Two individuals may have the same body weight or body size, but very different levels of fat and muscle. For example, an athlete may weigh more than a sedentary person of the same height due to having greater muscle mass, which is denser than fat. Therefore, focusing only on weight or size can be misleading when evaluating a person's overall health and fitness.

Understanding body composition offers a more accurate picture of health than body weight alone. While scale weight includes bones, muscles, fat, organs, and fluids, it does not distinguish between these components. High amounts of body fat, particularly visceral fat stored around internal organs, are associated with increased health risks such as heart disease, diabetes, and metabolic disorders. On the other hand, having a higher percentage of lean mass, such as muscle and bone, is linked to better metabolic health, strength, and physical function. This is why many health and fitness professionals assess body composition alongside or instead of body weight when developing health goals.

Body weight and body size are frequently used to assess health, but they do not reveal the full picture without considering body composition and the relative amounts of different types of tissue in the body. The main tissue types considered in body composition are fat tissue (adipose), muscle tissue (skeletal muscle), bone tissue, and body water. Two people may have similar body weights or sizes, but very different proportions of these tissues. Muscle tissue is significantly denser than fat tissue, meaning it weighs more per unit of volume, taking up about 18% less space than a pound of fat in the body. Thus, five pounds of muscle looks smaller than five pounds of fat on a body. This is why individuals with higher muscle mass may appear leaner and more compact than those with the same body weight but a higher proportion of fat tissue. For instance, one person may have a higher amount of muscle tissue and lower fat tissue, while another may have less muscle and more fat. Because muscle is denser than fat, individuals with more lean tissue may appear heavier on a scale but have a healthier body composition. The term **"skinny-fat"** refers to individuals who appear to have a normal or low body weight but have a high percentage of body fat and relatively low muscle mass. Despite looking slim, these individuals may lack muscle tone and carry excess fat—often around the abdomen or other areas—putting them at risk for health issues typically associated with higher body fat levels, such as insulin resistance, poor metabolic health, and increased cardiovascular risk. This condition highlights the importance of evaluating body composition, not just body weight or Body Mass Index (BMI), when assessing overall health and fitness.

Question

- Why might relying only on body weight or Body Mass Index (BMI) be misleading when assessing health, and how does understanding body composition provide a clearer picture?
- How could someone who appears slim still be at risk for health problems related to body composition?
- What does this suggest about the importance of building and maintaining lean muscle mass?

Body Fat Distribution

Body fat is not distributed evenly throughout the body, and where fat is stored can significantly affect health, physical performance, and overall body composition. Fat distribution is influenced by genetics, hormones, sex, age, and lifestyle factors, and understanding these patterns helps in assessing both aesthetic and health-related outcomes. 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 where body fat

is stored.

Patterns of Fat Distribution

Two primary patterns of fat storage are commonly recognized:

Android (Apple-Shaped) Distribution

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. Fat is predominantly stored in the abdominal region, including the waist, stomach, and upper body.

- This pattern is more common in biological males due to the influence of androgens (male hormones such as testosterone).
- Android fat distribution is associated with a higher proportion of visceral fat, which surrounds internal organs. This type of fat is metabolically active and linked to increased risks for cardiovascular disease, insulin resistance, type 2 diabetes, and metabolic syndrome.

Gynoid (Pear-Shaped) Distribution

A pear-shaped body fat distribution pattern, or **gynoid shape**, is more commonly found in premenopausal 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' childbearing abilities, as enzymes associated with fat storage and mobilization are activated during certain times of pregnancy and post-partum.

- Fat is primarily stored in the hips, thighs, and buttocks.
- This pattern is more common in biological females, influenced by estrogen and other female sex hormones.
- Gynoid fat is typically **subcutaneous**, lying beneath the skin rather than around internal organs. While excess fat in this pattern can contribute to increased total body fat, it is generally associated with lower metabolic risk compared to abdominal fat.

Implications for Body Composition and Health

Fat distribution is a critical factor in assessing body composition because total body fat percentage alone does not reflect where fat is stored. Two individuals may have the same body fat percentage, yet one may carry more abdominal fat (higher health risk) while the other stores more fat in the hips and thighs (lower health risk).

Measurements such as waist circumference, waist-to-hip ratio, and imaging techniques (e.g., DXA or MRI) are often used alongside body fat percentage to evaluate risk profiles more accurately. Recognizing patterns of fat distribution helps health professionals tailor interventions, including nutrition, exercise, and lifestyle recommendations. 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 (Doheny, 2009). [26]

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 the risk of disease (Harvard T.H. Chan School of Public Health, 2018). [37]

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 (National Heart, Lung, and Blood Institute, 2018). [59]

Overweight and Obesity

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.

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 (American College of Sports Medicine, 2016). [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 (Kravitz & Heward, 2017). [45]

Table 6.1.2: American Council on Exercise: Typical Fat Ranges

Biological Males	Biological Females
Essential Fat: ~2–5 %	Essential fat: ~10–13 %
General Population Average: ~18–24 %	General population average: ~25–31 %
Obesity threshold: >25 %	Obesity threshold: >32 %

According to the American Council on Exercise (ACE), Table 6.1.2 offers practical estimates of typical body fat ranges by sex (American Council on Exercise, 2023). [4] These ranges reflect typical distributions of body fat and lean mass between sexes and provide a useful benchmark for understanding differences in body composition between males and females.

Prevalence Trends of Overweight, Obesity, and Severe Obesity in U.S. Adults

Figure 6.1.4 is a chart showing the trends in overweight, obesity, and severe obesity among U.S. adults from 1960 to 2018. It illustrates a clear increase in obesity and severe obesity rates over time, while the prevalence of overweight has remained relatively stable (Freedman et al, 2005). [31]

Obesity (BMI ≥ 30 kg/m²)

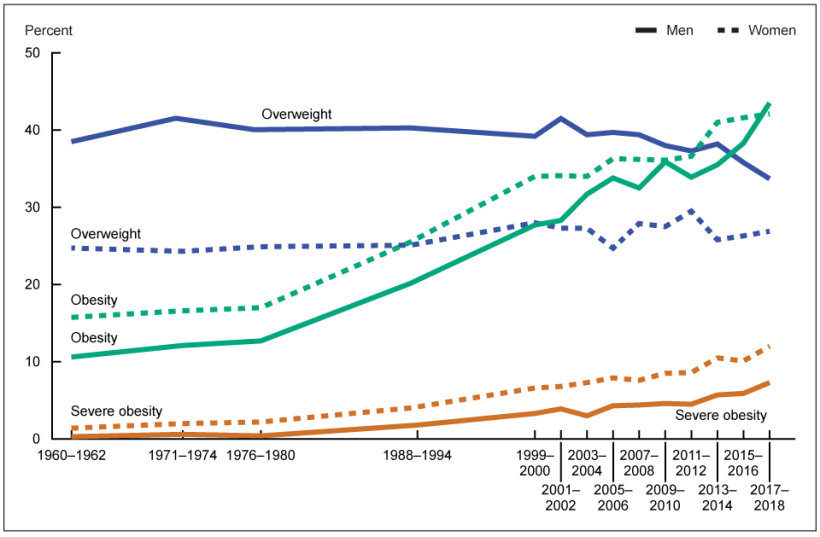
- In 1960–1962, approximately 13% of U.S. adults were classified as obese
- By 1988–1994, prevalence had grown to ~23%, and by 1999–2000, it reached the 30% threshold
- The upward trend continued to 42.4% by 2017–2018, indicating a nearly threefold increase over nearly six decades

Overweight (BMI 25.0–29.9 kg/m²)

- Prevalence among adults increased modestly and plateaued, hovering around 30–35% from 1988 onward
- As of 2017–2018, approximately 73.6% of adults were overweight or obese combined

Severe or Extreme Obesity (BMI ≥ 40 kg/m²)

- Remained very low in the 1960s (below 1%), rose to ~6% by 1988–1994, and reached ~9% by 2017–2018



NOTES: Data are age adjusted by the direct method to U.S. Census 2000 estimates using age groups 20–39, 40–59, and 60–74. Overweight is body mass index (BMI) of 25.0–29.9 kg/m^2. Obesity is BMI at or above 30.0 kg/m^2. Severe obesity is BMI at or above 40.0 kg/m^2. Pregnant women are excluded from the analysis.
SOURCES: National Center for Health Statistics, National Health Examination Survey and National Health and Nutrition Examination Surveys.

Figure 6.1.4: Trends in Overweight, Obesity, and Severe Obesity from 1960 to 2018. (Public Domain; Fryar, et al. via NCHS Health E-Stats)

NOTES: Data are age-adjusted by the direct method to U.S. Census 2000 estimates using age groups 20–39, 40–59, and 60–74. Overweight is a body mass index (BMI) of 25.0–29.9 kg/m^2. Obesity is BMI at or above 30.0 kg/m^2. Severe obesity is BMI above 40.0 kg/m^2. Pregnant women are excluded from the analysis.
SOURCES: National Center for Health Statistics, National Health Examination Survey, and National Health and Nutrition Examination Surveys.

Question

- How does understanding your body fat distribution and waist-to-hip ratio influence the way you assess your health?
- What steps could you take to reduce the health risks associated with visceral fat?

Key Points

- Body composition measures the proportions of fat, muscle, bone, and water in the body and provides a more meaningful indicator of health than body weight alone.
- Fat in the body is classified as essential fat, necessary for physiological function, and non-essential (storage) fat, which provides energy, insulation, and organ protection.
- Essential fat is higher in women (10–13%) than in men (3–5%) due to reproductive needs, while non-essential fat is stored subcutaneously and viscerally.
- Subcutaneous fat lies beneath the skin, whereas visceral fat surrounds internal organs and is linked to increased risk of type 2 diabetes, cardiovascular disease, and metabolic disorders.
- Body composition differentiates fat-free mass (muscle, bone, organs, fluids) from fat mass, making it more informative than weight alone for assessing health and fitness.
- Fat distribution patterns differ by sex: android (apple-shaped) fat is common in males and postmenopausal females, while gynoid (pear-shaped) fat is typical in premenopausal females.
- Android fat, concentrated in the abdomen, is associated with higher metabolic and cardiovascular risk, while gynoid fat, in the hips and thighs, generally carries lower risk.
- Waist circumference and waist-to-hip ratio are practical measures to assess body fat distribution and associated health risks.
- Overweight and obesity are defined by excess non-essential body fat, with thresholds differing by sex and age; excessive fat increases the risk of chronic diseases.
- U.S. trends show obesity rising from 13% in 1960–1962 to 42.4% in 2017–2018, while overweight prevalence has remained stable around 30–35%, and severe obesity increased from below 1% to ~9% over the same period.

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6.2: Factors Affecting Body Composition



Figure 6.2.1: Eating meals with friends is an integral part of society and humanity, which affects our body composition and our relationship to food. (Friends Gathering; Considerate Agency via Unsplash)

Introduction

Body composition refers to the proportion of fat, muscle, bone, and water that make up an individual's total body mass. Unlike body weight alone, which simply reflects the number on a scale, body composition provides deeper insight into health, performance, and disease risk. Two individuals of the same weight can have very different health outcomes depending on the relative amounts of lean tissue and fat mass in their bodies. Understanding the factors that shape body composition is essential for promoting long-term well-being, optimizing physical performance, and reducing the risk of chronic conditions such as cardiovascular disease, type 2 diabetes, and osteoporosis.

A variety of influences contribute to differences in body composition, ranging from genetic inheritance to lifestyle choices. Some of these factors, such as age, sex, and genetics, create a biological framework that individuals cannot control but that sets the foundation for how the body develops and stores fat and muscle. Other influences, including nutrition, physical activity, stress management, and hydration, are modifiable and provide opportunities to maintain or improve body composition through intentional behavior change.

Environmental and socioeconomic conditions also play a significant role in shaping access to healthy food, safe opportunities for physical activity, and resources that support wellness. Medical conditions and medications can further complicate body composition by altering metabolism, hormonal balance, and energy regulation. Finally, psychological and behavioral factors strongly influence how individuals make decisions about diet, exercise, and health habits, which directly affect body composition over time.

This chapter explores the major factors that influence body composition, organizing them into interconnected categories to provide a comprehensive understanding of how biology, environment, and behavior interact. By recognizing both the fixed and modifiable contributors to body composition, individuals and health professionals can identify strategies to support healthier fat-to-muscle ratios and reduce the risk of chronic disease.

Genetics and Heredity

Genetics plays a central role in shaping an individual's body composition by influencing how the body develops and maintains fat, muscle, and bone mass. While lifestyle choices such as diet and exercise are critical to managing body composition, genetic

factors establish a biological framework that can make it easier or more challenging for individuals to achieve certain outcomes.

Genes also influence **fat distribution patterns**. For example, some individuals are more likely to store fat in the abdominal region (central or visceral obesity), while others store it around the hips and thighs (peripheral or subcutaneous fat). These patterns not only affect appearance but also carry health implications, as visceral fat is more strongly associated with metabolic diseases such as type 2 diabetes and cardiovascular disease.

Muscle characteristics are likewise affected by genetics. The relative proportion of **fast-twitch** to **slow-twitch muscle fibers** is largely inherited and influences both body composition and physical performance. Individuals with a higher proportion of fast-twitch fibers may build muscle mass more readily and excel at strength or power-based activities, while those with more slow-twitch fibers may be better suited for endurance activities. Bone density, stature, and frame size, factors that also contribute to total body composition, are similarly shaped by genetic inheritance.



Figure 6.2.2: Genetics research can give us a window into reasons for certain body compositions. (Genetic Research; Edward Jenner via Pexels)

In addition, research has identified specific genetic variants linked to appetite regulation and **satiety**. For instance, variations in the FTO (*fat mass and obesity-associated*) gene—sometimes nicknamed the "fatso" gene—are among the strongest genetic predictors of obesity risk. Individuals who inherit certain variants of this gene tend to have higher levels of hunger, stronger cravings for energy-dense foods, and greater difficulty achieving a sense of fullness after meals. These traits can lead to increased calorie intake and higher body fat levels over time, especially in environments where high-calorie foods are easily accessible.

Although genetics provides the foundation, it does not completely predetermine outcomes. The expression of many genes is influenced by environmental factors such as nutrition, physical activity, sleep, and stress, a concept known as **gene-environment interaction**. For example, individuals with a genetic predisposition to obesity may mitigate their risk through regular exercise and dietary management.

In summary, genetics affects body composition by determining metabolic rate, fat distribution, muscle fiber type, bone structure, and even appetite regulation. While these inherited traits can create advantages or challenges, lifestyle choices and environmental influences remain powerful tools in shaping and maintaining a healthy body composition. Importantly, lifestyle factors can substantially mitigate these genetic effects. A recent study found that carriers of the FTO risk allele who were physically active showed body composition patterns similar to those without the risk variant, which emphasizes the power of behavior to counteract genetic predisposition (Martínez-López et al, 2024). [54]

Biological Age and Sex

Age is one of the most significant factors influencing body composition. As individuals grow older, there is a gradual decline in skeletal muscle mass and strength, a process known as **sarcopenia**. This change is often accompanied by an increase in fat mass, particularly visceral fat, even if overall body weight does not change significantly. These shifts are partly due to reductions in physical activity, but also stem from age-related hormonal changes, such as decreased growth hormone and testosterone levels,

which reduce protein synthesis and muscle maintenance (Janssen et al, 2002). [40] Older adults may also experience declines in basal metabolic rate, leading to a lower energy expenditure and greater susceptibility to weight gain if dietary intake is not adjusted accordingly (St-Onge & Gallagher, 2010). [83]



Figure 6.2.3: Body composition is further complicated as people age. (Couple Sitting; Sven Mieke via Unsplash)

Sex also plays a central role in shaping body composition. Men typically have higher muscle mass and lower body fat percentages than women, largely due to higher levels of testosterone, which promotes muscle protein synthesis, and differences in fat distribution patterns. Women generally carry more essential fat to support reproductive functions and tend to deposit fat subcutaneously, particularly in the hips and thighs. In contrast, men are more likely to store fat viscerally in the abdominal region, a distribution pattern that has been linked with increased risk for cardiovascular disease and metabolic syndrome (Wells, 2007). [90]

These sex-based differences persist across the lifespan but become more pronounced with hormonal transitions, such as menopause in women, when estrogen levels decline. The reduction in estrogen not only increases the likelihood of fat redistribution toward the abdominal region but also accelerates bone density loss, further altering body composition and raising the risk of osteoporosis (Lovejoy et al, 2008). [52] In men, gradual declines in testosterone levels with age are associated with reductions in lean body mass and an increase in fat accumulation. Together, these changes highlight the combined impact of biological sex and aging on body composition, influencing both health outcomes and physical performance throughout the lifespan.

Body Fat Distribution

Body fat distribution refers to the pattern of where fat is stored in the body, and it plays an important role in both health and body composition. These patterns differ by biological sex, with males more likely to store fat in the abdominal region and females more likely to store it around the hips and thighs due to hormonal influences. 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 (Doheny, 2009). [26]

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 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 premenopausal 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' childbearing 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 the risk of disease (Harvard T.H. Chan School of Publich Health, 2018). [37]

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 (National Heart, Lung, and Blood Institute, 2018). [59]

Question

- How does understanding your body fat distribution and waist-to-hip ratio influence the way you assess your health?
- What steps could you take to reduce the health risks associated with visceral fat?

Hormones and Metabolism

One of the most significant genetic contributions is the regulation of **metabolism**. Specific genes determine **resting metabolic rate (RMR)**, which is the energy the body requires to sustain basic physiological functions at rest. A higher RMR typically allows an individual to burn more calories throughout the day. In contrast, a lower RMR may predispose someone to greater fat storage when caloric intake is not closely matched to energy expenditure.



Figure 6.2.4: At younger ages, the body's ability to metabolize foods is usually much stronger than when we are older. (Teenagers on the Couch; Matheus Ferrero via Unsplash)

The **FTO gene** influences body composition through its role in energy balance and metabolism. Studies suggest that people with the "risk" version of the gene may burn fewer calories at rest and may preferentially store excess energy as fat rather than muscle. However, the gene's effects are not absolute. Research consistently shows that physical activity, balanced nutrition, and other

lifestyle factors can counteract much of the genetic predisposition. For example, individuals who carry the FTO variant but engage in regular exercise often display body composition patterns similar to those without the gene (Loos & Yeo, 2014). [51]

Nutrition and Dietary Habits

Nutrition plays a central role in determining body composition, as the balance of calories consumed versus calories expended directly influences changes in fat and lean tissue. When individuals consistently consume more calories than they expend, the surplus energy is stored primarily as adipose tissue, leading to increases in body fat. Conversely, sustained energy deficits typically result in reductions in both fat and lean mass, though adequate protein intake and resistance training can help preserve muscle during weight loss (Hall et al, 2012). [35] Thus, not only the quantity but also the quality and distribution of macronutrients, carbohydrates, fats, and proteins significantly shape body composition outcomes.

Protein intake is particularly influential in maintaining or increasing lean body mass. Research indicates that higher protein diets support muscle protein synthesis, preserve fat-free mass during periods of caloric restriction, and enhance satiety, which can facilitate adherence to a weight-management plan (Phillips & Van Loon, 2011). [68] Carbohydrates and fats also play important roles, serving as primary energy sources. However, diets excessively high in refined carbohydrates or saturated fats may promote fat storage, especially when coupled with low physical activity. The type and quality of fat consumed, such as replacing saturated fats with polyunsaturated fats, can also influence fat distribution and **cardiometabolic** risk (Mozaffarian et al, 2010). [57]



Figure 6.2.5: It is important to create and maintain good habits when deciding what to eat. (Person Eating; Farhad Ibrahimzade via Unsplash)

Beyond macronutrients, dietary patterns and habits such as meal timing, frequency, and food quality exert meaningful effects on body composition. Diets emphasizing whole foods, such as fruits, vegetables, whole grains, lean proteins, and healthy fats, are associated with healthier body composition profiles and lower rates of obesity. In contrast, frequent consumption of energy-dense, nutrient-poor foods—often found in highly processed diets—correlates with greater fat mass and reduced muscle quality (Monteiro et al, 2018). [55] Additionally, irregular eating patterns, such as skipping breakfast or late-night eating, have been linked to metabolic disruptions that may promote fat accumulation.

Ultimately, while genetics and other factors play a role, nutrition remains a modifiable determinant of body composition. Adopting balanced dietary habits that emphasize nutrient-dense foods, sufficient protein, and appropriate calorie intake can optimize fat-to-muscle ratios. Combined with regular physical activity, these dietary strategies help establish a sustainable foundation for improving and maintaining healthy body composition across the lifespan.

Physical Activity and Exercise

Physical activity is one of the most powerful modifiable factors influencing body composition. Regular exercise affects both fat mass and lean body mass by altering energy expenditure and stimulating physiological adaptations. Aerobic exercise, such as

running, cycling, or swimming, primarily enhances energy expenditure and can reduce total body fat when paired with appropriate nutrition. Resistance training, on the other hand, is the most effective form of exercise for increasing or maintaining lean body mass. Together, these exercise modalities can improve body composition by lowering fat-to-muscle ratios and enhancing metabolic health (Ross & Janssen, 2001). [76]

Resistance training is particularly critical because it stimulates muscle protein synthesis, which contributes to hypertrophy and counteracts the natural decline in lean body mass that occurs with aging or caloric restriction. When combined with sufficient protein intake, strength training helps preserve muscle during weight loss, reducing the risk of metabolic slowdown and sarcopenia. Moreover, increased muscle mass raises resting metabolic rate (RMR), which further supports long-term fat reduction and improved body composition (Westcott, 2012). [91]



Figure 6.2.6: Exercise has a profound effect on body composition. (Walking Stairs; Bruno Nascimento via Unsplash)

Aerobic exercise provides complementary benefits by improving cardiovascular fitness, insulin sensitivity, and fat oxidation. **High-intensity interval training (HIIT)** has gained attention for its efficiency in reducing fat mass and improving body composition, sometimes yielding results comparable to longer sessions of moderate-intensity exercise (Boutcher, 2011). [11] Importantly, the integration of both aerobic and resistance exercise appears to provide the most comprehensive benefits for improving body composition and overall health.

Beyond structured workouts, daily activity levels, sometimes referred to as **non-exercise activity thermogenesis (NEAT)**, also make a meaningful contribution to body composition. Simple habits like walking, standing, or taking the stairs increase total daily energy expenditure, supporting fat loss and weight maintenance. Thus, adopting an active lifestyle that blends structured exercise with daily movement is among the most effective strategies for achieving and sustaining a healthy body composition. [50]

Lifestyle and Daily Habits

Lifestyle choices and daily habits strongly influence body composition by shaping energy balance, hormonal regulation, and long-term health behaviors. One of the most important lifestyle factors is sleep. Inadequate or poor-quality sleep disrupts hormonal pathways that regulate appetite and metabolism. Short sleep duration has been associated with higher levels of **ghrelin**, a hormone that increases hunger, and lower levels of leptin, which signals satiety. Over time, these changes can lead to greater caloric intake and fat accumulation, particularly around the abdominal region. [82]



Figure 6.2.7: Managing stress and getting enough rest are important for maintaining proper body composition. (Woman Sleeping; Greg Pappas via Unsplash)

Stress management is another key component of lifestyle that affects body composition. Chronic stress elevates **cortisol** levels, which can increase appetite and promote fat storage in the abdominal area. High cortisol exposure has been linked to both weight gain and the loss of lean tissue. Individuals who cope with stress through sedentary behaviors or comfort eating may experience unfavorable shifts in body composition compared to those who adopt healthier coping strategies, such as physical activity, mindfulness, or social support (Epel et al, 2000). [28]

Substance use also plays a role in body composition outcomes. Excessive alcohol intake contributes additional calories while impairing fat metabolism, leading to greater fat storage over time. Smoking has complex effects, often associated with lower body weight but also with unfavorable fat distribution and loss of lean body mass. Caffeine use, in moderate amounts, may support energy expenditure and fat oxidation, although heavy consumption can interfere with sleep and recovery, thereby undermining healthy body composition (Hu et al, 2018). [39]



Figure 6.2.8: Substance abuse can increase and decrease body composition numbers depending on what drug is being abused. (Smoking a Joint; Ahmed Zayan via Unsplash)

Finally, daily activity habits outside of structured exercise, such as walking, standing, or engaging in recreational movement, accumulate to influence energy expenditure and long-term weight maintenance. Modern lifestyles that encourage prolonged

sitting and screen time are strongly correlated with higher fat mass and reduced muscle quality. In contrast, individuals who intentionally integrate regular movement into their routines tend to have healthier body composition and lower risks of obesity-related health conditions (Hamilton et al, 2007). [36]

Environment and Socioeconomic Factors

The environment in which people live plays a critical role in shaping their body composition. Access to safe recreational spaces, sidewalks, and community facilities influences the likelihood of engaging in regular physical activity. Individuals living in neighborhoods that lack parks or safe walking areas are often less active, which contributes to higher fat mass and lower muscle mass over time. Similarly, environments saturated with fast-food outlets and convenience stores, often referred to as "food deserts" or "food swamps," can limit access to fresh, nutrient-dense foods, leading to diets that promote weight gain and unhealthy fat distribution (Walker et al, 2010). [89]

Socioeconomic status (SES) is another powerful determinant of body composition. Individuals with lower SES often face financial and logistical barriers to healthy eating and active living. Limited financial resources may make cheaper, calorie-dense processed foods more accessible than fresh produce or lean protein. Time constraints from multiple jobs or long working hours can further reduce opportunities for exercise and meal preparation. These factors often interact to create environments where maintaining a healthy body composition becomes more challenging, contributing to the higher prevalence of obesity and related health conditions in lower-income populations (Drewnowski, 2009). [27]



Figure 6.2.9: Housing insecurity and food insecurity make it difficult for people to make the right decisions, or even be presented with options, for maintaining proper health and body composition. (Barefoot Man Eating; Paul Pineda via Unsplash)

Cultural and social environments also shape dietary and physical activity habits. Social norms and cultural traditions can influence food choices, portion sizes, and perceptions of body image. In some communities, larger body size may be associated with prosperity or health, while in others, thinness may be more highly valued. These cultural influences intersect with socioeconomic factors, affecting how individuals prioritize diet and exercise behaviors that ultimately shape body composition (Swinburn et al, 2011). [84]

Environmental stressors, including pollution, noise, and overcrowding, have also been linked to adverse changes in body composition. For example, chronic exposure to environmental stress can elevate cortisol levels, which increases the risk of abdominal fat accumulation. Together, environmental and socioeconomic influences create a powerful framework that affects both opportunities and choices, highlighting the need for public health interventions that address structural barriers as well as individual behavior in improving body composition (Block et al, 2004). [10]



Figure 6.2.10: Oftentimes, those of lower socio-economic standing are subjected to more pollution and environmental hazards. (Pollution; Peter Werkman via Unsplash)

Medical Conditions and Medications

Medical conditions can significantly alter body composition by affecting metabolism, hormone balance, and energy regulation. Endocrine disorders are particularly influential. For example, hypothyroidism reduces thyroid hormone production, which lowers metabolic rate and promotes fat accumulation. Conversely, hyperthyroidism can accelerate metabolism, leading to unintentional weight loss and reductions in both fat and lean tissue (Biondi & Cooper, 2010). [9] **Polycystic ovary syndrome (PCOS)** is another condition that affects body composition, often leading to increased visceral fat due to insulin resistance and hormonal imbalances. Similarly, type 2 diabetes is strongly associated with higher levels of abdominal fat, which increases the risk of cardiovascular disease and further metabolic complications (Kahn et al, 2006). [43]

Medications prescribed for various health conditions also influence body composition. **Corticosteroids**, commonly used for inflammatory diseases, are associated with increased fat deposition and muscle wasting when used long-term. Antidepressants, antipsychotics, and certain antiepileptic drugs have been linked to weight gain due to their effects on appetite, energy balance, and metabolic pathways. For example, second-generation antipsychotics can significantly increase fat mass and insulin resistance, contributing to long-term health risks (Newcomer, 2005). [63] On the other hand, some medications, such as stimulants prescribed for attention deficit hyperactivity disorder (ADHD), can suppress appetite and lead to unintended reductions in body mass.



Figure 6.2.11: Doctors are a resource when navigating medications and their effect on body composition and overall health. (Doctor's Advice by National Cancer Institute on Unsplash)

Chronic illnesses also play a role in altering body composition. Conditions such as cancer, chronic kidney disease, and chronic obstructive pulmonary disease (COPD) may cause **cachexia**, a syndrome characterized by severe muscle wasting and weight loss. Cachexia results not only from inadequate nutrition but also from systemic inflammation and metabolic dysregulation, which accelerate the breakdown of muscle tissue. This loss of lean body mass has serious implications for physical function, treatment tolerance, and overall survival (Evans et al, 2008). [29]

Ultimately, the effects of medical conditions and medications on body composition highlight the complex interplay between biological, pharmacological, and lifestyle factors. Health professionals must consider these influences when assessing body composition and recommending interventions. Strategies such as tailored exercise programs, nutritional support, and careful medication management can help mitigate adverse changes, preserve lean mass, and improve long-term health outcomes in affected individuals.

Hydration and Fluid Balance

Hydration status and fluid balance are important but sometimes overlooked factors that influence body composition. Water makes up the largest component of the human body, accounting for approximately 50 to 70 percent of total body mass. Lean tissue, such as muscle, contains a higher proportion of water than fat tissue, which means that fluctuations in hydration can directly impact measurements of body composition. For instance, dehydration reduces total body water and can make fat mass appear proportionally higher, while overhydration may obscure changes in fat or lean mass when using assessment methods such as bioelectrical impedance (Shirreffs, 2003). [80]



Figure 6.2.12: Humans are mostly water, so maintaining proper hydration is very important and can affect body composition and overall health. (Thirsty; Amanda María via Unsplash)

Fluid balance is closely tied to electrolyte regulation, glycogen storage, and cellular health, all of which affect body composition indirectly. Glycogen, the body's stored form of carbohydrate, binds water molecules in muscle tissue. As a result, individuals who increase carbohydrate intake often experience temporary increases in body weight due to water retention, whereas low-carbohydrate diets may cause rapid reductions in water weight rather than true fat loss (Kreitzman et al, 1992). [46] Similarly, excessive sodium intake can lead to fluid retention, altering body weight and composition measurements without meaningful changes in fat or muscle mass.

Hydration status also influences metabolic processes and physical performance, both of which have long-term effects on body composition. Even mild dehydration can impair exercise performance, reduce endurance, and decrease strength, making it more difficult to engage in the physical activity that supports muscle maintenance and fat loss. Chronic underhydration may also affect appetite regulation, as thirst is sometimes misinterpreted as hunger, leading to increased caloric intake and greater fat accumulation (Popkin et al, 2010). [69]

Maintaining proper hydration, therefore, is critical not only for accurate assessment of body composition but also for supporting the physiological processes that determine it. Encouraging adequate daily fluid intake, combined with balanced electrolyte consumption, helps stabilize body weight fluctuations and optimizes conditions for preserving lean mass and reducing excess fat. Recognizing the interplay between hydration and body composition can improve both short-term measurement accuracy and long-term health outcomes.

Psychological and Behavioral Factors

Psychological and behavioral factors play a major role in shaping body composition by influencing eating patterns, motivation for physical activity, and long-term adherence to health behaviors. Mental health conditions such as depression and anxiety are often associated with changes in appetite, emotional eating, and **sedentary** lifestyles. These factors can lead to increased fat mass and reductions in lean mass over time. For example, emotional distress may trigger overeating of high-calorie, nutrient-poor foods, while simultaneously reducing motivation for exercise. Conversely, individuals experiencing severe stress may lose weight unintentionally due to appetite suppression, although this often includes loss of lean tissue (Luppino et al, 2010). [53]

Body image and self-perception also strongly influence behaviors that affect body composition. Individuals dissatisfied with their body image may be more likely to engage in unhealthy behaviors such as restrictive dieting, disordered eating, or excessive exercise. These behaviors can result in imbalances between fat and muscle mass, sometimes leading to long-term metabolic disruption. In contrast, individuals with a positive body image are more likely to adopt sustainable eating patterns and engage in regular physical activity, both of which support healthier body composition outcomes (Neumark-Sztainer et al, 2006). [61]



Figure 6.2.13: Body image can be a factor for people trying to be healthier. (Mirror Image; Mariia Horobets on Unsplash)

Behavioral habits, such as mindful eating, self-monitoring, and goal setting, are key predictors of success in improving body composition. Mindful eating practices help individuals become more aware of hunger and satiety cues, reducing the likelihood of overeating. Self-monitoring strategies, such as keeping food or exercise journals, are consistently associated with better weight management and healthier fat-to-muscle ratios. Incorporating behavior change models, such as the Transtheoretical Model of Change, can also help individuals progress through stages of adopting and maintaining healthier lifestyle habits that positively affect body composition.

Ultimately, the interaction between psychological health and behavioral choices underscores the importance of addressing mental and emotional well-being in any strategy aimed at improving body composition. Interventions that combine nutrition education, exercise, and behavioral counseling are often the most effective because they support both the physical and psychological dimensions of health.

Key Points

- Body composition refers to the relative proportions of fat, muscle, bone, and water in the body and provides more meaningful insights into health and performance than body weight alone.
- Genetics influences metabolism, fat distribution, muscle fiber type, bone density, and appetite regulation, establishing a biological foundation for body composition outcomes.
- Although genetic variants like the FTO gene increase obesity risk, environmental factors such as exercise and diet can significantly mitigate these effects.
- Aging is associated with sarcopenia (loss of muscle mass), reduced metabolic rate, and increased fat accumulation, particularly visceral fat, even if overall weight remains stable.
- Men generally have more lean mass and less fat mass than women, while women carry more essential fat for reproductive health. Hormonal transitions, such as menopause, intensify these differences.
- Hormones such as insulin, leptin, ghrelin, cortisol, estrogen, and testosterone regulate metabolism, appetite, and fat storage, making hormonal balance essential for healthy body composition.
- Energy balance, macronutrient distribution, and dietary quality strongly affect fat and muscle mass. Adequate protein supports lean mass, while highly processed, calorie-dense diets promote fat gain.
- Resistance training preserves and builds lean mass, while aerobic activity enhances fat oxidation and cardiovascular health. Daily movement (NEAT) also makes a significant contribution to energy expenditure.
- Sleep quality, stress management, and substance use (alcohol, smoking, caffeine) influence appetite, hormonal regulation, and fat distribution, shaping long-term body composition.
- Access to safe activity spaces, healthy foods, financial resources, and cultural norms all affect body composition, contributing to health disparities across different populations.
- Disorders such as hypothyroidism, PCOS, and type 2 diabetes alter metabolism and fat storage. Medications, including corticosteroids and antipsychotics, can increase fat mass, while stimulants may reduce it.
- Hydration status affects performance and the accuracy of body composition measurement, while psychological factors such

as body image, stress, and behavior change strategies strongly influence long-term outcomes.

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6.3: Body Composition for Health



Figure 6.3.1: (Measured Hips; Huha Inc. via Unsplash)

Introduction

Maintaining a healthy body fat level is important because both excess fat and too little fat can negatively impact health. Excess body fat, especially when stored around the abdomen, is associated with an increased risk of chronic diseases such as cardiovascular disease, type 2 diabetes, hypertension, and certain cancers. Beyond disease risk, high levels of body fat can also impair physical mobility, joint health, and overall quality of life.

On the other hand, having too little body fat can also be harmful. Essential fat plays a vital role in protecting organs, regulating hormones, and supporting normal physiological functions such as reproduction and temperature regulation. Extremely low body fat levels may lead to decreased immune function, nutrient deficiencies, loss of bone density, and, in severe cases, organ damage. For athletes, very low fat levels can impair performance and increase the risk of injury.

Problems Associated with Excess Body Fat

Excess body fat is a major health concern because it places stress on nearly every system of the body and increases the risk of chronic disease. Carrying too much fat, particularly in the abdominal region, is strongly associated with conditions such as cardiovascular disease, type 2 diabetes, high blood pressure, certain cancers, and joint problems. Beyond physical health, excess body fat can also affect mental and emotional well-being, contributing to lower self-esteem, body dissatisfaction, and weight-related stigma. While some body fat is essential for normal physiological function, an excess creates imbalances that can compromise both health and quality of life.

Diseases Associated with Excess Body Fat

According to the National Institute of Health (NIH), a wide array of diseases can be linked to excessive body fat (National Institute of Diabetes and Digestive and Kidney Diseases, n.d.). [64]

Some of them are:

- **Type II Diabetes Mellitus**
- **Hypertension**

- **Cancer**
- **Cerebrovascular Disease**
- **Cardiovascular Disease**
- **Metabolic Syndrome**
- **Gout**
- **Gallbladder Disease**
- **Pancreatitis**
- **Non-Alcohol Fatty Liver Disease**
- **Dementia**
- **Kidney Disease**

More to Explore

An explanation of how being overweight relates to each disease (those highlighted) can be viewed by going to the NIH-Explanation of Disease Risk Associated with Overweight

Other Health Risks

Diseases are not the only concern with an unhealthy body fat percentage. Other problems associated with overweight and obesity include joint problems such as **Osteoarthritis**, **Sleep Apnea**, **Asthma**, pregnancy and reproductive problems, as well as psychological issues and quality of life.

Performance of Physical Activity

A key component of a healthy lifestyle and effective 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 that leads to increased body weight, which in turn leads to further inactivity.



Figure 6.3.2: Remaining physically active is important to maintaining appropriate body composition. (Runner; Clem Onojeghuo via Unsplash)

Emotional Wellness

Studies indicate that obesity is associated with a 25% increase in anxiety and mood disorders, regardless of age or gender. Other studies suggest that increases in BMI significantly increase the incidence of personality disorders, 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 (Knight, 2011). [44]

Premature Death

The association between obesity and diseases, such as cancer, CVD, and diabetes, suggests that people with more body fat generally have shorter life expectancies. The Centers for Disease Control (CDC) estimates up to 365,000 deaths each year can be linked to 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 the time of obese classification, and gender (Chang et al, 2013). [19]

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 preventive, diagnostic, and treatment costs. 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 $3.38 to $6.38 billion (Centers for Disease Control and Prevention, n.d.). [13]

Problems Associated with Too Little Body Fat

Having too little body fat can be just as harmful as having too much. Body fat is essential for storing energy, protecting organs, insulating the body, and supporting normal hormonal and reproductive function. When fat levels drop too low, individuals may experience problems such as fatigue, weakened immune function, loss of menstrual cycles in females, reduced testosterone in males, and decreased bone density. Extremely low body fat can also impair cognitive function, increase the risk of injury, and compromise long-term health. While maintaining a lean physique is often encouraged in athletics and popular culture, dropping below healthy fat levels can create serious physical and psychological consequences. One of the most recognized conditions related to inadequate body fat and energy availability is the Female Athlete Triad and its counterpart, the Male Athlete Triad. These syndromes link low energy availability to hormonal disruption and decreased bone health, underscoring the dangers of pushing body fat below healthy ranges (Concepcion, 2021). [22]

Female Athlete Triad

The **female athlete triad** is an important reality that coaches and trainers must pay attention to to keep their female athletes safe.

The Female Athlete Triad (FAT) is a syndrome that affects some female athletes and involves three interrelated components: low energy availability, menstrual dysfunction, and decreased bone mineral density. Similar to the Male Athlete Triad, these components are linked and can have serious health consequences if left unrecognized (Concepcion, 2021). [21]

1. **Low Energy Availability**
   - The first component of the triad is low energy availability, which occurs when caloric intake is insufficient to support both the energy demands of exercise and the body's basic physiological needs. Female athletes in sports emphasizing leanness, aesthetics, or weight categories, such as gymnastics, figure skating, or distance running, are particularly at risk. Chronic low energy availability can impair hormone production, reduce muscle recovery, and weaken the immune system.
2. **Menstrual Dysfunction**
   - Chronic low energy availability can disrupt normal reproductive function, leading to **menstrual dysfunction**. This can range from irregular cycles (oligomenorrhea) to the complete absence of menstruation (amenorrhea). Menstrual dysfunction is often a sign that the body is under metabolic stress, and prolonged disruptions can have long-term effects on fertility, bone health, and cardiovascular function.
3. **Decreased Bone Mineral Density**
   - The third component of the triad is decreased bone mineral density, which is largely a consequence of low estrogen levels associated with menstrual dysfunction. Low estrogen impairs bone formation and can result in osteopenia or osteoporosis over time. Female athletes with reduced bone density are at a higher risk for stress fractures, long-term

skeletal damage, and chronic musculoskeletal pain.

Risk Factors

Several factors increase the likelihood of developing the Female Athlete Triad:

- Participation in sports emphasizing thinness, leanness, or appearance
- High training volume without adequate caloric compensation
- Restrictive eating patterns or disordered eating behaviors
- Pressure from coaches, peers, or cultural expectations regarding body shape
- Psychological factors, such as perfectionism or low self-esteem

Emotional and Performance Consequences

The Female Athlete Triad can affect mental health and athletic performance. Fatigue, mood disturbances, anxiety, or depression may occur. Reduced energy, muscle strength, and endurance can impair training and competition outcomes. If untreated, the triad may also increase the risk of long-term metabolic, reproductive, and skeletal complications.

Prevention and Management

Preventing and managing the Female Athlete Triad requires a comprehensive approach:

- Ensuring adequate caloric intake to meet energy demands
- Monitoring menstrual function, hormone levels, and bone health regularly
- Promoting balanced nutrition and discouraging extreme dieting
- Educating athletes, coaches, and parents about the triad
- Providing professional support, including dietitians, sports medicine physicians, and mental health counselors

Early recognition and intervention are crucial. With proper management, athletes can restore energy balance, normalize menstrual function, and improve bone health, allowing them to maintain both their performance and overall well-being.

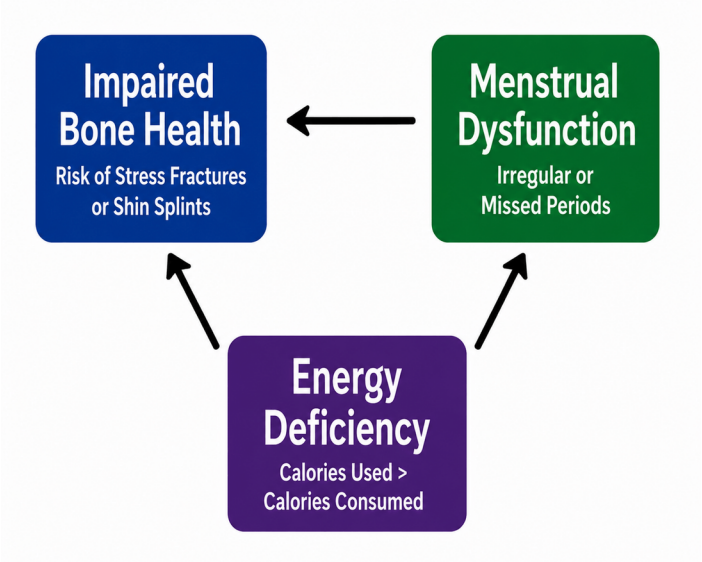


Figure 6.3.3: This flow chart shows how the female-athlete triad, starting with energy deficiency (bottom center), leads to menstrual dysfunction (right) and impaired bone health (left), and menstrual dysfunction also contributes to impaired bone health. (ChatGPT Generated Picture via OpenAI)

The female athlete triad can lead to serious long-term health consequences, including infertility, irreversible bone loss, and increased injury risk if not properly addressed. In Figure 6.3.3, it shows the cycle of potential health issues. On the bottom in purple is "Energy Deficiency" which happens from burning more calories than one consumes. "Energy Deficiency" leads to both

"Menstrual Dysfunction", indicated in green on the right of the diagram, which causes irregular or missed periods and "Impaired Bone Health" indicated in dark blue on the left of the diagram, which causes risk of stress fractures or shin splints. Menstrual Dysfunction is also a cause for impaired bone health, as indicated by the arrow going from right to left. Early detection, nutritional intervention, and appropriate training adjustments are essential for prevention and recovery (De Souza et al, 2014). [24]

Male Athlete Triad

While the female athlete triad has been widely studied, male athletes are also susceptible to a related condition known as the **Male Athlete Triad (MAT)**. The triad is a combination of three interrelated health issues: low energy availability, low testosterone levels, and decreased bone mineral density. Like its female counterpart, the Male Athlete Triad can have serious short- and long-term health consequences if left unrecognized (Concepcion, 2021). [21]

1. **Low Energy Availability**
   - The first component of the triad is low energy availability, which occurs when caloric intake is insufficient to meet the energy demands of both daily activity and exercise. Male athletes may unintentionally restrict calories due to dieting, weight-class sports (such as wrestling or boxing), or intense training schedules. Over time, insufficient energy intake can impair physiological processes, including hormone production, muscle recovery, and immune function.
2. **Low Testosterone**
   - Chronic low energy availability can lead to **hypogonadism**, a condition in which the body produces insufficient testosterone. Low testosterone can cause fatigue, reduced strength, decreased libido, and impaired muscle growth. It also contributes to decreased bone density, making bones more susceptible to stress fractures and long-term osteoporosis.
3. **Decreased Bone Mineral Density**
   - The third component of the triad is reduced bone mineral density. Testosterone plays a key role in bone formation and maintenance, so deficiencies in this hormone, combined with insufficient energy intake and inadequate nutrition, can compromise skeletal health. Male athletes with low bone density are at higher risk for stress fractures, chronic pain, and future bone-related health issues.

Risk Factors

Several factors increase the likelihood of developing the Male Athlete Triad:

- Participation in sports emphasizing leanness, weight classes, or aesthetics (e.g., wrestling, gymnastics, distance running)
- High training volumes without adequate caloric compensation
- Use of extreme dieting or restrictive eating practices
- Underlying psychological factors, including body dissatisfaction or disordered eating

Emotional and Performance Consequences

Beyond physical health, the Male Athlete Triad can affect mental well-being and athletic performance. Athletes may experience mood swings, anxiety, or depression, and chronic fatigue can reduce endurance, strength, and overall performance. Left untreated, these conditions can persist into adulthood, increasing the risk of long-term metabolic and skeletal issues.

Prevention and Management

Preventing the Male Athlete Triad requires a holistic approach:

- Ensuring adequate energy intake relative to training demands
- Monitoring body composition, hormone levels, and bone health regularly
- Encouraging balanced nutrition and avoiding extreme weight-control practices
- Providing education about the triad to athletes, coaches, and parents

Early recognition and intervention are critical. When managed properly, athletes can recover normal hormone levels, improve bone density, and maintain both health and performance.

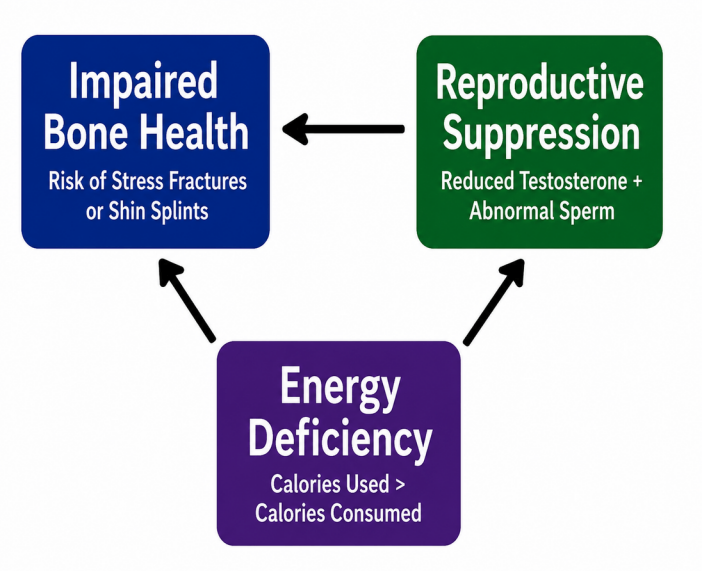


Figure 6.3.4: This flow chart shows how the male-athlete triad, starting with energy deficiency, leads to reproductive suppression and impaired bone health, and reproductive suppression also contributes to impaired bone health. (ChatGPT Generated Picture via OpenAI)

The male-athlete triad can have serious health consequences. Figure 6.3.4 shows the cycle of potential health issues. On the bottom in purple is "Energy Deficiency" which happens from burning more calories than one consumes. "Energy Deficiency" leads to both "Reproductive Supression", indicated in green on the diagram, which can cause reduced testosterone and abnormal sperm and "Impaired Bone Health" indicated in dark blue (left) on the diagram, which causes risk of stress fractures or shin splints. "Reproductive Suppression" is also a cause for impaired bone health, as indicated by the arrow going from right to left.

Special Populations and Considerations

While body composition is an important aspect of wellness for all individuals, certain populations face unique challenges and considerations that require tailored approaches. Athletes, children and adolescents, older adults, and clinical populations each have distinct physiological, developmental, and health-related needs that influence how body composition should be assessed and managed. Understanding these differences allows for more effective strategies to promote health, optimize performance, and prevent disease across the lifespan.

Athletes

Athletes represent a unique population in which body composition is closely linked to performance, injury prevention, and recovery. Unlike the general population, where body composition is often evaluated primarily for health and disease prevention, in athletes, it is also tied to sport-specific demands. For example, endurance athletes such as distance runners may benefit from lower fat mass to optimize energy efficiency, while strength and power athletes such as sprinters or weightlifters rely on higher proportions of lean muscle mass for explosive movements (Ackland et al, 2012). [1] Monitoring and optimizing body composition can therefore provide a competitive advantage by ensuring that an athlete's physique aligns with the physical requirements of their sport.



Figure 6.3.5: (Ready, Set...; Sam Knight via Unsplash)

Maintaining appropriate body composition is also important for reducing injury risk and supporting recovery. Excess body fat can increase mechanical stress on joints, while inadequate lean mass may limit stability and resilience during training or competition. In addition, very low levels of body fat, often pursued in sports with weight classifications or aesthetic components, may compromise hormonal balance, immune function, and bone density, leading to conditions such as Relative Energy Deficiency in Sport (RED-S) (Mountjoy et al, 2018). [56] This underscores the need for individualized and evidence-based approaches to body composition management in athletes.

Body composition assessment in athletes often relies on more advanced techniques, such as dual-energy X-ray absorptiometry (DEXA), air displacement plethysmography, or skinfold calipers conducted by trained professionals. These tools provide more precise estimates of fat mass, lean mass, and bone density than body mass index (BMI), which is a poor indicator for athletic populations due to their higher levels of muscle mass (Ode et al, 2007). [65] By combining accurate assessment methods with nutrition and training strategies, athletes can maintain body composition targets that promote both health and peak performance.

Children and Adolescents

Children and adolescents represent a critical period in the development of body composition, as rapid growth and hormonal changes shape fat distribution, muscle mass, and bone density. Unlike adults, body composition in youth is dynamic and continually shifting with age, sex, and pubertal status. Monitoring these changes is important because both undernutrition and excess adiposity during childhood can have lasting effects on physical health and wellness. The Centers for Disease Control and Prevention notes that childhood obesity increases the risk of early-onset type 2 diabetes, cardiovascular conditions, and orthopedic complications, while also increasing the likelihood of obesity persisting into adulthood (Centers for Disease Control and Prevention, 2022). [16]



Figure 6.3.6: (Happy Kids; Cybèle and Bevan via Unsplash)

Adolescence in particular is a sensitive stage for body composition because of the interplay between hormonal changes and lifestyle factors such as nutrition and physical activity. Puberty brings about increases in lean body mass in boys and changes in fat distribution in girls, which are natural but often misunderstood in the context of body image (Rogol et al, 2000). [75] Unrealistic cultural ideals about body size and shape can place pressure on adolescents, increasing the risk for disordered eating, poor self-esteem, and unhealthy weight-control practices (Neumark-Sztainer et al, 2002). [61] Supporting positive body image and providing education about normal growth patterns are, therefore, essential components of promoting both physical and emotional wellness in this population.

Accurate assessment of body composition in children and adolescents requires age- and sex-specific standards. Body mass index (BMI) percentiles are commonly used, but they do not distinguish between fat mass and lean mass. More precise methods, such as skinfold measurements, bioelectrical impedance analysis, or dual-energy X-ray absorptiometry (DEXA), can provide a clearer picture of body composition when needed (Freedman et al, 2005). [31] Interventions that encourage balanced nutrition, daily physical activity, and adequate sleep are effective strategies for helping young people maintain healthy body composition and establish lifelong habits that support wellness.

Older Adults

Older adults represent a unique population in which body composition plays a critical role in health, independence, and quality of life. Aging is associated with sarcopenia, the progressive loss of muscle mass and strength, as well as increases in fat mass, particularly visceral fat. These changes contribute to reduced mobility, greater risk of falls, and increased vulnerability to chronic diseases such as type 2 diabetes, cardiovascular disease, and osteoporosis (Volpi et al, 2004). [88] Maintaining lean muscle mass while limiting excess fat is therefore essential for supporting functional ability and prolonging independence in older adulthood.



Figure 6.3.7: Paying attention to overall health becomes more important ands complicated as people age. (Elderly Couple; Sasha Matveeva on Unsplash)

In addition to physical health, shifts in body composition among older adults can affect metabolic efficiency and energy balance. Muscle tissue is metabolically active, and its loss lowers resting metabolic rate, which can lead to gradual weight gain if dietary intake is not adjusted (Roubenoff, 2000). [77] This combination of sarcopenia and increased fat mass, known as sarcopenic obesity, poses a dual threat by compounding frailty with cardiometabolic risks (Zamboni et al, 2008). [96] Addressing body composition in older adults thus requires interventions that both preserve muscle mass and reduce excess fat.

Regular resistance training, adequate protein intake, and physical activity are among the most effective strategies to counter age-related declines in body composition. The American College of Sports Medicine recommends strength training at least two days per week for older adults to maintain muscle mass and bone density American College of Sports Medicine, 2014). [2] In addition, balanced nutrition with sufficient protein and micronutrients supports muscle synthesis and reduces the risk of malnutrition, which is common in older populations. Lifestyle interventions that combine exercise, nutrition, and fall-prevention strategies have been shown to improve both body composition and quality of life in older adults (Landi et al, 2014). [47]

Clinical Populations

Clinical populations such as individuals with obesity, type 2 diabetes, cardiovascular disease, cancer, and eating disorders experience unique challenges related to body composition that directly affect health outcomes and quality of life. In these groups, excess body fat, particularly visceral adiposity, is strongly associated with insulin resistance, hypertension, dyslipidemia, and systemic inflammation, all of which contribute to chronic disease progression (Després, 2012). [25] On the other end of the spectrum, conditions such as anorexia nervosa or advanced cancer can lead to dangerously low body fat and muscle wasting. These changes increase the risk of frailty, immune dysfunction, and poor recovery from illness (Fearon et al, 2011). [30] Because of these extremes, accurate assessment and careful management of body composition are critical in clinical care.



Figure 6.3.8: Close monitoring of hospitalized persons is important for determining future issues. (Child Sitting on a Bed; National Cancer Institute via Unsplash)

Maintaining or restoring a healthy body composition is often a therapeutic goal in clinical settings. For individuals with type 2 diabetes, reducing fat mass, especially visceral fat, can improve glycemic control and lessen the need for medication (Lean et al, 2019). [49] For cancer patients, preventing or treating sarcopenia and cachexia is essential for preserving strength, maintaining tolerance to treatments, and improving overall survival (Prado et al, 2008). [70] Patients with cardiovascular disease also benefit from changes in body composition that include lowering fat mass while increasing lean mass, which together improve cardiac function, mobility, and long-term prognosis (Lavie et al, 2014). [48]

Clinical interventions that target body composition typically involve a multidisciplinary approach. This may include medical treatment, individualized nutrition therapy, and supervised physical activity. For example, resistance training combined with adequate protein intake can help preserve muscle mass in patients undergoing cancer treatment. Structured exercise and dietary modification are also central to the management of obesity and diabetes. Individualized care plans that account for the patient's medical condition, functional ability, and psychosocial needs are essential to achieving improvements in both body composition and overall wellness (Arends et al, 2017). [6]

Key Points

- Maintaining a healthy body composition is critical because both excess body fat and insufficient fat can negatively affect physical, metabolic, and reproductive health.
- Excess body fat, particularly visceral fat stored around the abdomen, increases the risk of chronic diseases such as cardiovascular disease, type 2 diabetes, hypertension, certain cancers, and metabolic syndrome.
- High levels of body fat also impair mobility, joint health, physical performance, and overall quality of life, and can contribute to psychological stress, low self-esteem, and weight-related stigma.
- Too little body fat, especially essential fat, compromises hormone regulation, reproductive function, immune response, and organ protection, and may lead to nutrient deficiencies, decreased bone density, and increased injury risk.
- The Female and Male Athlete Triads highlight the consequences of chronic low energy availability, which can result in hormonal disruptions, menstrual dysfunction, low testosterone, decreased bone density, and reduced athletic performance.
- Body fat distribution patterns influence health risk, with android (apple-shaped) fat linked to higher metabolic and cardiovascular risk, while gynoid (pear-shaped) fat generally carries lower risk.
- Lifestyle factors such as nutrition, exercise, sleep, and stress management significantly influence fat-to-lean mass ratios, helping prevent excess fat accumulation or excessive fat loss.
- Special populations, including athletes, children and adolescents, older adults, and clinical populations, require tailored approaches to manage body composition for optimal health, performance, and disease prevention.
- Clinical interventions targeting body composition often combine medical treatment, individualized nutrition, and supervised exercise to reduce fat mass, preserve or increase lean mass, and improve functional and metabolic health.
- Regular monitoring and assessment of body composition, including fat percentage, lean mass, and fat distribution, are

essential for preventing disease, optimizing performance, and supporting long-term physical and emotional wellness.

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6.4: Body Composition for Wellness



Figure 6.4.1: (Two women high-fiving each other; Docusign via Unsplash)

Introduction

Body composition is more than a measure of weight; it reflects the balance of fat, muscle, bone, and water that supports health and overall wellness. Its influence extends across multiple dimensions of well-being, including physical, emotional, social, and occupational domains. A healthy body composition enhances strength, energy, and mobility, while also shaping self-esteem, social relationships, and performance in daily life. Conversely, imbalances in body composition, whether through excess fat or loss of lean mass, can contribute to chronic disease, reduced quality of life, and diminished vitality.

In addition, certain populations face unique challenges and considerations when it comes to body composition. Athletes, children and adolescents, older adults, and clinical populations each require tailored approaches due to differences in physiology, development, or health status. Understanding these distinctions allows educators, health professionals, and individuals to better support wellness across the lifespan, promoting not only the prevention of disease but also the pursuit of balance, performance, and long-term vitality.

Emotional Wellness

Emotional wellness refers to the ability to understand, manage, and healthily express emotions. It also encompasses maintaining positive relationships, coping with stress, and cultivating resilience. Body composition is closely tied to emotional wellness, as individuals' perceptions of their bodies and the societal pressures related to body image often affect self-esteem, mood, and overall mental health. Research shows that individuals with higher levels of body dissatisfaction are at greater risk for low self-esteem, anxiety, and depression, regardless of their actual body size or fat distribution (Neumark-Sztainer et al, 2006). [61] This demonstrates that the relationship between body composition and emotional wellness is not solely biological but deeply psychological and social as well.

Cultural ideals of thinness or muscularity, reinforced through media and social networks, often influence how individuals perceive their own body composition. Unrealistic comparisons can contribute to body image disturbance and disordered eating behaviors. The American Psychological Association highlights that constant exposure to idealized body standards can lead to negative self-talk and a distorted sense of self-worth, particularly among adolescents and young adults. These pressures illustrate how emotional wellness can be undermined not by body composition itself, but by how it is perceived in the context of societal expectations (American Psychological Association, 2019). [5]

Body Image

Body image plays a significant role in shaping how individuals think, feel, and behave regarding their bodies. Body image refers to how individuals perceive, think, and feel about their physical appearance. While body composition can influence how someone looks, body image is shaped not only by objective measurements but also by social, cultural, and psychological factors. It is a complex and multidimensional concept influenced by personal perceptions, emotions, and behaviors, as well as external factors such as social pressures, media, and family influences. Developing a positive body image is essential for mental and physical well-being, yet many people struggle with body dissatisfaction, which can lead to serious health concerns, including eating disorders. As one will learn in Chapter 9, eating disorders such as anorexia nervosa, bulimia nervosa, and binge-eating disorder are severe and potentially life-threatening conditions that involve unhealthy eating patterns and negative body image. Additionally, concerns about both excessive body fat and low body composition present unique health risks. Understanding body image, eating disorders, and the health implications of body composition is crucial to promoting balanced self-perception, healthy eating habits, and overall well-being.

A person with a positive body image has a clear and true perception of their body, seeing the various parts of their body as they are. **Body positivity** (or body satisfaction) involves feeling comfortable and confident in your body, accepting your natural body shape and size, and recognizing that physical appearance says very little about one's character and value as a person.

A person with a negative body image or a distorted perception of their body has feelings of shame, anxiety, and self-consciousness. People who experience high levels of body dissatisfaction feel their bodies are flawed in comparison to others, and they are more likely to suffer from feelings of depression, isolation, low self-esteem, and eating disorders.

In modern society, exposure to media images, social pressures, and cultural ideals often leads people to compare their bodies with unrealistic standards of beauty or fitness. These comparisons can strongly affect self-esteem, motivation, and mental health.

A healthy body image involves accepting and appreciating one's body, while recognizing its strengths and limitations. However, when dissatisfaction becomes extreme or persistent, it can contribute to unhealthy behaviors such as disordered eating, compulsive exercise, or misuse of supplements and performance-enhancing drugs.

Body Dysmorphic Disorder (BDD)

One clinical condition related to body image is **body dysmorphic disorder (BDD)**. BDD is a psychological disorder in which individuals become excessively preoccupied with perceived flaws in their appearance, even when these flaws are minor or not noticeable to others. People with BDD often engage in repetitive behaviors, such as mirror-checking, excessive grooming, or seeking reassurance, which interfere with daily life. BDD is linked to anxiety, depression, and reduced quality of life. Importantly, body dysmorphic disorder is not resolved by changes in body composition alone, since the root issue is a distorted perception of one's appearance. Effective treatments often include cognitive-behavioral therapy (CBT) and, in some cases, medication.

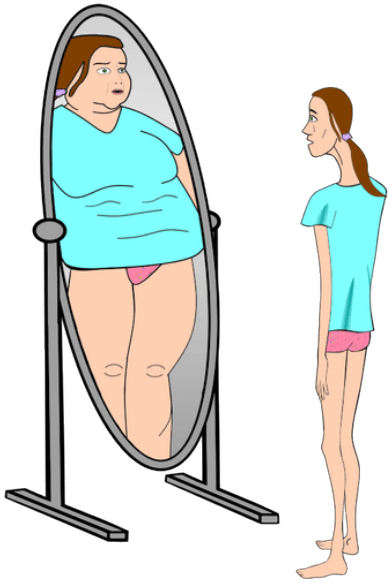


Figure 6.4.2: Some disorders make us see something different from what others might see. (Public Domain; Anonymous via Wikimedia Commons)

Muscle Dysmorphia

A related condition, particularly relevant in fitness and athletic contexts, is **muscle dysmorphia**. Sometimes called "reverse anorexia" or "bigorexia," muscle dysmorphia occurs when individuals—most often men, though not exclusively—believe they are too small or not muscular enough, even if they have above-average muscle size and strength. This perception drives behaviors such as excessive weight training, rigid dieting, and, in some cases, the use of anabolic steroids or other performance-enhancing substances.

Muscle dysmorphia can negatively impact physical and mental health. Physically, overtraining can increase the risk of injury, while steroid use may cause serious long-term health complications. Psychologically, the obsession with size and muscularity often leads to distress, social withdrawal, and impaired relationships.



Figure 6.4.3: Overtraining is possible and potentially dangerous, especially for individuals with muscle dysmorphia. (Man Lifting; Alora Griffiths via Unsplash)

Origins of Body Image and Its Emotional Impact

Body image does not develop in isolation. From early childhood through adulthood, it is shaped by a combination of personal experiences, social influences, and cultural expectations. Two of the most powerful sources of body image development are family and media exposure.

Family Influence

Family is often the first and most consistent influence on how individuals view their bodies. Parents, siblings, and close relatives provide both direct and indirect messages about appearance, weight, and health. Supportive families who emphasize balanced nutrition, physical activity, and self-acceptance can foster a positive body image. In contrast, frequent criticism about weight, comparisons among siblings, or parental modeling of dieting behaviors can lead to body dissatisfaction.

For example, a child who hears repeated comments about needing to lose weight may internalize the belief that their worth is tied to appearance. Similarly, observing a parent express dissatisfaction with their own body can teach children that self-criticism is normal. These early experiences often set the foundation for how individuals evaluate themselves later in life.

Positive Family Strategies

Families can counteract negative influences by avoiding appearance-based criticism, modeling healthy attitudes toward food and exercise, and celebrating body function rather than body size. For instance, praising children for what their bodies can *do*—such as running, playing, or dancing—encourages confidence in physical ability rather than focusing only on appearance. Shared activities like cooking balanced meals together or enjoying recreational exercise as a family can also reinforce a healthy and supportive environment.

Media Influence

In addition to family, the media plays a central role in shaping body image. Television, movies, advertisements, and especially social media platforms often present narrow and idealized standards of beauty and fitness. These images are frequently digitally altered, making them unrealistic and unattainable for most people. Constant exposure can create pressure to conform to these ideals, fueling dissatisfaction even in individuals who are otherwise healthy.

Social media has amplified these effects by providing platforms for comparison. While some online communities promote body positivity, many others reinforce the idea that appearance defines value. “Fitspiration” or “thinspiration” content, for instance, can encourage unhealthy behaviors such as extreme dieting or compulsive exercise in the pursuit of the “ideal” body.

More to Explore - Positive Media Campaigns

In recent years, initiatives such as the **Dove Campaign for Real Beauty** and the **#AerieREAL campaign** have challenged traditional beauty standards by featuring models of different shapes, sizes, and ethnicities, often without digital retouching.

Social media movements such as **#BodyPositivity** and **#HealthAtEverySize** encourage acceptance of diverse body types while promoting health-focused, rather than appearance-focused, goals. These campaigns provide young people with counter-narratives that celebrate authenticity and self-acceptance.

Emotional Consequences

The internalization of family messages and media portrayals can have profound emotional effects. Negative body image is strongly linked to low self-esteem, anxiety, depression, and social withdrawal. Individuals who feel that their bodies do not meet external expectations may experience shame, embarrassment, or a persistent sense of inadequacy.

Conversely, when family and media promote diverse, realistic, and positive representations of body types, individuals are more likely to feel confident and accepting of themselves. This healthier outlook fosters resilience, improves mental well-being, and encourages behaviors that support overall health rather than the pursuit of unrealistic appearance goals.

Linking Body Image and Emotional Wellness

Although body composition is an important measure of physical health, it is equally important to recognize the psychological dimensions of how people view their bodies. Negative body image, whether in the form of dissatisfaction, BDD, or muscle dysmorphia, can drive harmful behaviors that undermine both mental and physical well-being. Promoting a balanced perspective, valuing function and overall health over appearance alone, is essential in fostering both a positive body image and sustainable health practices.

Question

- If body image is what you think, feel, perceive, and behave regarding your body, when you look in the mirror, how do you see yourself and feel about your body (e.g., height, shape, and weight)?
- Does "I'm too fat" or "I'm too skinny" or I'd be happy if I were.....(taller, shorter, more muscular, had longer legs, etc)" sound familiar?

Many people have difficulty accepting their bodies, and this dissatisfaction can harm self-esteem and emotional wellness (Hosseini & Padhy, 2021). [38] Body image is a multidimensional concept that includes:

- Cognitive: thoughts and beliefs about the body
- Perceptual: how people perceive the size and shape of their body and body parts
- Affective: feelings about the body
- Behavioral: the actions that people perform to check on, tend to, alter, or conceal their bodies

Factors affecting body image and body image disorders include: BMI, family, social pressures, media, social media, self-esteem, chronic illness, depression, and sexual abuse.



Figure 6.4.4: How we think about ourselves and our bodies can have profound effects on our mental health. (Standing in Mirror; MART PRODUCTION via Pexels)

At the same time, positive changes in body composition can improve emotional wellness when approached in healthy ways. Regular physical activity and balanced nutrition not only support reductions in body fat and improvements in muscle mass but also release endorphins and improve mood regulation. Studies have shown that individuals who engage in regular exercise report better body satisfaction and reduced symptoms of depression, independent of actual changes in weight or fat percentage (Rebar et al, 2015). [74] This suggests that emotional wellness benefits both from the physiological improvements of body composition and the psychological empowerment gained from adopting healthy behaviors.

It is also important to acknowledge the risks of overemphasizing body composition in the pursuit of wellness. Excessive focus on leanness or muscularity can lead to unhealthy behaviors such as over-exercising, restrictive dieting, or the development of

eating disorders, which negatively affect emotional health. The National Eating Disorders Association emphasizes that emotional wellness depends on cultivating a balanced and compassionate relationship with one's body rather than striving for an unrealistic standard (National Eating Disorders Association, 2023). [58] Encouraging individuals to measure progress through functional health outcomes, such as energy levels, strength, or improved mood, rather than appearance, can foster healthier attitudes toward body composition.

Ultimately, emotional wellness and body composition are interwoven in ways that extend beyond physical appearance. By developing a positive body image, practicing self-compassion, and embracing sustainable lifestyle habits, individuals can protect their mental and emotional well-being while also supporting healthy physical outcomes. A holistic view of wellness recognizes that true health is not defined solely by numbers on a scale or body fat percentages, but by the harmony between physical health, emotional resilience, and overall quality of life.

Question

- How have cultural or social influences shaped the way you think about body composition?
- How might these perceptions affect your emotional wellness?
- What are some practical ways you could shift your focus from appearance-based goals to functional or health-based outcomes to support both emotional wellness and body composition?

Strategies to Improve Self-Image

There are a variety of strategies that can help improve one's self-image

- **Focus on Function, Not Just Appearance**
  - Appreciate what your body can do - such as moving, learning, playing sports, or simply getting you through the day.
- **Limit Harmful Media Exposure**
  - Unfollow or mute social media accounts that trigger negative comparisons.
  - Follow pages that promote diverse, realistic, and positive body representations.
- **Practice Positive Self-Talk**
  - Replace self-critical thoughts with affirmations that emphasize strengths and abilities.
- **Surround Yourself with Supportive People**
  - Spend time with family, friends, or communities that value health, kindness, and personal growth over looks.
- **Set Realistic Goals**
  - Focus on achievable, health-oriented goals (e.g., improving strength, energy, or stamina) instead of chasing an "ideal" body type.
- **Engage in Enjoyable Physical Activity**
  - Choose an exercise that feels good and builds confidence rather than only exercising for appearance-related reasons.
- **Avoid Comparison Traps**
  - Remember that bodies naturally vary by genetics, age, and lifestyle; comparing yourself to others is often misleading.
- **Practice Gratitude**
  - Keep a journal or mental list of things you value about yourself—both physical and non-physical traits.
- **Seek Professional Support When Needed**
  - Counselors, therapists, or support groups can help address deeper body image issues, such as body dysmorphic disorder or eating concerns.
- **Promote Body Positivity in Others**
  - Compliment peers on qualities unrelated to looks (e.g., effort, creativity, kindness), helping to create a healthier environment for everyone.

Recognizing Unhealthy Habits

Table 6.4.1 highlights common habits that can contribute to a negative body image and offers healthier alternatives to replace them. By shifting focus from appearance to function, surrounding oneself with supportive influences, and practicing gratitude and self-compassion, individuals can build a more positive self-image. The goal is not to ignore physical health, but to view it in a balanced way that emphasizes well-being, confidence, and self-acceptance over unrealistic ideals

Table 6.4.1: Unhealthy habits v. Positive Alteratives for Body Image

Unhealthy Habit	Positive Alternative
Criticizing your body in the mirror	Practice positive self-talk and highlight strengths
Following unrealistic “ideal body” accounts	Curate your feed to include diverse, body-positive role mo
Exercising only to “burn calories.”	Engage in activities you enjoy that make you feel strong a
Comparing yourself constantly to others	Focus on personal progress and set realistic, health-orien
Avoiding social events due to appearance	Spend time with supportive friends and family who value y
Focusing only on flaws	Practice gratitude by listing things you appreciate about y
Ignoring emotional distress about body image	Seek help from a counselor, therapist, or support group w
Commenting on others’ appearance	Compliment qualities related to looks (e.g., creativity, kind

Physical Wellness

Physical wellness is the dimension of wellness that emphasizes maintaining a healthy body through regular physical activity, balanced nutrition, adequate rest, and the prevention of disease. A central aspect of physical wellness is body composition, which reflects the proportion of fat, muscle, bone, and water in the body. Unlike body weight alone, which simply measures total mass, body composition provides a more accurate indicator of physical health. Excess adiposity, particularly visceral fat, is associated with elevated risk for cardiovascular disease, type 2 diabetes, and hypertension, while maintaining an appropriate level of lean body mass is linked to greater strength, endurance, and mobility (Centers for Disease Control and Prevention, 2022). [15]

An optimal body composition supports the functional capacity of the body by enabling efficient movement and reducing strain on joints and connective tissues. For example, higher levels of lean muscle mass contribute to improved posture, balance, and metabolic health, while lower levels of fat mass reduce the burden on the cardiovascular and musculoskeletal systems. The World Health Organization notes that regular physical activity not only improves body composition but also reduces premature mortality by mitigating the effects of chronic disease (World Health Organization, 2021). [94] This demonstrates that physical wellness and body composition are inseparable when considering the overall quality of life.

In addition to chronic disease prevention, body composition directly affects energy balance and metabolism. Skeletal muscle is a metabolically active tissue that plays a critical role in regulating glucose uptake and energy expenditure. Higher muscle mass increases resting metabolic rate, which makes weight management and fat loss more achievable when combined with regular exercise and appropriate nutrition (Jensen et al, 2014). [41] On the other hand, low levels of lean mass or sarcopenia, often associated with aging, increase risk for frailty, falls, and loss of independence, underscoring the importance of preserving muscle throughout the lifespan (Volpi et al, 2004). [88]



Figure 6.4.5: Physical wellness can make us feel and look younger. (Fit Man in the Gym; Asso Myron via Unsplash)

Physical wellness also requires the prevention of unhealthy practices related to body composition. Crash dieting, excessive exercise, or reliance on unregulated supplements can compromise both lean mass and long-term metabolic health. Instead, evidence supports moderate, sustainable approaches that combine resistance training, aerobic activity, and balanced dietary patterns such as the Mediterranean or DASH diets for achieving a healthy body composition (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). [86] These strategies not only promote healthier body fat distribution but also enhance cardiovascular fitness, muscular strength, and endurance—all essential aspects of physical wellness.

In sum, body composition is a key determinant of physical wellness, influencing disease risk, functional capacity, and overall vitality. By focusing on maintaining lean body mass and minimizing excess fat through consistent lifestyle habits, individuals can achieve improvements in strength, mobility, and metabolic health that extend far beyond appearance. This holistic approach highlights that physical wellness is not merely the absence of illness, but an active pursuit of balance and vitality that allows individuals to engage in life fully.

Question

- How does focusing on body composition, rather than body weight alone, change the way you think about your own physical wellness and long-term health?
- What sustainable strategies could you incorporate into your daily life to help maintain or improve lean body mass while preventing excess fat accumulation?

Social Wellness

Social wellness refers to the quality of relationships, sense of belonging, and the ability to interact positively with others in personal, professional, and community settings. Body composition can influence social wellness in complex ways, as perceptions of appearance and fitness levels often affect how individuals engage with peers and communities. Research shows that individuals who are dissatisfied with their bodies or who perceive themselves as overweight are more likely to experience social withdrawal, bullying, or stigmatization, which negatively impacts social well-being (Puhl & Heuer, 2010). [73] In this way, body composition and more importantly, perceptions of body composition, can shape social confidence and participation.

Social norms and cultural standards play a significant role in how body composition is evaluated and valued. Many societies idealize thinness or muscularity, creating pressure to conform to specific body types. These pressures can foster discrimination or weight stigma, which may reduce opportunities for social connection and inclusion (Tomiyama et al, 2018). [85] Such stigma not only undermines emotional wellness but can also lead to avoidance of social situations, decreased participation in group activities, and even reduced access to health care due to fear of judgment. This demonstrates how social wellness is intertwined

with societal attitudes toward body composition.



Figure 6.4.6: How we are accepted socially can have profound effects on physical and mental health. (Shame; La Fabbrica Dei Sogni via Unsplash)

At the same time, supportive social networks can enhance both social wellness and body composition. Participation in group-based physical activities, such as recreational sports, exercise classes, or walking groups, provides opportunities for connection while also encouraging healthy lifestyle habits. Social support has been found to increase adherence to physical activity and dietary goals, leading to improvements in both health outcomes and quality of life (Carron et al, 2004). [12] This highlights how positive social environments not only nurture emotional resilience but also facilitate healthier body composition through encouragement and accountability.

Importantly, promoting social wellness in the context of body composition requires reducing stigma and fostering inclusivity. Initiatives that celebrate diverse body types and emphasize functional health over appearance can create more supportive communities. The World Health Organization stresses the importance of reducing health inequities and social determinants of stigma, which affect both physical and social wellness outcomes (World Health Organization, 2021). [95] By creating environments where individuals feel accepted regardless of body shape or size, communities can enhance social cohesion and overall well-being.

In summary, social wellness and body composition are linked through both individual experiences and broader cultural dynamics. While body composition can influence how individuals are perceived and treated socially, supportive environments and inclusive practices can mitigate negative effects and promote healthier lifestyles. Recognizing the social dimension of body composition encourages a shift away from stigmatization and toward building connections that empower individuals to thrive physically, emotionally, and socially.

Question

- In what ways have social norms or cultural standards influenced how you view your own body composition?
- How has this shaped your willingness to engage in social situations?
- How could building or participating in supportive social networks help you maintain both healthy relationships and healthy lifestyle habits related to body composition?

Occupational Performance

Occupational performance refers to the ability to effectively fulfill roles and responsibilities in work, academic, and daily living environments. Body composition plays an important role in this dimension of wellness because it influences energy levels, functional capacity, and overall productivity. Individuals with healthier body composition often report greater stamina, reduced

fatigue, and improved concentration, which enhance their ability to meet the physical and cognitive demands of their occupations (Pronk et al, 2004). [71] Conversely, excess adiposity has been linked with higher absenteeism, presenteeism (working while ill or impaired), and reduced occupational performance (Goetzel et al, 2014). [33]

Excess body fat, particularly visceral fat, increases the risk for chronic diseases such as cardiovascular disease, type 2 diabetes, and musculoskeletal disorders. These conditions can directly impair occupational functioning by causing physical limitations or increasing medical leave (Organization for Economic Co-operation and Development, 2019). [67] For example, low back pain and joint problems associated with excess body weight are among the leading causes of lost workdays worldwide. On the other hand, maintaining lean body mass through regular physical activity not only supports physical strength but also reduces injury risk, enabling individuals to remain more consistently engaged in occupational tasks.



Figure 6.4.7: Cognitive performance can be affected by body composition issues. (Brain; Lisa Yount via Unsplash)

Body composition also influences cognitive performance, which is essential for most modern occupations. Research suggests that obesity and metabolic dysfunction are associated with poorer executive function, memory, and processing speed (Smith et al, 2011). [81] These cognitive impairments can affect workplace efficiency, decision-making, and safety, especially in occupations that require high levels of attention and problem-solving. By contrast, improvements in body composition through lifestyle interventions such as exercise and healthy eating have been shown to support brain health and cognitive performance across the lifespan (Gomez-Pinilla, 2008). [34]

Occupational performance is further shaped by psychosocial factors linked to body composition. Weight stigma in the workplace can affect career opportunities, self-esteem, and interpersonal relationships, undermining both productivity and job satisfaction (Puhl & Heuer, 2009). [72] Creating inclusive work environments that value employees for their skills and contributions rather than appearance is essential to supporting occupational wellness. Workplace wellness programs that emphasize health behaviors over body size have demonstrated success in improving both physical outcomes and organizational performance (Baicker et al, 2010). [8]

In summary, body composition is a significant determinant of occupational performance through its effects on physical capacity, cognitive function, and psychosocial well-being. A healthy body composition enhances energy, reduces disease-related absences, and supports sharper cognitive functioning, all of which contribute to sustained productivity and career success. By recognizing the connection between wellness and occupational performance, both individuals and organizations can foster environments that promote health, inclusivity, and long-term professional fulfillment.

Question

- How might your current body composition affect your ability to focus, maintain energy, and perform effectively in school, work, or other daily responsibilities?
- What steps could you take to support both your body composition and your occupational performance?
- How might these changes improve your productivity and overall well-being?

Key Points

- Body composition refers to the balance of fat, muscle, bone, and water in the body, making it a more meaningful measure of health than weight alone.
- Body composition influences multiple wellness dimensions, including physical, emotional, social, and occupational health.
- Maintaining lean muscle mass and minimizing excess fat improves strength, endurance, mobility, and reduces chronic disease risk.
- Skeletal muscle is metabolically active, increasing resting metabolic rate and aiding weight management. Sarcopenia, or muscle loss, raises risks for frailty and falls.
- Body image perceptions strongly influence self-esteem, mood, and mental health. Unrealistic cultural ideals may lead to anxiety, depression, or eating disorders.
- Body composition affects relationships and social participation. Weight stigma and discrimination can undermine connection and inclusion, while supportive networks encourage healthy behaviors.
- Healthy body composition enhances stamina, concentration, and productivity. Excess adiposity is linked to absenteeism and presenteeism, while poor metabolic health can impair cognition.
- Athletes' body composition needs are sport-specific: endurance athletes benefit from lower fat mass, while strength athletes require more lean mass. Both extremes of fatness or leanness carry risks.
- Growth and puberty drive dynamic changes in body composition. Obesity in childhood raises lifelong health risks, while body image concerns in adolescence can lead to unhealthy behaviors.
- Aging leads to sarcopenia and an increase in visceral fat. Sarcopenic obesity compounds risks for chronic disease and frailty, making resistance training and adequate nutrition essential.
- Excess fat is linked to diabetes, cardiovascular disease, and cancer progression, while severe fat or muscle loss in conditions like anorexia or cachexia increases frailty. Individualized, multidisciplinary care is required.
- Across all populations, the goal is balance. Sustainable nutrition, regular activity, and inclusive attitudes support healthy body composition, overall wellness, and quality of life.

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6.5: Assessing Body Composition



Figure 6.5.1: (Measuring; Huha Inc. via Unsplash)

Introduction

Evaluating body composition allows for a deeper understanding of physical health. A high proportion of fat tissue, especially visceral fat around internal organs, is associated with an increased risk of chronic conditions like cardiovascular disease and type 2 diabetes. In contrast, higher levels of lean tissue, such as muscle and bone, are linked to better strength, mobility, and metabolic function. By examining the types and distribution of tissue in the body, health professionals can make more accurate assessments and recommendations than by using weight or body size alone. In addition to BMI, other measures such as waist circumference, hip circumference, and body composition assessments can provide complementary information about fat distribution and health risk

Body Mass Index

Body Mass Index (BMI) is an indirect method for estimating body fat and assessing potential health risks associated with body weight. Unlike direct measures of body composition, which differentiate between fat mass and lean mass, BMI relies solely on a person's height and weight. It is calculated by dividing body weight in kilograms by the square of height in meters (kg/m^2). BMI is widely used in both clinical and public health settings because it is quick, noninvasive, and easy to calculate.

BMI Calculation

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}.$$

For example, according to BMI guidelines, a female who is 5'6" (1.68 meters) tall would ideally weigh no more than approximately 155 pounds (70 kilograms) to fall within the "normal weight" range (green). If her weight exceeded this range, she would be categorized as "overweight" (yellow), which may indicate an increased risk for certain health complications. It is important to note, however, that BMI does not distinguish between fat mass and lean muscle mass, so very muscular individuals may be classified as overweight even when they have a healthy body composition.

As noted previously, BMI is the most used tool to assess healthy weight, but for many people, it is not an accurate measurement because it does not assess their body composition. For example, two people can have the same height and weight, thus the same

BMI, but one could be a professional athlete who is very active with low body fat, and the other could be sedentary with high body fat. Using the example in Table 6.5.1, a person who is 5'9" and 203 pounds is considered obese using the BMI; it does not matter whether that person is a 203-pound professional weightlifter or a sedentary person with high body fat.

Table 6.5.1: Weight Status by BMI Measurement

BMI	Weight Status
Below 18.5 (Blue)	Underweight
18.5 - 24.9 (Green)	Healthy Weight
25.0 - 29.9 (Yellow)	Overweight
30.0 - 34.9 (Orange)	Moderately Obese
35.0 - 39.9 (Dark Orange)	Severely Obese
40.0 and above (Red)	Very Severely Obese

Question

- What is your Body Mass Index?
- Do you think it is an accurate assessment of your body composition?

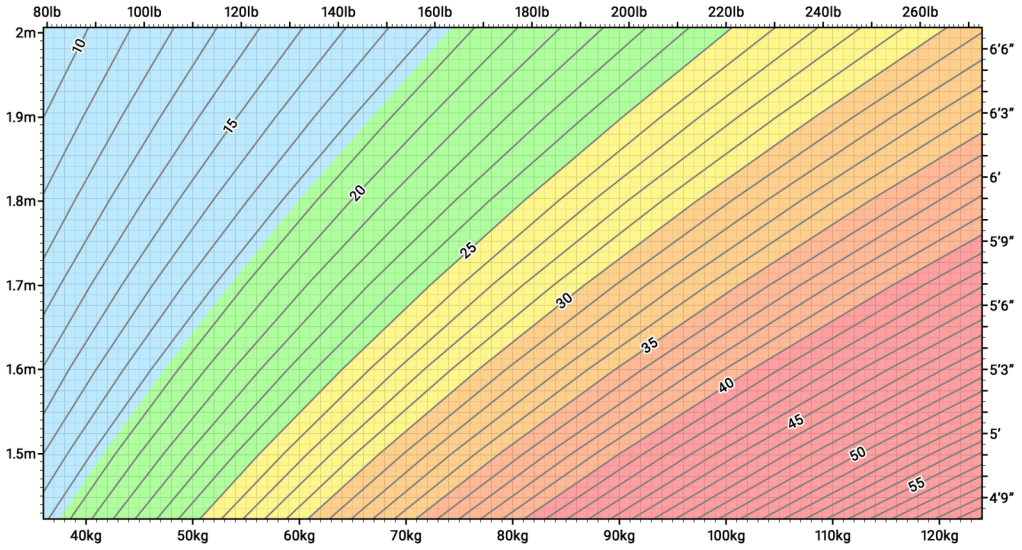


Figure 6.5.2: A color-coded BMI chart showing height and weight ranges in both metric and imperial units. (CC BY-SA 4.0; nagualdesign via Wikimedia Commons)

To use the table, find your height in the first column on the left, labeled Height. Move across the row to your weight. The number at the top of the column directly above your weight is your BMI.

	Healthy Weight						Overweight					Obese										Extreme Obesity														
BMI	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Height	Body Weight (pounds)																																			
4'10"	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258
4'11"	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	232	242	247	252	257	262	267
5'0"	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276
5'1"	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	253	259	264	269	275	280	285
5'2"	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295
5'3"	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304
5'4"	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314
5'5"	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324
5'6"	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334
5'7"	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344
5'8"	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354
5'9"	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365
5'10"	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376
5'11"	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386
6'0"	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397
6'1"	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408
6'2"	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420
6'3"	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431
6'4"	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443

Figure 6.5.3: A BMI chart showing height and weight ranges in imperial units. An accessible PDF is available from the NIH. (NIH; free use)

Body Mass Index Accuracy

Among several criticisms, the BMI method has been faulted for not distinguishing between FM and FFM, since only the overall weight is considered. For athletes, who may be more massive because of larger muscles, this criticism holds. For example, a professional football player who weighs 215 pounds and stands at 6’3” would have the same BMI as a relatively sedentary armchair 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 is 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 (Centers for Disease Control and Prevention, n.d.). [13]

More To Explore

For more information on Adult BMI measurement and interpretation, visit the Centers for Disease Control website.

Methods for Estimating Percent Body Fat

Multiple methods exist to estimate body composition. Remember, body composition is the ratio 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.

Evaluate Your Current Status

- For a more hands-on approach to your data, engage in Lab 6.7.1 and Lab 6.7.2 to explore BMI and Body Fat Distribution.

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 limit access for most. Also, for those with a fear of water, this would not be the preferred method.

Dual Energy X-Ray Absorptiometry (DEXA)

Replacing underwater weighing as the new "gold standard" is the **Dual Energy X-Ray Absorptiometry** (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 guesswork 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, **plethysmography** or air displacement, determines body density using the same principle as underwater weighing, by measuring mass and volume. The main difference is that mass and volume are determined by air displacement rather than water displacement. Using a commercial device (the Bod Pod is most 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 personnel training that air displacement requires limit accessibility for many. Additionally, its accuracy is slightly less than underwater weighing.

Bio-electrical Impedance Analysis (BIA)

Bio-electrical Impedance (BIA) takes a slightly different approach to measuring FFM. The premise behind BIA is that FFM is proportional to the body's electrical conductivity. 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-programmed 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 considered. 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. Skinfold measurement assumes that the amount of subcutaneous fat is

proportional 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.

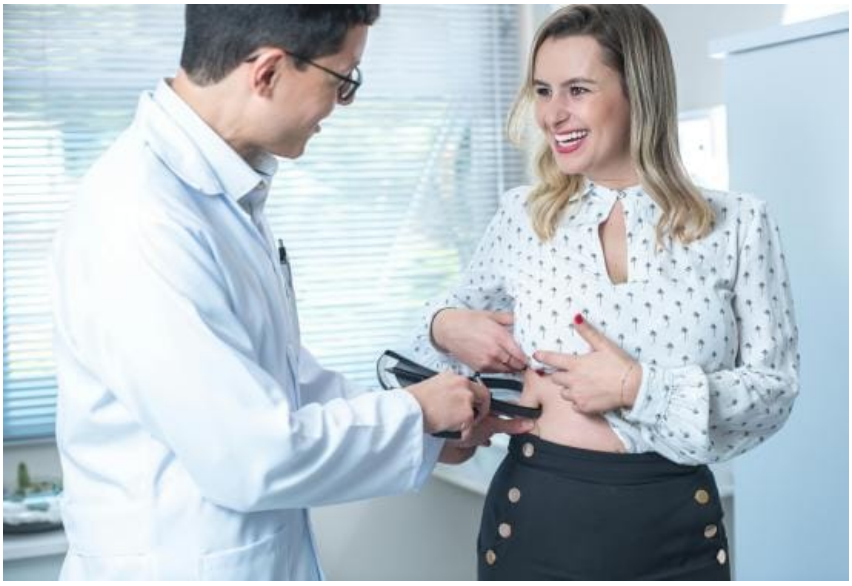


Figure 6.5.4: Using a skinfold test to determine body composition is one of the least expensive methods available. (Skinfold Test; Lucas Guimarães Bueno via Pexels)

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.

Question

- Considering the variety of methods available to measure body composition, which method would you be most likely to use and why?
- How might the accessibility, cost, or accuracy of these methods influence your approach to tracking your health?

Methods for Assessing Body Fat Distribution

Fat distribution is a critical factor in assessing body composition because total body fat percentage alone does not reflect where fat is stored. Two individuals may have the same body fat percentage, yet one may carry more abdominal fat (higher health risk) while the other stores more fat in the hips and thighs (lower health risk).

Measurements such as waist circumference, waist-to-hip ratio, and imaging techniques (e.g., DXA or MRI) are often used alongside body fat percentage to evaluate risk profiles more accurately. Recognizing patterns of fat distribution helps health professionals tailor interventions, including nutrition, exercise, and lifestyle recommendations, to

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.



Figure 6.5.5: (Measured Food; Deon Black via Pexels)

Waist Circumference

Waist circumference is commonly used to assess body fat distribution because it reflects the amount of fat stored in the abdominal region. Unlike total body weight or Body Mass Index (BMI), waist circumference specifically measures central or visceral fat, which is the fat that surrounds internal organs. This type of fat is more metabolically active than subcutaneous fat and is strongly linked to increased risks of cardiovascular disease, type 2 diabetes, and metabolic syndrome.

By measuring the waist, health professionals can identify whether an individual has an "apple-shaped" body pattern (more abdominal fat) versus a "pear-shaped" pattern (more fat stored in the hips and thighs). Since abdominal fat poses a greater health risk, waist circumference is considered a valuable tool for predicting disease risk beyond what BMI alone can provide.

WHO Risk Cut-Off Values

According to the **World Health Organization (WHO)**:

- **Men:** A waist circumference greater than **102 cm (40 in)** indicates a substantially increased risk of metabolic complications.
- **Women:** A waist circumference greater than **88 cm (35 in)** indicates a substantially increased risk of metabolic complications.

These thresholds highlight the importance of assessing fat distribution, not just overall body weight, in evaluating long-term health risks.

Waist-to-hip ratio

Waist-to-hip ratio (WHR) is a widely used measure for estimating body fat distribution by comparing the circumference of the waist to that of the hips. This ratio (waist circumference divided by the hip circumference) indicates where fat is stored in the body, distinguishing between "apple-shaped" (more abdominal fat) and "pear-shaped" (more hip and thigh fat) body types. Higher WHR values suggest a greater accumulation of fat around the abdomen, which is linked to increased risk of cardiovascular disease, type 2 diabetes, and other metabolic disorders. Unlike overall body fat percentage, WHR specifically reflects central or visceral fat, which is more strongly associated with health risks. 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 (Centers for Disease Control and Prevention, 2022). [16]

Waist to Height Ratio

Waist-to-height ratio (WHtR) is a simple and effective method for estimating body fat distribution, particularly the amount of abdominal or visceral fat. This ratio is calculated by dividing an individual's waist circumference by their height, providing an index that reflects fat stored around the midsection relative to overall body size. Higher ratios indicate a greater concentration of abdominal fat, which is associated with increased risk for cardiovascular disease, type 2 diabetes, and metabolic syndrome. Unlike body mass index (BMI), which only considers weight relative to height, WHtR focuses on fat distribution, making it a more sensitive predictor of health risks related to central obesity. A commonly suggested guideline is that a waist-to-height ratio above 0.5 signals elevated health risk for both men and women.

Table 6.5.2: Comparing Methods of Estimating Body Composition

Method	What It Measures	Cut-Off Values	Indications
Body Mass Index (BMI)	Relationship between height and weight (kg/m^2)	• Underweight: < 18.5 • Normal: 18.5–24.9 • Overweight: 25–29.9 • Obesity: ≥ 30	Estimates weight status, but does not distinguish between fat and muscle.
Waist Circumference	Abdominal fat storage (measured at the narrowest point of the waist)	• Men: > 102 cm (40 in) = increased risk • Women: > 88 cm (35 in) = increased risk	Identifies central obesity and risk from visceral fat.
Waist-to-Hip Ratio (WHR)	Proportion of waist circumference to hip circumference (waist ÷ hip)	• Men: > 0.90 = increased risk • Women: > 0.85 = increased risk	Differentiates "apple" (android) vs. "pear" (gynoid) body types; indicates fat distribution patterns.
Waist-to-Height Ratio (WHtR)	Proportion of waist circumference to height (waist ÷ height)	• Men: WHR ≥ 0.90 • Women: WHR ≥ 0.85	how fat is distributed in the body, specifically whether an individual carries more fat around the abdomen versus the hips

Table 6.5.2 shows a comparison of some of the at-home ways to estimate body fat and body fat distribution for body mass index, waist circumference, waist-to-hip ratio, and waist-to-height ratio. It describes what each method measures, what the cut-off values for health risks are, and what the results indicate.

Key Points

- Body composition evaluates the proportion of fat mass (FM) and fat-free mass (FFM), providing deeper insight into physical health than weight or BMI alone.
- Excess visceral fat around internal organs increases the risk of chronic conditions like cardiovascular disease and type 2 diabetes.
- Higher lean tissue (muscle and bone) is associated with improved strength, mobility, and metabolic function.
- BMI is a widely used, indirect measure of body fat based on height and weight, but it does not distinguish between fat mass

and lean mass.

- BMI limitations: It does not account for muscle mass, age, gender, or fat distribution, which can lead to misclassification of health risk, especially in athletes or older adults.
- Other body measurements, such as waist circumference, waist-to-hip ratio, and waist-to-height ratio, provide additional information about fat distribution and related health risks.
- Hydrostatic weighing measures body density using water displacement and provides accurate body fat estimates, but it is costly and not widely accessible.
- DEXA scans are considered the current “gold standard,” measuring fat, lean tissue, and bone mineral density with high accuracy, though they require specialized equipment and personnel.
- Bioelectrical impedance analysis (BIA) and skinfold measurements are practical, less expensive methods for estimating body composition, though accuracy can vary with hydration, technician skill, and measurement technique.
- Fat distribution matters: Central or abdominal fat (apple-shaped) poses higher health risks than fat stored in the hips or thighs (pear-shaped). Measures like waist circumference, WHR, and WHtR help assess these risks.

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6.6: Strategies for Change



Figure 6.6.1: Change can be subtle or dramatic. Any positive change is better than none. (CC BY-SA 4.0; mriggs1 via Wikimedia Commons)

Introduction

Improving body composition, which is the process of optimizing the balance between lean tissue and fat tissue, is an important aspect of overall health and physical fitness. Achieving and maintaining a healthy body composition can be challenging in today's environment, where many people have sedentary jobs or lifestyles and are surrounded by abundant high-calorie food options. These factors can make it difficult to manage weight, reduce excess fat, and support muscle development. This section will introduce the concept of energy balance, which provides a framework for understanding how lifestyle choices, including diet and physical activity, influence body composition and long-term health outcomes.

Setting Goals

Setting realistic and effective goals is a critical step in improving body composition. Before establishing goals, it is important to review the results of body composition assessments, such as body fat percentage, waist circumference, or BMI, as well as any health-related risk factors. These results provide valuable insight into current health status and help guide the development of safe, achievable, and personalized objectives. For example, an individual with a high waist-to-hip ratio might set a goal to reduce abdominal fat through a combination of targeted exercise and dietary changes, while someone with low muscle mass may focus on increasing lean tissue through strength training. By using assessment data to inform goal setting, individuals can create a clear plan to improve both body composition and overall health.

Once goals are established, applying the S.M.A.R.T. criteria can help ensure they are clear, achievable, and effective. Introduced in Chapter 1, S.M.A.R.T. goals should be realistic and achievable, providing a structured framework for planning and tracking progress. For example, instead of setting a vague goal like "lose fat," a S.M.A.R.T. goal would be "reduce body fat by 3% over the next 12 weeks through a combination of strength training three times per week and reducing daily calorie intake by 250 calories." By making goals specific and measurable, individuals can track progress and adjust strategies as needed. Ensuring goals are achievable and relevant helps maintain motivation, while a time frame encourages consistency and accountability. Using S.M.A.R.T. criteria makes goal setting a practical tool for improving body composition and overall health outcomes.

Before beginning any program to improve body composition, individuals who are significantly overweight or overfat, or who have existing health risks such as high blood pressure, type 2 diabetes, or cardiovascular disease, should consult a physician or qualified healthcare professional. A medical evaluation can help identify potential complications, ensure that exercise and dietary plans are safe, and provide personalized guidance based on current health status. This step is particularly important for

developing an appropriate and effective plan, as certain exercises, dietary strategies, or rapid weight changes may pose risks if underlying conditions are present. Even a modest amount of fat loss, such as 5–10% of body weight, can have significant health benefits for individuals who are obese, including improvements in blood pressure, blood sugar control, and cholesterol levels (Ryan & Yockey, 2017). [78] Consulting a healthcare professional also allows for monitoring of health markers during the program, helping to maximize benefits while minimizing potential harm.

Monitoring progress is an essential part of improving body composition. Keeping a record of dietary intake, physical activity, and lifestyle habits allows individuals to see patterns, identify areas for improvement, and stay motivated over time. Tracking progress also helps evaluate whether the strategies being used, such as changes in nutrition, exercise frequency, or intensity, are producing the desired outcomes. By consistently reviewing this information, individuals can make informed adjustments to their plan, celebrate successes, and maintain accountability toward their body composition goals. It is important, however, not to become too focused on any single measure, as body composition is multifaceted and no single metric tells the whole story.

Regularly repeating body composition assessments or monitoring weight is important for accurately tracking progress. Methods such as BMI, waist circumference, waist-to-hip ratio, or body fat percentage measurements can provide objective data on changes in fat and lean tissue over time. Even simple tools like a scale or tape measure, when used consistently, can reveal trends that indicate whether adjustments to diet, exercise, or lifestyle are needed. It is also valuable to check in on subjective measures, such as energy levels, how clothes fit, and other small successes that result from healthier choices, as these can provide motivation and a broader sense of progress beyond the numbers. Reassessing at planned intervals, such as every 4–8 weeks, helps ensure that goals remain realistic, achievable, and aligned with overall health objectives.

Focus on Energy Balance

One of the most effective ways to influence body composition is through **energy balance**. Energy balance is the relationship between the calories consumed through food and beverages or "energy in"(**energy intake**) and the calories the body uses for basal metabolism, daily activities, and exercise or "energy out" (**energy expenditure**). When energy intake matches energy expenditure, body weight remains stable, which is considered a state of energy balance. Consuming more calories than the body burns creates a **positive energy balance**, leading to weight gain, which can come from fat, muscle, or both. In some cases, when energy intake exceeds energy expenditure, the body stores excess calories as fat, potentially leading to increased body fat and associated health risks. On the other hand, a person may be eating extra calories while engaging in strength training to build muscle and is striving to gain weight through a positive energy balance. Conversely, consuming fewer calories than the body uses creates a **negative energy balance**, resulting in weight loss, like reducing portion sizes or increasing physical activity to burn additional calories. Understanding energy balance is fundamental for managing body composition and making informed choices about diet and exercise.



Figure 6.6.2: Balance is key when considering energy and intake. (CC BY-SA 3.0; eurobas via Wikimedia Commons)

Dieting alone may lead to weight loss, but much of that loss can be attributed to water and lean muscle, rather than fat. Without incorporating regular physical activity, especially resistance training, dieting alone is often not the most effective or

sustainable way to reduce body fat while maintaining healthy muscle mass. In addition, weight loss does not always equal fat loss, because changes on the scale can reflect shifts in body water, muscle mass, or even the contents of the digestive tract rather than reductions in stored fat. For example, a person may see rapid weight loss in the first week of dieting due to decreased carbohydrate intake and the associated loss of water stored with glycogen. Similarly, severe calorie restriction without adequate protein or resistance training can cause the body to break down muscle tissue for energy, leading to a loss of lean mass rather than primarily fat. This is why assessing body composition, rather than just body weight, provides a clearer picture of true progress and helps ensure that the goal is not only weight loss but the preservation of muscle mass and the reduction of excess body fat.

It is important to note that it is also impossible to target only one area for fat loss. "**Spot reduction**" is the idea that performing exercises targeting a specific body part will lead to fat loss in that area. Research has consistently shown that this approach does not work because the body does not burn fat from only the muscles being exercised (National Strength and Conditioning Association, n.d.). [60] Fat loss occurs systemically, meaning the body draws energy from fat stores throughout the entire body rather than from a localized area. For example, doing hundreds of abdominal crunches will strengthen and build the muscles in the abdomen, but will not specifically burn belly fat. To reduce body fat in a targeted area, a combination of overall calorie deficit through diet (energy in), regular aerobic exercise, and resistance training for the whole body (energy out) is necessary.

Figure 6.6.1*: Energy Balance*

Goal	Energy Balance Description	Explanation
Maintain Weight	Energy Intake EQUALS Energy Expenditure	In balance: Calories consumed match calories burned, so body v
Gain Weight	Energy Intake is greater than Energy Expenditure	Positive energy balance: Consuming more calories than burned r usually from fat, muscle, or both.
Lose Weight	Energy Intake is less than Energy Expenditure	Negative energy balance: Burning more calories than consumed deficit, leading to weight loss. The body is using energy from fat energy, so weight will decrease.

Body composition goals may vary depending on the individual. As can be seen in Figure 6.6.1, there are three primary goals for body composition: maintaining, gaining, or losing weight. When a person's weight is stable, and they are satisfied with how their body looks and feels, it usually indicates that their energy intake and energy expenditure are balanced. For those aiming to gain weight, the focus is on consuming more energy-dense foods, often in larger portions or more frequent meals, to create a positive energy balance. In contrast, losing weight does not have a single "best" approach, but strategies that address both energy intake and energy expenditure tend to be most effective. Creating a moderate energy deficit through a combination of dietary adjustments and regular physical activity can help reduce fat mass while preserving, or even increasing, lean tissue. Understanding these principles of energy balance allows individuals to make informed decisions about nutrition and exercise that support healthy weight management, enhance metabolic function, and improve long-term physical performance.



Figure 6.6.3: Even a subtle calorie deficit can change body composition over time. (CC0 1.0; Petr Kratochvil via Wikimedia Commons)

Energy In

“Energy in” refers to the calories a person consumes from food and beverages, which provide the body with fuel to function. The energy value of these foods comes from the three macronutrients, carbohydrates, fats, and proteins**,** as well as from alcohol, which also contributes calories. Carbohydrates and proteins provide 4 calories per gram, fats provide 9 calories per gram, and alcohol provides 7 calories per gram. The total amount of calories consumed each day makes up the “energy in” side of the energy balance equation.

For example, eating a sandwich, fruit, and a glass of milk at lunch contributes to energy intake from multiple macronutrients: carbohydrates in the bread and fruit, protein in the meat and milk, and fat in cheese or spreads. Beverages can also add significantly to energy intake, such as a specialty coffee drink or soda that contains several hundred calories. Portion sizes and food choices play a key role in determining how much energy is consumed. When “energy in” regularly exceeds “energy out,” the body stores the extra energy, usually as fat, leading to weight gain. Conversely, adjusting food intake to better match activity levels helps support a healthy body composition and stable weight.

Energy Out

“Energy out” refers to the calories the body uses to support basic functions, physical activity, and other energy-demanding processes. This includes three main components: **basal metabolic rate (BMR)**, which is the energy needed to maintain essential functions like breathing, circulation, and body temperature at rest; **thermic effect of food (TEF)**, which is the energy required to digest, absorb, and process nutrients; and **physical activity**, which includes both structured exercise (such as running or lifting weights) and daily movements (such as walking, climbing stairs, or doing household chores). Chapter 8 provides detailed information about nutrition, including energy values of certain foods. Chapter 9 provides detailed information about healthy food choices and recommended strategies for adjusting one's diet to lose or gain weight safely.

Improving body composition typically involves a combination of different types of physical activity that work together to reduce excess fat and build or maintain lean muscle mass. As discussed in Chapter 3, **aerobic exercise** such as walking, running, cycling, or swimming helps burn calories and supports cardiovascular health, making it an effective tool for fat loss. Chapter 4 details building muscular strength and endurance, another important type of exercise that can be used for both weight gain and weight loss. **Resistance training**, such as lifting weights, bodyweight exercises, or resistance bands, is essential for preserving and increasing muscle mass, which boosts metabolism and improves overall body composition. Additionally, incorporating flexibility and **mobility exercises**, such as stretching or yoga, can help prevent injury and support consistent participation in other forms of exercise. Even daily lifestyle activities, like taking the stairs, gardening, or active commuting, contribute to energy expenditure and support healthier body composition over time. Ultimately, engaging in an exercise program that encompasses in multiple types of exercise is ideal. If this feels overwhelming, consider that in addition to improved body composition, there is also an increase in one's cardiorespiratory and muscular fitness, as well as improved flexibility. Consider that there are multiple gains

involved for the effort.

For example, a person burns energy while sitting in class (BMR), digesting their breakfast (TEF), and later going for a jog (physical activity). The total of these processes makes up “energy out” in the energy balance equation. Energy expenditure can vary greatly from person to person depending on body size, muscle mass, age, and activity level. Because physical activity is the most variable part of “energy out,” increasing exercise or daily movement is often a key strategy for creating a negative energy balance to promote fat loss or a positive energy balance to support muscle gain.

Figure 6.6.1 indicates a comparison between "energy in" and energy out" concerning energy balance.

Figure 6.6.2: Energy in v. Energy Out

Energy In	Energy Out
Calories consumed through food and beverages	Calories the body uses for basic functions, digestion, and activity
Comes from macronutrients: carbohydrates (4 kcal/g), protein (4 kcal/g), fat (9 kcal/g), and alcohol (7 kcal/g)	Includes basal metabolic rate (BMR), thermic effect of food (TEF), and physical activity
Example: calories from a sandwich, fruit, and milk at lunch	Example: energy burned while breathing (BMR), digesting that lunch (TEF), and going for a jog (physical activity)
Portion size, food choices, and beverages strongly affect intake	Activity level is the most variable factor influencing expenditure
Excess intake leads to energy storage (usually as fat)	Increased expenditure can help create negative energy balance for weight loss or positive balance for muscle gain

According to the U.S. Department of Health and Human Services, these are the estimates for the amount of exercise needed for specific goals. For example, to prevent weight gain, the Physical Activity Guidelines for Americans recommend that adults accumulate at least 150 minutes of moderate-intensity aerobic activity (such as brisk walking) or 75 minutes of vigorous-intensity activity (such as running) per week for general health benefits (U.S. Department of Health and Human Services, 2018). [86] However, HHS notes that more physical activity may be necessary to prevent weight gain or maintain weight loss. Research suggests that closer to 300 minutes of moderate-intensity activity per week (about 60 minutes on most days) is often needed to prevent gradual weight gain over time. These recommendations highlight that while even small amounts of exercise are beneficial for health, higher volumes of activity provide stronger protection against excess weight gain. For significant weight loss, even more physical activity may be needed, as much as 40+ minutes a day. Without incorporating regular physical activity, especially resistance training, dieting on its own is often not the most effective or sustainable way to decrease body fat while maintaining healthy muscle mass. It also increases resting metabolic rate for several days after a workout, increasing energy out even while not actively participating in physical activity.

See Chapter 7 for creating an individualized, comprehensive exercise program for lifelong health. It is important to focus on aspects of the body that can be influenced through healthy lifestyle choices, rather than fixating on features that are largely determined by genetics or cannot be changed, such as bone structure or natural body shape. Emphasizing gradual improvements in body composition, like reducing excess fat, increasing lean muscle, and improving strength and endurance, supports overall health and well-being. Healthy bodies come in many different shapes and sizes, and well-being is not determined solely by appearance. By prioritizing sustainable nutrition, regular physical activity, and positive habits, individuals can achieve improvements in fitness and body composition while maintaining a realistic and supportive perspective on their bodies.

Key Points

- Energy In refers to the calories a person consumes from food and beverages, which come from macronutrients (carbohydrates, protein, fat) and alcohol.
- Energy Out includes calories used for basal metabolic rate (BMR), the thermic effect of food (TEF), and physical activity, both structured and daily movements.
- Energy balance determines weight change: when intake equals expenditure, weight is stable; excess intake leads to fat storage and weight gain; higher expenditure than intake promotes weight loss.
- Portion size, food choices, and beverages strongly influence energy intake, while activity level is the most variable factor affecting energy expenditure.
- Physical activity types that improve body composition include aerobic exercise for calorie burning, resistance training to maintain or build lean muscle, and flexibility/mobility exercises to prevent injury and support fitness.
- Physical activity guidelines: 150 minutes/week of moderate-intensity activity prevents weight gain; about 300 minutes/week may be needed to maintain weight or prevent gradual gain; significant weight loss often requires even more activity.
- Dieting alone may lead to weight loss but can reduce lean muscle; combining calorie management with exercise, especially resistance training, preserves muscle and supports fat loss.
- Exercise increases metabolism: Physical activity, particularly resistance training, can elevate resting metabolic rate for several days after exercise, contributing to additional energy expenditure.
- Focus on achievable, healthy changes: Improvements in body composition, strength, and fitness are more important than appearance alone; healthy bodies come in many shapes and sizes, and sustainable lifestyle habits support long-term health.

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6.7: Comprehension Check

Summary

Achieving and maintaining a healthy weight involves more than tracking pounds; it requires understanding body composition, which distinguishes between fat mass (FM) and fat-free mass (FFM), including muscle, bone, and water. This distinction provides a clearer picture of health than body weight alone. Body composition is influenced by genetics, age, sex, hormones, lifestyle behaviors, and environmental factors, all of which interact to shape fat distribution, muscle mass, and overall physical fitness.

Body composition has important implications for health and wellness. Excess body fat, especially visceral fat, increases the risk of cardiovascular disease, type 2 diabetes, and metabolic dysfunction, while low lean mass can reduce strength, mobility, and energy metabolism. Beyond physical health, body composition affects emotional, social, and occupational wellness, as perceptions of one's body and societal pressures can influence self-esteem and mental health. Maintaining a balanced composition supports functional capacity, energy, and overall quality of life.

Assessing body composition can be done using methods like skinfold measurements, bioelectrical impedance analysis (BIA), DEXA scans, and waist-to-hip ratios. Strategies for improving body composition include sustainable lifestyle changes, such as combining aerobic and resistance exercise with balanced nutrition, adequate sleep, and stress management. Interventions may focus on fat loss, lean mass gain, or both, emphasizing functional health and long-term wellness rather than appearance alone, ensuring healthier outcomes physically, mentally, and socially.

Test Your Understanding

1. What is the main difference between body weight and body composition, and why is the latter more informative for health?
2. List three diseases that are strongly linked to excessive body fat.
3. Why is visceral fat more concerning than subcutaneous fat in terms of health risks?
4. How does body fat distribution, such as android (apple-shaped) versus gynoid (pear-shaped), influence health risks and physical performance?
5. How can body image concerns, such as body dysmorphic disorder (BDD) and muscle dysmorphia, affect an individual's approach to maintaining a healthy body composition and overall wellness?
6. Why might BMI and waist-to-hip ratio be limited in assessing an individual's health compared to more accurate body composition tests like DEXA, hydrostatic weighing, or bioelectrical impedance?
7. Explain the concept of energy balance and how it affects body composition. How do "energy in" (calories consumed) and "energy out" (calories expended) interact to influence fat loss, muscle gain, or weight maintenance?
8. Why is incorporating both aerobic and resistance training, along with proper nutrition, more effective for improving body composition than dieting alone? Include an explanation of why "spot reduction" does not work.

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Chapter 6 Glossary

- **Adipose Tissue**: Body fat that makes up the fat mass in body composition; includes subcutaneous (under skin) and visceral (around organs) fat.
- **Aerobic Exercise**: Continuous, rhythmic physical activity that uses large muscle groups and relies primarily on oxygen for energy production.
- **Android Shape**: A fat distribution pattern where fat is stored mainly in the abdomen and upper body. It is linked to a higher waist-to-hip ratio and a greater risk of heart disease, diabetes, and metabolic syndrome due to excess visceral fat.
- **Asthma**: A chronic respiratory condition where the airways become inflamed and narrowed, causing difficulty breathing, wheezing, coughing, and shortness of breath. Symptoms can be triggered by allergens, exercise, cold air, or stress.
- **Basal Metabolic Rate (BMR)**:
- **Bio-Electrical Impedance**: A method for estimating body composition by measuring how easily a low electrical current passes through the body. Since muscle conducts electricity better than fat, the resistance (impedance) helps estimate body fat percentage.
- **Body Composition**: The proportion of fat, muscle, bone, and other tissues that make up a person's total body weight. It is often used to assess health and fitness more accurately than weight alone.
- **Body Image**: A person's perception and feelings about their body size, shape, and composition, which may or may not reflect their actual body composition.
- **Body Dysmorphic Disorder (BDD)**: A mental health condition in which a person becomes excessively preoccupied with perceived flaws or defects in their physical appearance. These flaws are often minor or not noticeable to others, but to the individual, they feel significant and distressing. People with BDD may engage in repetitive behaviors such as mirror-checking, excessive grooming, or seeking reassurance, and the condition can interfere with daily functioning, relationships, and overall quality of life. Treatment often involves cognitive-behavioral therapy (CBT) and, in some cases, medication.
- **Body Mass Index (BMI)**: A numerical value calculated from a person's weight and height, used to classify individuals as underweight, healthy weight, overweight, or obese. It helps assess potential health risks related to body weight.
- **Body Positivity**: A social movement and mindset that encourages individuals to accept, appreciate, and respect their bodies regardless of size, shape, appearance, or ability. It challenges unrealistic beauty standards promoted by media and culture, and instead emphasizes that all bodies are worthy of dignity, confidence, and care. Body positivity also promotes self-compassion, balanced health behaviors, and the idea that physical appearance should not define a person's value or self-worth.
- **Cachexia**: Severe loss of muscle and fat mass due to disease, leading to unhealthy body composition and weakness.
- **Cancer**: A disease in which abnormal cells grow uncontrollably and can invade or spread to other parts of the body, disrupting normal body functions and potentially leading to serious health complications.
- **Cardiometabolic**: Refers to health risks (like heart disease and type 2 diabetes) linked to excess body fat, especially visceral fat, in body composition.
- **Cardiovascular Disease**: A group of conditions that affect the heart and blood vessels, including heart disease, stroke, and high blood pressure, often caused by blocked or narrowed blood vessels, leading to reduced blood flow and increased risk of heart attack or stroke.
- **Cerebrovascular Disease (Stroke)**: A group of conditions that affect blood flow to the brain, often leading to strokes, brain damage, or other neurological issues, usually caused by blocked or ruptured blood vessels.
- **Corticosteroids**: Medications that can alter body composition by increasing fat mass (especially visceral fat) and reducing muscle mass when used long-term.
- **Cortisol**: A stress hormone that can influence body composition by promoting fat storage, especially visceral fat, and breaking down muscle when chronically elevated.
- **Dementia**: A group of disorders characterized by a decline in memory, thinking, behavior, and the ability to perform everyday activities, often caused by damage to brain cells.
- **Dual Energy X-Ray Absorptiometry**: A medical imaging technique that uses low-dose X-rays to measure bone density and body composition, including the amount of fat, muscle, and bone in the body.
- **Energy Balance**: The relationship between calories consumed (energy intake) and calories expended (energy output through metabolism, physical activity, and thermic effect of food).
- **Energy Expenditure**: The total amount of energy (calories) the body uses to sustain life and support physical activity. Energy expenditure includes basal metabolic rate (BMR), the thermic effect of food (TEF), and energy used during physical activity.
- **Energy Intake**: The total number of calories consumed from food and beverages. Energy intake provides the fuel needed for basal metabolism, physical activity, and physiological functions.
- **Essential Fat**: The minimum amount of fat needed for normal body function, including hormone production, nerve function,

and protecting organs; part of healthy body composition.
- **Fast-Twitch Muscle Fibers**: Muscle fibers that generate quick, powerful movements but fatigue rapidly; in body composition, they contribute to lean mass and athletic performance.
- **Fat Distribution Patterns**: The way body fat is stored in the body, such as android (apple-shaped, around the abdomen) or gynoid (pear-shaped, around hips and thighs), which influences health risks and overall body composition.
- **Fat-Free Mass (FFM)**: The total weight of all body components excluding fat, including muscles, bones, organs, fluids, and tissues.
- **Fat Mass (FM)**: The total amount of fat tissue in the body, including both essential fat needed for normal body functions and non-essential fat stored for energy.
- **FTO Gene**: A gene linked to body composition that can increase the likelihood of higher body fat levels and obesity by influencing appetite and energy balance.
- **Gallbladder Disease**: Conditions that affect the gallbladder, such as gallstones, inflammation (cholecystitis), or infection, often cause pain, digestive issues, and in some cases, require surgical removal of the gallbladder.
- **Gene-Environment Interaction**: How genetic factors (like those affecting fat storage or muscle growth) and lifestyle factors (such as diet, physical activity, and stress) work together to shape body composition.
- **Ghrelin**: A hormone that increases hunger and food intake; it influences body composition by promoting fat storage when energy intake exceeds energy use.
- **Gout**: A type of arthritis caused by the buildup of uric acid crystals in the joints, leading to sudden episodes of severe pain, swelling, redness, and stiffness, most often in the big toe.
- **Gynoid Shape**: A fat distribution pattern where more fat is stored in the hips and thighs; in body composition, it's generally linked to lower health risks than abdominal (android) fat storage.
- **High Intensity Interval Training (HIIT)**: A workout style alternating short bursts of intense exercise with recovery periods; it improves body composition by reducing fat mass and preserving or increasing lean muscle.
- **Hydrostatic Weighing**: A method of measuring body composition by determining body density through underwater weighing, where a person's weight on land and underwater are compared to estimate body fat percentage.
- **Hypertension**: A condition characterized by consistently high blood pressure, which forces the heart to work harder to pump blood and increases the risk of heart disease, stroke, kidney problems, and other health issues.
- **Hypogonadism**: A medical condition characterized by reduced production of sex hormones (such as testosterone in males or estrogen in females).
- **Kidney Disease**: A condition where the kidneys are damaged and cannot properly filter waste and excess fluids from the blood, which can lead to fluid buildup, waste accumulation, and other serious health problems.
- **Male Athlete Triad (MAT):** a syndrome observed in male athletes that involves three interrelated components: low energy availability, low testosterone levels, and decreased bone mineral density.
- **Menstrual Dysfunction**: Any abnormality in the menstrual cycle, such as absent, irregular, heavy, or painful periods, often caused by hormonal, lifestyle, or medical factors.
- **Metabolic Syndrome**: A cluster of conditions — including high blood pressure, high blood sugar, excess abdominal fat, and abnormal cholesterol levels — that occur together, increasing the risk of heart disease, stroke, and type 2 diabetes.
- **Metabolism**: The body's process of converting food into energy; in body composition, metabolism affects how efficiently calories are used for maintaining muscle, storing fat, and supporting overall energy balance.
- **Mobility Exercises**: Dynamic movements designed to improve joint range of motion, muscle flexibility, and movement quality.
- **Muscle dysmorphia:** A subtype of body dysmorphic disorder in which an individual becomes excessively preoccupied with the belief that their body is too small or insufficiently muscular, even if they have above-average muscle size. It is sometimes called "bigorexia" or "reverse anorexia." People with muscle dysmorphia may engage in compulsive weightlifting, strict dieting, or use of anabolic steroids to increase muscle mass. This condition can negatively affect physical health, mental well-being, social relationships, and daily functioning.
- **Negative Energy Balance**: A state in which energy expenditure exceeds energy intake, resulting in a caloric deficit.
- **Non-Alcohol Fatty Liver Disease**: A condition where excess fat builds up in the liver of people who drink little or no alcohol, potentially leading to liver inflammation, scarring, and liver damage over time.
- **Non-Exercise Activity Thermogenesis (NEAT)**: The calories burned through daily movements outside of structured exercise (like walking, fidgeting, or doing chores); it contributes to energy expenditure and influences body composition by affecting fat gain or loss.
- **Osteoarthritis**: A degenerative joint disease where the cartilage that cushions the ends of bones wears down over time, leading to pain, stiffness, swelling, and reduced joint mobility.
- **Overweight**: A condition where a person has more body weight than is considered healthy for their height, typically defined by a body mass index (BMI) between 25 and 29.9.
- **Pancreatitis**: The inflammation of the pancreas, a gland that helps with digestion and blood sugar regulation, causing symptoms such as abdominal pain, nausea, vomiting, and digestive problems. It can be acute (sudden) or chronic (long-

lasting).

- **Percent Body Fat**: The proportion of total body weight made up of fat mass compared to fat-free mass; a key measure of body composition used to assess health and fitness.
- **Physical Activity**: Any bodily movement produced by skeletal muscles that increases energy expenditure above resting levels.
- **Polycystic Ovary Syndrome (PCOS)**: A hormonal disorder that often affects body composition by increasing fat mass (especially abdominal fat) and making it harder to maintain or build lean muscle.
- **Positive Energy Balance**: A state in which energy intake exceeds energy expenditure, resulting in a caloric surplus.
- **Plethysmography**: A method used to measure changes in volume within an organ or the whole body, often used in body composition testing (such as air displacement plethysmography) to determine body fat percentage by assessing body density through air pressure changes.
- **Resistance Training**: A form of exercise that involves working against an external force (e.g., free weights, machines, resistance bands, or body weight) to stimulate muscular contraction.
- **Resting Metabolic Rate**: The number of calories the body burns at rest to maintain basic functions; it plays a key role in body composition by influencing how easily someone gains or loses fat and muscle.
- **Sarcopenia**: The age-related loss of muscle mass and strength, leading to unfavorable changes in body composition with a higher fat proportion and reduced lean mass.
- **Satiety**: The feeling of fullness after eating that reduces the urge to eat; it helps regulate calorie intake and influences body composition by affecting fat gain or loss.
- **Sedentary**: A lifestyle with little physical activity; it negatively impacts body composition by lowering energy expenditure, reducing muscle mass, and increasing fat storage.
- **Skinfold Analysis**: A method of estimating body fat percentage by measuring the thickness of skin folds at specific sites on the body using calipers, based on the assumption that the thickness of subcutaneous fat is proportional to total body fat.
- **Skinny-Fat**: A body composition where a person has a normal or low body weight but a high body fat percentage and low muscle mass, increasing health risks despite appearing thin.
- **Sleep Apnea**: A sleep disorder where a person's breathing repeatedly stops and starts during sleep, leading to poor sleep quality and low oxygen levels, often causing daytime fatigue, snoring, and increased risk of health problems.
- **Slow-Twitch Muscle Fibers**: Muscle fibers that are fatigue-resistant and support endurance activities; in body composition, they contribute to lean mass and help with fat metabolism during prolonged exercise.
- **Socioeconomic status (SES)**: A person's social and economic standing, which influences body composition through access to nutritious food, opportunities for physical activity, healthcare, and education about healthy habits.
- **Spot Reduction**: The belief, and common misconception, that exercising a specific body part will selectively reduce fat in that area.
- **Storage Fat**: Body fat stored in adipose tissue for energy reserves; includes subcutaneous fat under the skin and visceral fat around organs, both contributing to overall body composition.
- **Subcutaneous Fat**: Fat stored directly under the skin; it is part of total body composition and less harmful than visceral fat, though excess amounts still affect health and appearance.
- **Thermic Effect of Food (TEF)**: The energy (calories) expended by the body to digest, absorb, transport, and metabolize nutrients from food.
- **Type II Diabetes Mellitus**: A chronic condition where the body becomes resistant to insulin or doesn't produce enough insulin, leading to elevated blood sugar levels and increasing the risk of heart disease, kidney problems, nerve damage, and other health complications.
- **Visceral Fat**: Fat stored deep in the abdomen around internal organs; in body composition, it is linked to higher risks of heart disease, type 2 diabetes, and other metabolic disorders.

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7: CREATING A FITNESS PROGRAM FOR LIFELONG HEALTH



Figure 7.1: (A gym filled with lots of machines; Alex Tyson via Unsplash)

Introduction

Creating a personal fitness program is one of the most important steps toward achieving lifelong health and wellness. A well-rounded plan includes activities that build strength, endurance, flexibility, and support a healthy body composition. This chapter will guide you through the process of setting goals, choosing enjoyable and effective exercises, and applying the FITT-VP principle to structure your routine. You'll also learn how to stay motivated, track your progress, and adjust your plan based on your needs, lifestyle, and health status.

Learning Objectives

- Identify the key steps involved in creating a personal fitness plan.
- Describe strategies for maintaining a long-term exercise routine.
- Apply the FITT-VP principle to design a well-rounded fitness plan that includes all components of health-related fitness.
- Adjust fitness programs for various life stages and special health concerns.

7.1: Creating a Personal Fitness Plan

7.2: Getting started with your Fitness Plan

7.3: Physical Activity and Special Health Needs in Older Adults

7.4: Physical Activity for Individuals with Chronic Conditions and Disabilities

7.5: Comprehension Check

7.6: Glossary

7.7: References

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7.1: Creating a Personal Fitness Plan



Figure 7.1.1: Group workouts can be a strong part of a personal fitness plan. (Three persons lifting barbells overhead; Sven Mieke via Unsplash)

Creating a Personal Fitness Plan

Creating a balanced fitness program involves setting clear goals, selecting appropriate activities, and building in strategies for adherence and flexibility. This section walks you through a structured, evidence-based approach to designing a personal plan. In Chapter 2, physical activity, exercise, and physical fitness were covered. Although often used interchangeably, the terms physical activity, exercise, and physical fitness have different meanings. In short, physical activity refers to any body movement, exercise is physical activity that is planned and structured to achieve physical fitness, and physical fitness refers to how well your heart, lungs, muscles, and joints respond to daily tasks. The goal is to increase your physical activity and exercise to move more and sit less.

Set Realistic Goals

Start by setting general or long-term goals, such as reducing the risk of chronic disease, improving posture, increasing daily energy, adjusting the fit of your clothes, or enhancing body composition (Fahey et al, 2025). [12] These provide meaningful direction. Then identify specific or short-term measurable goals, for instance, jogging two miles without stopping, lowering your BMI, or increasing your push-up repetitions from 10 to 20 in four weeks.

Using the S.M.A.R.T. goal framework (Specific, Measurable, Achievable, Results Focused, Time-bound) is a helpful strategy to enhance motivation and success. S.M.A.R.T. goals were introduced in Chapter 1 of this text. It is important to have specific goals as this allows a person to track progress and enjoy the measurable changes brought about by their fitness program.

Choose Activities

An effective fitness program targets the five essential health-related components of fitness, each of which plays a key role in overall health and physical performance. Chapters 2 through 6 explored these components in depth, guiding how to improve cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition. At this stage, previously developed plans for individual components can be combined into one complete program. As the plan is assembled, it is important to choose activities that not only address each health-related fitness component but also match the individual's interests, abilities, and goals. Referring back to earlier chapters can be helpful when selecting or modifying exercises that support long-term success. The 5 health-related components of fitness are:

- **Cardiorespiratory Endurance:** The ability to perform large-muscle, whole-body exercise at moderate-to-vigorous intensities for extended periods of time. Activities like walking, swimming, or cycling improve this component and are key to reducing the risk of chronic disease (US Department of Health and Human Services, 2018). [15]
- **Muscular Strength:** The maximum amount of force a muscle or muscle group can produce in a single effort. This is developed through resistance training such as lifting weights or performing bodyweight exercises like squats (Fahey et al, 2025). [12]
- **Muscular Endurance:** The ability of a muscle or group of muscles to perform repeated contractions over time without fatigue. Circuit training and high-repetition resistance exercises enhance this component (Fahey et al, 2025). [12]
- **Flexibility:** The range of motion available at a joint or group of joints. (Fahey et al, 2025). [12] Flexibility can be improved through regular stretching, yoga, or mobility work and contributes to better posture and reduced injury risk.
- **Body Composition:** The ratio of fat mass to lean mass (muscle, bone, organs). While not improved through one specific activity, body composition is positively influenced by combining aerobic exercise, resistance training, and healthy nutrition (Fahey et al, 2025). [12]

Choose Activities that Support Commitment

One of the most important elements of a successful fitness program is selecting exercises that are enjoyable and fit your lifestyle. Activities that feel like a chore are less likely to be maintained over time. Consider the following factors when selecting activities:

- Fun and Interest: Choose forms of exercise that you genuinely enjoy, whether that's dancing, hiking, swimming, or playing a team sport. Enjoyment increases the likelihood of adherence and promotes a positive association with physical activity.
- Current Skill and Fitness Level: Select activities appropriate to your current fitness and skill level. A beginner might start with walking before progressing to jogging, or use machines before transitioning to free weights.
- Time and Convenience: Look for exercises that fit into your daily schedule. Short, high-intensity workouts might be ideal for those with limited time, while others may prefer longer sessions. Consider proximity—gyms, parks, or walking routes close to home or work improve convenience.
- Cost. Consider what is financially realistic: Walking, running, and bodyweight workouts are free. Others, like yoga classes or gym memberships, may come with costs that should be evaluated based on your budget and commitment.
- Special Health Concerns: If you have health conditions such as arthritis, diabetes, or cardiovascular disease, consult with a healthcare provider to identify safe options. Exercise should accommodate and support your specific health concerns.

Apply the FITT-VP Principle

Applying the **FITT-VP principle**: Frequency, Intensity, Time, Type, Volume, and Progression, is essential for building a safe and effective fitness plan that targets all components of health-related fitness. For cardiorespiratory endurance, the U.S. Department of Health and Human Services recommends at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity activity per week, based on over 50 years of research on exercise and health. Activities such as brisk walking, jogging, or cycling should be performed with a frequency of three to five days per week for 20 to 60 minutes per session. These sessions may be done continuously or in bouts of at least 10 minutes. Intensity can be monitored using heart rate or rating of perceived exertion (RPE), and individuals should progress gradually to avoid injury. **High-intensity interval training** (HIIT) may also be used for shorter sessions when performed safely at higher intensities.

For muscular strength and endurance, the FITT-VP principle recommends resistance training at least two non-consecutive days per week. A typical program involves one or more sets of 8–12 repetitions for 8–10 exercises that work all major muscle groups. Weights should be challenging enough to fatigue the muscles while still allowing for proper form. Bodyweight exercises are an effective alternative. To maximize cardiovascular and vascular health, combining strength training with aerobic exercise is encouraged.
Flexibility training should occur at least two to three days per week—and ideally daily—for best results. Stretches should be performed when muscles are warm and should target all major muscle groups. Each stretch should be held for 10 to 30 seconds and repeated two to four times. Intensity is guided by a slight feeling of tension without pain, and progression occurs as the range of motion improves over time. While body composition doesn't use FITT-VP directly, it improves as a result of consistent adherence to aerobic, resistance, and flexibility training paired with sound nutrition. The key is creating a program that sustains calorie expenditure and muscle development over time. The FITT-VP principle helps structure a well-rounded fitness program by adjusting Frequency, Intensity, Time, Type, Volume, and Progression. Table 7.1.1 is a compilation of the five health-related fitness components and **neuromotor exercise** (older adults). The importance of neuromotor exercise is covered later in this chapter.

Table 7.1.1 FITT-VP Chart by Exercise Component including Neuromotor Exercise.

Component	Frequency	Intensity	Time	Type	Volume	Progression
Cardiovascular endurance (aerobic)	≥3-5 days/ week combination of moderate to vigorous or ≥5 days/ week (moderate), or ≥3 days/ week (vigorous)	Moderate (40–59% HRR) to vigorous (60–89% HRR) for most adults; light-to-moderate for deconditioned individuals	30–60 min/ day/ moderate intensity or 20-60 min/ day vigorous intensity or a combination of moderate and vigorous exercise <20 min of exercise per/day can be beneficial in previously sedentary individuals	Regular, purposeful exercise that involves major muscle groups and Rhythmic, continuous in nature (e.g., walking, cycling, swimming)	≥500–1,000 MET·min/week; or increasing step count by ≥2,000 steps/day to reach ≥7,000 steps/day For individuals unable or unwilling to reach these amounts, exercise below these volumes may still be beneficial.	Gradual progression of exercise time, frequency, and intensity until the desired exercise goal (maintenance) is attained. "Start low and go slow". Reduce risk and increase adherence
Muscle Strength	2–3 days/ week, non-consecutive days, for each major muscle group	60–80% 1-RM for strength, <50% 1-RM for endurance, 40–50% 1-RM for older adults	2–4 sets of 8–12 repetitions for strength and power; 15–25 reps for muscular endurance	Exercises for each major muscle group: multi-joint exercises; single-joint exercises targeting major muscle groups, free weights, machines, or body weight	2–4 sets/muscle group; 8–12 reps/set; 1 set sufficient for beginners, (10-15 reps for older adults)	Gradual increase in resistance, sets, and frequency
Muscle Endurance	≥2-3 days/ week	<50% 1-RM Lower resistance with higher repetitions	≥2 sets of 15-25 reps	Circuit training or light resistance exercises or bodyweight	Increased sets/ reps of activity Adjust based on the number of sets and exercises.	Add reps or reduce rest time. Increase reps or add sets gradually.
Flexibility	≥2-3 days/ week; daily, most effective	Stretch to the point of mild discomfort but not pain.	10–30 sec/ stretch; older adults: 30–60 sec; accumulate 60 sec/ target area	Static, dynamic, PNF targeting all major muscle-tendon groups	2-4 reps for a total stretching time of 60 seconds for each exercise	Gradual increase in duration, reps, or complexity

Component	Frequency	Intensity	Time	Type	Volume	Progression
Body Composition	Combined with aerobic activity	Moderate to vigorous	≥150 min/ week moderate intensity	Aerobic + resistance	Targeted kcal deficit of	Monitor body comp changes
Neuromotor Exercise (balance)	≥ 2-3 days/ week (≥60 minutes/ week total)	Not well established; may include bodyweight or light resistance for balance/agility	≥ 20-30 minutes/ session	Balance, coordination, gait, agility (e.g., tai chi, yoga)	≥ 60 minutes/ week total	Progress as tolerated; limited evidence for optimal progression

Table 7.1.1 is adapted from the American College of Sports Medicine, *Guidelines for Exercise Testing and Prescription* [13] and the U.S. Department of Health and Human Services, *Physical Activity Guidelines for Americans (2nd ed.)* [15]

Question

- Why is it important to include all five health-related components of fitness in your program?
- How can the FITT-VP principle help achieve this balance?

Set Up a System of Mini-Goals and Rewards

Setting one big goal can feel overwhelming, especially when progress takes time. Breaking your long-term fitness goal into smaller, achievable mini-goals can provide momentum and boost motivation. For example, if your ultimate aim is to walk 10,000 steps a day, you might begin by reaching 5,000 steps daily for the first week, then increase by 1,000 steps each subsequent week.

Celebrate these smaller victories with non-food rewards. Examples include treating yourself to new workout clothing, fitness gear, a massage, or a fun, active outing like paddleboarding or rock climbing. These incentives reinforce positive behaviors and help turn your fitness journey into something enjoyable and sustainable.



Figure 7.1.2: (Scrabble tiles with quote; Brett Jordan via Unsplash)

Incorporate Lifestyle Physical Activity

Structured workouts are only one part of the physical activity puzzle. Increasing your daily lifestyle activity, the informal movement that occurs throughout your day, can significantly improve your overall fitness and health. Simple strategies include:

- Parking farther from building entrances
- Taking the stairs instead of the elevator
- Walking or biking for short errands
- Doing light chores or stretching while watching TV

These small changes reduce sedentary time and improve overall activity levels. These changes reduce sedentary time, promote energy expenditure, and help meet weekly physical activity guidelines. According to the **U.S. Department of Health and Human Services (USDHHS)**, even short bouts of movement, such as 10 minutes at a time, can accumulate to provide health benefits throughout the day. [15]

To better understand your current habits, consider keeping a health journal for 3–5 days. Record not only how much time you spend sitting, walking, or engaging in light activity, but also track your energy levels, mood, stress, sleep quality, and general attitude throughout the day. This holistic approach can help you identify patterns between physical activity and overall well-being, revealing opportunities for improvement in both your physical and mental health. By becoming more aware of how your lifestyle choices affect how you feel, you can make more informed, positive changes.

Track Your Progress

Tracking your progress is crucial for staying consistent and making adjustments as needed. Monitoring can reveal whether your workouts are effective, help you avoid plateaus, and provide a sense of accomplishment.

You can use a variety of tools to track your activity:

- A paper exercise log or calendar
- Smartphone apps like MyFitnessPal, Strava, or Google Fit
- Wearable fitness trackers (e.g., Fitbit, Apple Watch, Garmin)
- A shared Google Doc or spreadsheet if you're working with a coach or partner

Track key variables such as frequency, duration, intensity, heart rate, perceived exertion, and how you felt after each workout. Recording how your mood, sleep, and stress level are can help you see patterns that could help you maintain exercise consistently. Over time, this data enables you to see trends, celebrate progress, and stay motivated.

Make a Commitment

Accountability plays a key role in maintaining long-term exercise habits. Making a personal commitment to your fitness goals helps you stick to the plan, even when motivation dips.

Here are some effective ways to commit:

- Tell a friend or family member about your goals so they can support and encourage you.
- Find a workout buddy—exercising with someone else increases both enjoyment and consistency.
- Join a class or club for structure and social connection.
- Write a contract that outlines your goals, timelines, and rewards. Signing it adds a sense of seriousness and ownership.

Social support and self-accountability increase the chances of long-term adherence to physical activity routines (American College of Sports Medicine & Thompson, 2021). [2]

Question

- What strategies can help maintain motivation and consistency in your fitness journey, especially when facing challenges like limited time, low energy, or changing schedules?

Key Points

- Begin with general long-term goals and break them down into specific, measurable, achievable, results-focused, and time-bound (SMART) short-term goals to enhance motivation and track progress.
- Select exercises that are enjoyable, appropriate for your fitness level, accessible, affordable, and aligned with personal health needs and interests. This increases the likelihood of long-term commitment.
- In addition to structured workouts, small daily movements (e.g., taking stairs, walking during breaks) significantly boost overall activity and help meet fitness goals.
- Monitoring your activity and mood using apps, journals, or wearables helps reveal trends, maintain motivation, and adjust the plan when needed. Social support and personal commitment boost long-term adherence.

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7.2: Getting started with your Fitness Plan



Figure 7.2.1: The fitness industry tries to innovate different ways that people will enjoy exercising. (Workout equipment; Chuttersnap via Unsplash)

Getting Started

Designing a fitness plan is an important first step, but staying committed over the long term is what leads to meaningful health benefits. Once your plan is in place, follow these evidence-based strategies to keep yourself motivated and consistent:

- **Start Slowly and Increase Gradually**: If you're new to exercise or returning after a break, resist the urge to do too much too soon. Gradual increases in intensity, duration, and frequency reduce the risk of injury and allow your body to adapt over time
- **Find an Exercise Buddy**: Working out with a partner or group can enhance accountability, provide encouragement, and make exercise more enjoyable. A friend, classmate, or coworker can also help you stay consistent, especially on days when motivation is low.
- **Ask for Support from Others**: Let your family, friends, or instructors know about your fitness goals. Their emotional support or practical help (e.g., babysitting, joining a walk) can significantly increase your chances of success.
- **Vary Activities**: Variety prevents boredom and keeps your workouts mentally stimulating. Alternating between activities, such as walking, swimming, strength training, and yoga, also promotes balanced development across the components of fitness.
- **Cycle Duration and Intensity**: Structured variation, known as **periodization**, helps avoid plateaus and overtraining. For example, alternate between weeks of moderate and higher intensity, or vary the length of your sessions to challenge your body in different ways.
- **Adapt to Changing Environments and Schedules**: Stay flexible. If your schedule changes, modify the time or location of your workout. If the weather is bad, substitute an indoor option. Being adaptable helps sustain progress during life's ups and downs.
- **Expect Fluctuations and Lapses**: Give Yourself Grace. Everyone experiences setbacks. Missed workouts, illness, or low motivation are part of the journey. Rather than giving up, acknowledge the lapse and get back on track without guilt.
- **Choose Other Healthy Lifestyle Behaviors**: Physical activity works best when paired with other positive habits—eating a nutritious diet, getting adequate sleep, managing stress, and avoiding tobacco or excessive alcohol. These behaviors reinforce your overall well-being and support your fitness goals (Centers for Disease Control and Prevention, 2024). [9]

Adapting for Life Stages and Special Health Conditions

Physical activity is important across a person's lifespan and for people with varying health conditions. However, modifications are

often necessary to ensure safety, comfort, and effectiveness. A fitness program may need to be adjusted for people of all ages and many people with special health concerns. Exercise guidelines vary across life stages, with specific recommendations for children, adults, and older adults.

Physical Activity for Children and Adolescents

Childhood and adolescence are critical periods for developing movement skills, learning healthy habits, and establishing a firm foundation for lifelong health and well-being. (PA guidelines) Regular physical activity in children and adolescents promotes health and fitness (US Department of Health and Human Services, 2018). [15]

According to the CDC healthy benefits of physical activity for children include:

- **Academic Performance-** Improves attention and memory.
- **Brain Health-** Reduces the risk of depression.
- **Muscular Fitness-** Builds strong muscles and endurance.
- **Heart and Lung Health-** Improves blood pressure and aerobic fitness.
- **Cardiometabolic Health-** Helps maintain normal blood sugar levels.
- **Long-term Health-** Reduces the risk of several chronic diseases, including type 2 diabetes and obesity.
- **Healthy Weight**- Helps regulate body weight and reduce body fat.
- **Bone Strength-** Strengthens bones (Centers for Disease Control and Prevention, 2024). [6]

Physical activity is essential for healthy growth and development in children and adolescents, and national guidelines provide specific recommendations to support their physical, mental, and social well-being. Providing opportunities for children and adolescents to exercise every day.

- Preschool-aged children (ages 3 through 5 years) should be physically active throughout the day to enhance growth and development.
- Children ages 6 to 17 should engage in at least 60 minutes of physical activity daily, including moderate to vigorous aerobic activity and age-appropriate muscle- and bone-strengthening activities at least three days a week. Less fit kids should start with 30 minutes a day until their fitness improves.
- Activities should emphasize fun, fitness, and skill development, rather than excellence in competitive sport, especially for children under 12.
- Avoid overly structured or competitive programs for young children who are still developing basic motor skills.
- Children benefit from family outings that incorporate physical activity, such as biking, hiking, or playing tag.
- Provide plenty of water, especially in warm weather or when playing for long periods (US Department of Health and Human Services, 2018). [15]

Physical Activity During Pregnancy and Postpartum

Regular physical activity in all phases of life, including pregnancy, promotes health benefits. Women who begin their pregnancy with a healthy lifestyle (eg, exercise, good nutrition, nonsmoking) should be encouraged to maintain those healthy habits. Women who do not have healthy lifestyles should be encouraged to view the prepregnancy period and pregnancy as opportunities to embrace healthier routines (American College of Obstetricians and Gynecologists, 2020). [1] Pregnancy and the postpartum period bring unique changes to a woman's body, but they do not mean physical activity should stop. Women who begin their pregnancy with a healthy lifestyle (eg, exercise, good nutrition, nonsmoking) should be encouraged to maintain those healthy habits. Women who do not have healthy lifestyles should be encouraged to view the prepregnancy period and pregnancy as opportunities to embrace healthier routines. Regular exercise during these life stages provides important physical and emotional health benefits. With proper guidance and precautions, most women can safely begin or continue moderate activity throughout pregnancy and after childbirth. According to the American College of Obstetricians and Gynecologists (ACOG), physical activity during pregnancy is not only safe for most women but also strongly recommended. ACOG encourages women with uncomplicated pregnancies to engage in at least 150 minutes of moderate-intensity aerobic activity spread throughout the week. Activities should be adjusted based on individual comfort, fitness level, and medical advice. Pregnant individuals should avoid contact sports, activities with a high risk of falling, and exercises that involve lying on their backs after the first trimester. ACOG also advises that pregnant individuals drink water before, during, and after physical activity and avoid exercising in hot, humid environments to prevent overheating and dehydration.

In the absence of medical or obstetric complications or contraindications, engaging in physical activity during pregnancy is both

safe and desirable. Pregnant individuals should be encouraged to continue or begin appropriate forms of physical activity to support maternal and fetal health. In the absence of medical or obstetric complications or contraindications, engaging in physical activity during pregnancy is both safe and desirable. Pregnant individuals should be encouraged to continue or begin appropriate forms of safe physical activity to support maternal and fetal health. The following forms of exercise have been extensively studied and are considered safe and beneficial during pregnancy.

Examples of Safe and Beneficial Exercises During Pregnancy

- Walking
- Stationary Cycling
- Aerobic Exercises
- Dancing
- Resistance Exercise (e.g., using weights, elastic bands)
- Stretching Exercises
- Hydrotherapy, water aerobics (American College of Obstetricians and Gynecologists, 2020) [1]

The key is to listen to the body, make adjustments as needed, and consult with a healthcare provider when planning or modifying an exercise routine. Physical Activity can provide many benefits during pregnancy and postpartum.

Benefits During Pregnancy

- Higher incidence of vaginal delivery
- Helps maintain or improve cardiorespiratory fitness
- Reduces the risk of excessive weight gain
- Lowers the likelihood of developing gestational diabetes mellitus
- May reduce the risk of pregnancy complications, such as preeclampsia
- Supports better mood and mental health, reducing symptoms of anxiety and depression
- May reduce the likelihood of a Cesarean section
- Helps shorten the duration of labor
- Encourages faster postpartum recovery
- Does not increase the risk of low birth weight, preterm birth, or pregnancy loss (American College of Obstetricians and Gynecologists, 2020). [1]

Benefits During the Postpartum Period

- Improves cardiorespiratory fitness after delivery
- Enhances mood and reduces symptoms of postpartum depression
- Supports healthy weight loss, especially when combined with a balanced diet
- Does not negatively affect breast milk volume or composition.
- Helps women return to pre-pregnancy activity levels safely and gradually (American College of Obstetricians and Gynecologists, 2020). [1]



Figure 7.2.2: Safely exercising while pregnant involves knowing limitations and getting advice from a medical professional. (Pregnant lady lifting weights; Gabrielle Durant via Pexels)

Exercising during pregnancy provides several evidence-based benefits not only for the mother but also for the developing baby. Here's a summary of the known and potential benefits for the baby:

Benefits of Prenatal Exercise for the Baby

- **Healthy Birth Weight**: Physical activity during pregnancy helps regulate maternal weight gain, reducing the risk of **macrosomia** (being born significantly larger than average) and associated delivery complications.
- **Reduced Risk of Preterm Birth**: Moderate physical activity is associated with a lower risk of preterm delivery, particularly in healthy women with uncomplicated pregnancies.
- **Improved Placental Function**: Regular maternal exercise promotes better blood flow to the placenta, enhancing oxygen and nutrient delivery to the fetus.
- **Improved Fetal Heart Rate Variability**: Babies of physically active mothers may have healthier heart rate patterns, indicating improved autonomic nervous system development.
- **Reduced Risk of Future Obesity**: Some evidence suggests that maternal exercise may reduce the infant's risk of excessive fat accumulation and metabolic issues later in life.
- **Potential Benefits for Brain Development**: Early studies suggest a link between maternal physical activity and enhanced brain development, including improved memory and learning in the child.
- **Fewer Complications at Birth**: Babies of active mothers may experience fewer delivery-related complications due to shorter labor and reduced risk of Cesarean section (American College of Obstetricians and Gynecologists, 2020). [1]

Physical activity is both safe and highly beneficial for most women during and after pregnancy. Unless a healthcare provider advises otherwise, women can begin or continue light to moderate aerobic and muscle-strengthening activities. Regular exercise during pregnancy also improves mood, energy levels, posture, and sleep quality, while helping to prevent gestational diabetes, excessive weight gain, and pregnancy-related complications (ACOG, 2020). It also supports healthy weight management, prepares the body for childbirth, and promotes faster postpartum recovery. Women who were regularly active before pregnancy can typically continue their routines with appropriate adjustments for comfort and safety. Monitoring intensity using the talk test or ratings of perceived exertion is recommended to ensure safe and effective activity.

Warning Signs to Discontinue Exercise While Pregnant

- Vaginal bleeding
- Abdominal pain
- Regular painful contractions
- Amniotic fluid leakage
- **Dyspnea** before exertion

- Dizziness
- Headache
- Chest Pain
- Muscle weakness affecting balance
- Calf pain or Swelling (American College of Obstetricians and Gynecologists, 2020) [1]

Engaging in physical activity and exercise throughout pregnancy presents minimal risks and offers significant benefits for most women. While the physiological and anatomical changes associated with pregnancy, along with fetal requirements, may necessitate some modifications to existing exercise routines, these adjustments are generally minor. For pregnancies without obstetric or medical complications or contraindications, physical activity is not only safe but also highly recommended. Pregnant individuals should be encouraged to either maintain their current safe physical activity levels or initiate appropriate new ones.

Question

- Why is physical activity important during childhood and adolescence?
- How might working out with a friend help you stay committed to your fitness goals?
- Identify at least three evidence-based benefits of maternal physical activity during pregnancy for both the mother and the baby.



Figure 7.2.3: Exercise can be fun when shared with a pet. (Woman with her dog; Roger Chapman via Unsplash)

Physical Activity for Older Adults

Older adults are individuals aged 65 years and older. This diverse group includes people with varying levels of physical ability, from those who are active and healthy to those managing chronic conditions or disabilities. Regardless of health status, engaging in regular physical activity is beneficial and achievable for most older adults.

Why Physical Activity Is Important for Older Adults

Regular physical activity is crucial for older adults to maintain independence and quality of life. It helps prevent or manage chronic diseases such as heart disease, diabetes, and arthritis. Physical activity also reduces the risk of falls, improves mental health, and enhances cognitive function. Even modest increases in activity can lead to significant health benefits (Centers for Disease Control and Prevention, 2024). [3]

Benefits of Physical Activity

Engaging in regular physical activity offers numerous benefits for older adults:

- Improved Physical Health: Enhances cardiovascular health, strengthens muscles and bones, and helps maintain a healthy weight.
- Mental Well-being: Reduces symptoms of depression and anxiety, and improves mood and overall mental health.
- Cognitive Function: Supports brain health, potentially reducing the risk of cognitive decline and dementia.
- Enhanced Mobility and Balance: Improves flexibility and coordination, reducing the risk of falls and injuries.
- Social Engagement: Provides opportunities for social interaction, which can alleviate feelings of loneliness and isolation (Centers for Disease Control and Prevention, 2024). [4]

Regular physical activity provides significant health benefits for older adults, including both immediate effects and long-term improvements. Engaging in a combination of aerobic, muscle-strengthening, and multi-component activities enhances the ability to perform **activities of daily living (ADLs)**, such as bathing, dressing, and household tasks, more easily and independently. In addition, physical activity supports the ability to carry out **instrumental activities of daily living (IADLs)** more complex tasks essential for independent living, such as preparing meals, managing medications, shopping, and handling finances (National Academies of Sciences, Engineering, and Medicine, 2020). [14] Maintaining strength, balance, and mobility through regular exercise helps older adults preserve autonomy and quality of life.

The following is a comprehensive list of health benefits associated with physical activity for older adults. While many of these advantages apply to individuals of all ages, certain benefits, such as fall prevention and reduced risk of fall-related injuries, are particularly significant for older adults. In addition, physical activity may offer protective effects against osteoporosis and age-related sarcopenia (US Department of Health and Human Services, 2023). [16] Regular physical activity can lead to improvements in physical health, mental well-being, and overall quality of life. These benefits highlight the importance of regular physical activity in promoting healthier aging (US Department of Health and Human Services, 2023). [16]

Health Benefits Associated with Physical Activity for Older Adults

- Lower risk of all-cause mortality
- Lower risk of cardiovascular disease mortality
- Lower risk of cardiovascular disease (including heart disease and stroke)
- Lower risk of hypertension
- Lower risk of type 2 diabetes
- Lower risk of adverse blood lipid profile
- Lower risk of cancers of the bladder, breast, colon, endometrium, esophagus, kidney, lung,and stomach
- Slowed or reduced weight gain
- Weight loss, particularly when combined with reduced calorie intake
- Prevention of weight regain following initial weight loss
- Improved bone health
- Improved physical function
- Lower risk of falls
- Lower risk of fall-related injuries
- Improved mental and cognitive outcomes, including:
    - Improved quality of life
    - Reduced risk of dementia (including Alzheimer's disease)
    - Improved cognition
    - Reduced risk of depression
    - Reduced long-term feelings and signs of anxiety (trait anxiety) for people with and without anxiety disorders
    - Reduced short-term feelings of anxiety (state anxiety)
    - Improved sleep outcomes (increased sleep efficiency, sleep quality, deep sleep; reduced daytime sleepiness, reduced frequency of use of medication to aid sleep)

These benefits highlight the importance of regular physical activity in promoting healthier aging (US Department of Health and Human Services, 2023). [16]



Figure 7.2.4: Staying active later in life is important for physical and mental wellness as people age. (A group of people playing soccer; Age Cymru via Unsplash)

Examples of Physical Activities for Older Adults

Aerobic Activities

- Walking or hiking
- Dancing
- Swimming
- Water aerobics
- Jogging or running
- Aerobic exercise classes
- Some forms of yoga
- Bicycle riding (stationary or outdoors)
- Some yard work, such as raking and pushing
- a lawn mower
- Sports like tennis or basketball
- Walking as part of golf

Muscle-Strengthening Activities

- Strengthening exercises using exercise bands,
- weight machines, or hand-held weights
- Body-weight exercises (push-ups, pull-ups,
- planks, squats, lunges)
- Digging, lifting, and carrying as part of gardening
- Carrying groceries
- Some yoga postures
- Some forms of tai chi

Note: The intensity of these activities can be either relatively moderate or relatively vigorous, depending on an older adult's level of fitness (US Department of Health and Human Services, 2018). [15]

Multicomponent Physical Activity

Multicomponent physical activity combines aerobic, muscle-strengthening, and balance exercises. This comprehensive approach addresses multiple aspects of health and functional ability, making it particularly beneficial for older adults. Examples

include dancing, gardening, tai chi, sports, and group exercise classes that incorporate various types of movement.

Multicomponent activities are recommended because they help:

- Improve overall physical function
- Reduce the risk of falls and fall-related injuries
- Maintain independence by enhancing the ability to perform activities of daily living (ADLs)
- Increase mobility, strength, and cardiovascular endurance (US Department of Health and Human Services, 2023) [16]

The CDC and the Physical Activity Guidelines for Americans recommend multicomponent activity at least 3 days per week for older adults, particularly those at risk of falling. These activities help support healthy aging and reduce the decline in physical function. By incorporating these guidelines into daily routines, older adults can enhance their health, maintain independence, and improve their overall quality of life.

A well-rounded physical activity program for older adults (65 and older) should include a minimum of two of the multicomponent activites a session:

- **Aerobic Activity:** Engage in at least 150 minutes of moderate-intensity aerobic activity, 30 minutes per day 5 days (e.g., brisk walking) per week, or 75 minutes of vigorous-intensity activity (e.g., jogging) per week, or an equivalent combination.
- **Muscle-Strengthening Activities:** Perform activities that strengthen all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms) on two or more days per week.
- **Balance Exercises:** Incorporate balance training activities, such as standing on one foot or tai chi, to reduce the risk of falls (Centers for Disease Control and Prevention, 2023). [11]

Balance activities help prevent falling, reducing the risk of injuries such as bone fractures. Walking backward, standing on one leg, or using a wobble board are examples of balance activities. Strengthening back, abdomen, and leg muscles also improves balance.

Measuring Intensity

Understanding the intensity of physical activity helps ensure safety and effectiveness:

- **Moderate-Intensity Activity:** On a scale of 0 to 10, where sitting is 0 and the highest level of effort is 10, moderate-intensity activity is a 5 or 6. You should be able to talk but not sing during the activity (Centers for Disease Control and Prevention, 2023). [11]
- **Vigorous-Intensity Activity:** Rated as a 7 or 8 on the same scale, vigorous activity makes you breathe hard and fast, and you won't be able to say more than a few words without pausing for breath (Centers for Disease Control and Prevention, 2023). [11]

Question

- Why is multi-component physical activity especially important for older adults?
- How should physical activity be adapted for different life stages?
  - Childhood?
  - Pregnancy?
  - Older adulthood?
- What types of exercises should be included to maximize health and function?

Key Points

- Beginners and those returning to exercise should start with light activity and increase intensity and duration gradually to avoid injury and allow for adaptation.
- Children and adolescents should get at least 60 minutes of physical activity each day, including aerobic, muscle-strengthening, and bone-strengthening activities.
- In the absence of medical complications, physical activity during pregnancy is safe and promotes maternal and fetal health.

- Staying motivated requires strategies like exercising with a partner, varying activities, and seeking support from family or friends to stay accountable.
- Physical activity guidelines should be adjusted for different life stages (children, pregnancy, older adults) and for individuals with chronic conditions or disabilities to ensure safety and effectiveness.
- Regular physical activity in older adults improves cardiovascular health, strength, mental well-being, balance, and helps manage or prevent chronic conditions such as diabetes, hypertension, and arthritis.
- Combining aerobic, strength, and balance training, especially in older adults, yields the greatest functional and health benefits, supporting independent living and reducing fall risk.
- Adults should aim for at least 150 minutes/week of moderate-intensity aerobic activity, 2+ days of muscle-strengthening, and include balance training when appropriate. Intensity can be gauged using perceived effort or the talk test.
- Look for opportunities to move more throughout the day, take the stairs, walk or bike instead of driving, or do short activity breaks.

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7.3: Physical Activity and Special Health Needs in Older Adults



Figure 7.3.1: (A group of people exercising; Centre For Ageing Better via Unsplash)

Introduction

This section includes adults aged 65 and older who live with chronic conditions, such as type 2 diabetes, osteoarthritis, or hypertension, or who have physical or cognitive disabilities. Some were born with these conditions, while others developed them through injury, illness, or aging. Many of these individuals are still able to perform physical activity and benefit greatly from it.

Why Physical Activity Is Important

For older adults with **chronic** conditions or disabilities, regular physical activity improves health, functional ability, and quality of life. It helps:

- Reduce the risk of new chronic diseases
- Manage existing conditions
- Improve the ability to perform activities of daily living (ADLs) like walking, dressing, or household tasks
- Enhance brain health and reduce symptoms of anxiety or depression
- Prevent falls and improve balance
- Support healthy weight and heart function

Even small amounts of activity provide significant benefits and are safer than remaining inactive (US Department of Health and Human Services, 2018). [15]

How Much Activity Is Recommended?

For those who are able, the recommended amounts are:

- 150–300 minutes per week of moderate-intensity aerobic activity, OR
- 75–150 minutes of vigorous-intensity aerobic activity, OR
- An equivalent combination of both, spread throughout the week

Plus:

- Muscle-strengthening activities involving all major muscle groups at least 2 days a week
- Balance training, particularly for those at risk of falling

If these goals can't be met, individuals should still do as much activity as their abilities allow and avoid complete inactivity (US Department of Health and Human Services, 2018). [15]

Special Considerations by Health Condition

While many older adults can follow general activity guidelines, those with chronic health conditions or disabilities may need to tailor their routines based on their individual needs. The type, intensity, and duration of physical activity should reflect the person's abilities, medical status, and comfort level. It is recommended that individuals with disabilities or chronic conditions consult their doctor for guidance, complete the PAR-Q+, and collaborate with their doctor to develop a personalized plan. Additional information on the PAR-Q+ can be found in Chapter 2. With support from a healthcare provider or fitness specialist, most older adults can safely engage in regular exercise and gain substantial health benefits. Below are guidelines and examples for some of the most common chronic conditions and physical disabilities in older adults. Older adults with chronic conditions or disabilities can safely benefit from physical activity tailored to their abilities. With proper guidance and adaptations, they can experience improved function, reduced disease risk, and a better quality of life.

Osteoporosis

- Osteoporosis is a condition where bones become brittle and fragile due to low bone density, increasing the risk of fractures.
- Regular exercise helps maintain and improve bone density, strengthening bones and muscles, and reducing the risk of fractures.
- Weight-bearing exercises (e.g., walking, running, dancing) and resistance training (e.g., lifting weights) are particularly effective in strengthening bones and improving balance to prevent falls.
- Osteoporosis primarily affects older adults, especially women after menopause, due to decreased estrogen levels, though it can also affect men as they age.
- Bone density naturally decreases with age, making osteoporosis more common in individuals over 50, though preventive measures can help maintain bone health throughout life.

Asthma

- Asthma is a chronic respiratory condition where the airways become inflamed and narrowed, making breathing difficult and causing wheezing, coughing, and shortness of breath.
- Regular physical activity can help improve lung function, increase stamina, and reduce asthma symptoms by promoting better airflow and respiratory health.
- Low-impact exercises like walking, swimming, and cycling can help improve cardiovascular fitness without overly stressing the respiratory system. It's important to warm up properly and avoid triggers.
- Asthma can affect individuals of all ages, though it is most commonly diagnosed in childhood. It is more prevalent in people with a family history of asthma or allergies.
- Asthma symptoms can be managed through medication, proper warm-up routines, and avoiding environmental triggers (e.g., pollen, pollution) during exercise.
- Carry medication during workouts and avoid exercising alone. Use your inhaler as recommended by your doctor.

Obesity

- Obesity is a condition characterized by excessive body fat that increases the risk of developing serious health problems, such as heart disease, diabetes, and joint issues.
- Regular exercise helps burn calories, build muscle, and improve metabolism, making it a key component in managing and preventing obesity. It also reduces the risk of associated health conditions.
- Cardiovascular exercises (e.g., walking, jogging, swimming) combined with strength training (e.g., weightlifting, resistance bands) are effective for weight loss and improving overall fitness.
- Obesity affects individuals of all ages and backgrounds, though it is more common in adults, particularly those with poor diet habits, sedentary lifestyles, or certain genetic factors.

- Obesity can become more prevalent with age due to hormonal changes, decreased physical activity, and muscle loss. However, healthy eating and regular physical activity can help manage weight at any age.

Osteoarthritis

- Common in older adults, osteoarthritis causes joint pain and stiffness.
- Lifting weights is a muscle-strengthening activity that is important for bone health. As we age, muscle mass is reduced.
- Low-impact activities like walking, swimming, and tai chi are best.
- Activity improves joint function, reduces pain, and enhances quality of life without worsening the condition.

Type 2 Diabetes

- Physical activity helps control blood sugar, reduces heart disease risk, and manages weight.
- Both aerobic and muscle-strengthening activities are effective.
- Careful monitoring of blood glucose, proper footwear, and medical consultation are advised.
- Regular physical activity can reduce your risk of developing type 2 diabetes and metabolic syndrome.
- Benefits can be seen with 150 minutes of moderate-intensity physical activity. More physical activity could lower the risk even more.

Hypertension

- One of the most common chronic conditions in older adults.
- Physical activity lowers blood pressure and reduces heart disease risk.
- Moderate activity for as little as 90 minutes per week offers benefits.
- Healthcare providers may need to adjust medications as activity increases.

Cancer Survivors

- Activity improves fitness, mood, and quality of life after treatment.
- May reduce the risk of cancer recurrence and death, particularly for breast, colorectal, and prostate cancers.
- Survivors should seek guidance to tailor activity to treatment side effects and functional ability.
- Cancer survivors participating in regular physical activity can have a better quality of life, and their physical fitness improves.

Physical Disabilities

Includes conditions such as:

- Parkinson's Disease – Improved physical function, including walking, balance, strength, and disease-specific motor scores
- Multiple Sclerosis – Improved physical function, including walking speed and endurance, and fitness.
- Spinal Cord Injury – Improved walking function, wheelchair skills, and muscular strength
- Stroke – Enhances walking speed and endurance

Multi-component programs, which combine aerobic, muscle-strengthening, and balance training, are especially effective (Centers for Disease Control and Prevention, 2023). [11]

Engaging in regular, appropriate exercise is safe and beneficial for everyone. For many people with health conditions, the risks of not exercising are far greater than those associated with a moderate program of regular exercise.

Question

- How can physical activity benefit individuals with:
  - Osteoporosis?
  - Asthma?
  - Hypertension?

- Give an example for each.



Figure 7.3.2: Hiking can be a multi-component activity, combining aerobic endurance with balance and strengthening. (A couple holding hands walking; Ged Lawson via Unsplash)

Creating an Individualized Plan

Adults with chronic conditions or disabilities should work with a healthcare provider or physical activity specialist to design a program that meets their specific needs. When designing physical activity plans, these are areas that should be considered:

- Condition severity
- Physical abilities
- Risk factors
- Need for supervision or equipment adaptations

Examples of adapted activities include:

- Arm ergometers or wheelchair walking for those with leg limitations
- Seated resistance exercises for those with balance challenges

Most healthy older adults can begin a physical activity program without needing medical clearance, particularly when they plan a gradual increase in intensity, duration, and frequency. However, older adults living with chronic conditions should consult a healthcare provider to determine if their condition affects their ability to exercise safely. These conversations can also help identify suitable types and amounts of activity that align with their health status and goals.

To stay safe and reduce the risk of injury, it's important to choose appropriate activities, use the right equipment, and exercise in safe environments. Starting with low-intensity activities and progressing slowly—an approach often summarized as "start low and go slow"—allows the body time to adapt, especially for those who are new to exercise or returning after a break. Physical activity professionals can also offer valuable guidance on how to begin or modify exercise routines based on current fitness levels and individual needs.

Question

- What are the recommended types and amounts of physical activity for older adults?
- How should these be adjusted for those with limited mobility or chronic health conditions?

Key Points

- Physical activity is beneficial and safe for most older adults, including those with chronic diseases or disabilities, when properly adapted to their abilities.
- Health benefits include reduced risk of chronic diseases, improved functional capacity, better mood and brain health, fall prevention, and enhanced quality of life.
- General guidelines recommend: 150–300 minutes of moderate-intensity aerobic activity per week (or 75–150 minutes of vigorous intensity), Muscle-strengthening activities at least 2 days per week
- Balance training for those at risk of falling
- Tailoring activity plans based on individual conditions, risks, and abilities is essential. Tools like the PAR-Q+ (Chapter 2) and consultation with healthcare providers help ensure safety.
- Creating individualized plans involves considering severity, equipment needs, and supervision. The principle of “start low and go slow” is key to safety and success.

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7.4: Physical Activity for Individuals with Chronic Conditions and Disabilities



Figure 7.4.1: (Man riding green racing chair; Seth Kane via Unsplash)

Introduction

Engaging in regular physical activity is important for all adults, including those with chronic health conditions or disabilities. Some individuals may be born with a disability, while others may acquire one as a result of illness, injury, or the progression of a chronic condition. In either case, these individuals often face an increased risk of developing additional health problems. Despite differences in ability, adults with chronic conditions or disabilities can benefit greatly from being physically active.

The specific type and amount of recommended physical activity should be tailored to each person's physical abilities and the nature and severity of their condition. While the guidelines do not address therapeutic exercise or rehabilitation in depth, they emphasize that physical activity aimed at preventing disease and promoting general health is both safe and beneficial for adults with chronic conditions and disabilities. For many chronic illnesses, physical activity is even considered part of the recommended treatment plan.

Scientific research has demonstrated that regular physical activity leads to improved cardiovascular and muscular fitness, better brain health, and increased ability to perform everyday tasks. Physical activity also improves quality of life. These benefits have been observed in individuals with a wide range of conditions and disabilities, including those with stroke, spinal cord injuries, multiple sclerosis, Parkinson’s disease, muscular dystrophy, cerebral palsy, traumatic brain injury, limb amputations, mental illness, intellectual disabilities, Alzheimer’s disease, and other forms of dementia. In many of these populations, physical activity may also help preserve or improve cognitive function.

Overall, there is strong evidence that regular physical activity leads to better cardiovascular and muscular fitness, improved brain health, and greater ability to perform everyday activities in people with disabilities. While more research is needed to determine the best approaches for specific conditions, current knowledge supports the recommendation that adults with disabilities or chronic conditions should be encouraged to engage in regular physical activity suited to their abilities.

Physical Activity and Disability: Overcoming Barriers to Improve Health

Physical activity plays a vital role in promoting overall health and well-being, and this is equally true for individuals living with disabilities. One in four U.S. adults, approximately 61 million people, lives with a disability. Disabilities can take many forms,

including serious difficulty walking or climbing stairs; deafness or significant hearing impairment; blindness or difficulty seeing even with glasses; challenges with memory, concentration, or decision-making; and difficulties with basic daily tasks like dressing, bathing, or running errands alone. These individuals are disproportionately affected by chronic health conditions. Adults with disabilities are more likely than those without disabilities to experience obesity, heart disease, stroke, type 2 diabetes, and certain types of cancer.

Despite the proven health benefits of regular physical activity, including improved cardiovascular health, enhanced mood, better mobility, and reduced risk of chronic disease, people with disabilities are significantly less likely to meet national physical activity guidelines. Nearly half of all adults with a mobility disability report no leisure-time aerobic activity. This inactivity can lead to further declines in physical function, increased healthcare needs, and diminished quality of life.

The Physical Activity Guidelines for Americans recommend that all adults, including those with disabilities, engage in at least 150 minutes of moderate-intensity aerobic activity (such as brisk walking or wheelchair propulsion) or 75 minutes of vigorous-intensity activity each week. These should be complemented by muscle-strengthening activities on two or more days per week. Although modifications may be necessary, the fundamental health benefits of physical activity apply to everyone, regardless of ability (US Department of Health and Human Services, 2018). [15]

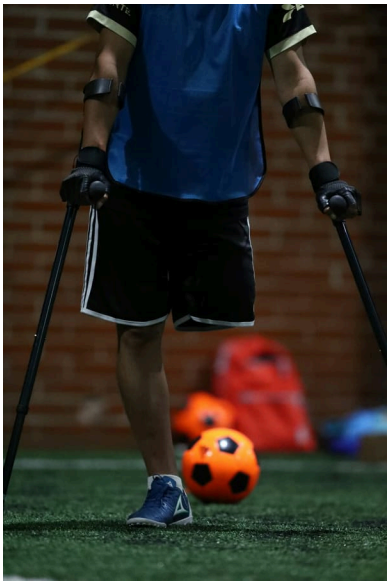


Figure 7.4.2: Overcoming barriers to physical activity is essential for improving quality of life for people with disabilities. (Amputee soccer; José Pablo Domínguez via Unsplash)

However, people with disabilities often face additional challenges when trying to be physically active. Environmental barriers such as inaccessible sidewalks, limited public transportation, and a lack of safe exercise spaces can make physical activity difficult or unsafe. Social and informational barriers are also common. Many individuals report that they do not receive guidance from healthcare providers or have difficulty accessing inclusive fitness programs.

Fortunately, there are effective strategies for promoting physical activity among individuals with disabilities. Home-based options, such as adaptive online exercise videos, allow people to stay active in the comfort and safety of their own environment. Programs like “14 Weeks to a Healthier You” from the National Center on Health, Physical Activity and Disability (NCHPAD) and the Special Olympics’ “Fit 5” initiative offer structured, inclusive plans tailored to different ability levels. Adaptive sports, including wheelchair basketball, skiing, wheelchair racing, hand-cycling, and aquatic exercise, also provide engaging and empowering ways to build fitness and community.

Healthcare professionals play a critical role in encouraging physical activity among people with disabilities. Research shows that individuals are far more likely to become physically active if a provider recommends it. However, only about 44% of adults with a disability report receiving such guidance. To improve these outcomes, the CDC recommends a five-step clinical approach found in Table 7.4.1. When clinicians feel prepared to have these conversations, patients are more likely to receive meaningful and motivating advice.

Question

- List two health benefits of regular physical activity for adults with disabilities.
- According to national guidelines, how many minutes of moderate-intensity aerobic activity should adults with disabilities aim for each week?

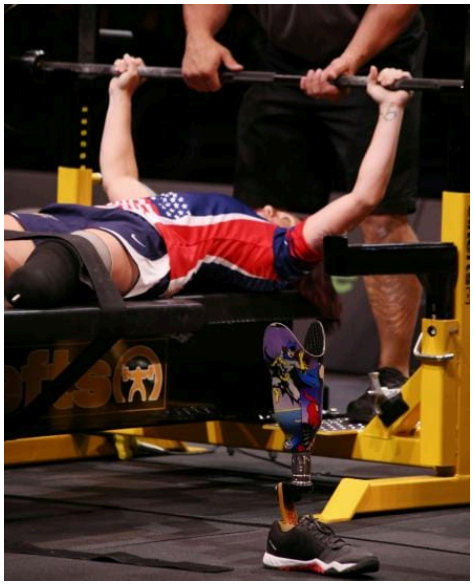


Figure 7.4.3: People with disabilities can typically do most things with minimal assistance. (Weightlifter; Audi Nissen via unsplash)

Increasing Physical Activity Among Adults with Disabilities

Doctors and other health professionals can use these steps to recommend aerobic physical activity options that match each person's specific abilities and connect him or her to resources that can help each person be physically active.

1. Know the physical activity guidelines
   - The physical activity guidelines are for everybody
   - Review the patient's charts before each visit
   - Explain that adults of all shapes, sizes, and abilities can benefit from being physically active.
   - Encourage at least 2 1/2 hours a week of moderate-intensity physical activity.
2. Ask about physical activity
   - Remember to look beyond the disability and put the person first.
   - Use terms such as "person with a disability" instead of "disabled" or "handicapped person".
   - How can you add more physical activity to your life?
   - What types of physical activity do you enjoy?
   - How much physical activity are you currently doing each week?
3. Discuss barriers to physical activity
   - Physical barriers, stairs, doors, and no ramps
   - Emotional barriers
4. Recommend physical activity options
   - Describe the physical activity options based on patients' abilities.
   - Brisk walking
   - Wheeling oneself in a wheelchair
   - Swimming laps
   - Water aerobics
   - Hand-cranked bicycle
   - Wheelchair basketball, tennis, football, or softball
5. Refer the patient to resources and programs
   - Check in with the patient about his or her activity level at every visit.

- Refer the patient to resources and programs to help them begin or maintain their physical activity.
- Remember to use the “teach-back” method to make sure the patient understands the recommendations (Centers for Disease Control and Prevention, 2025). [10]

Beyond the individual and clinical levels, community and national programs are essential to expanding opportunities for physical activity. The CDC collaborates with organizations such as Special Olympics to promote inclusive health, funds state-based initiatives that support fitness for people with mobility or cognitive challenges, and advances public campaigns like Active People, Healthy Nation™. These efforts are designed to make physical activity more accessible and sustainable for all Americans, including those with disabilities.

Making physical activity inclusive is not only a matter of public health; it is a matter of health equity. With thoughtful design, inclusive programming, and healthcare provider support, people with disabilities can fully participate in active lifestyles that enhance their physical, mental, and social well-being.

Question

- Identify one common barrier that may prevent people with disabilities from being physically active.
- Name one adaptive or inclusive program that supports physical activity for individuals with disabilities.
- Why is it important for healthcare providers to talk to patients with disabilities about physical activity?



Figure 7.4.4: Wheelchair basketball is a great way for someone unable to walk to enjoy an activity. (Wheelchair basketball; Audi Nissen via unsplash)

Key Guidelines for Adults With Chronic Health Conditions and Adults With Disabilities

- Adults with chronic conditions or disabilities, who are able, should do at least 150 minutes a week (2 hours and 30 minutes) to 300 minutes (5 hours) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) to 150 minutes (2 hours and 30 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Preferably, aerobic activity should be spread throughout the week.
- Adults with chronic conditions or disabilities, who are able, should also do muscle-strengthening activities of moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these activities provide additional health benefits.
- When adults with chronic conditions or disabilities are not able to meet the above key guidelines, they should engage in regular physical activity according to their abilities and should avoid inactivity.
- Adults with chronic conditions should be under the care of a healthcare provider. People with chronic conditions can consult a health care professional or physical activity specialist about the types and amounts of activity appropriate for their abilities

and chronic conditions (US Department of Health and Human Services, 2018). [15]

Key Points

- Regular physical activity in individuals with chronic health and disabilities improves cardiovascular fitness, muscular strength, brain health, and daily functioning in adults with disabilities or chronic conditions, while also enhancing quality of life.
- Adults with disabilities who are able should aim for 150–300 minutes of moderate-intensity or 75–150 minutes of vigorous-intensity aerobic activity per week, plus muscle-strengthening exercises on two or more days.
- Individuals with disabilities often face physical, social, and informational barriers to activity, including a lack of accessible spaces, equipment, and healthcare guidance.
- Home-based programs, adaptive sports, and inclusive community initiatives (e.g., NCHPAD, Special Olympics) help make physical activity more accessible and empowering for people with disabilities.
- Healthcare professionals can increase activity participation by discussing physical activity at appointments, identifying barriers, recommending suitable options, and referring patients to resources.
- Promoting inclusive physical activity is essential to advancing health equity and reducing chronic disease risks in the disability community.

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7.5: Comprehension Check

Summary

Creating a successful fitness plan begins with setting meaningful goals, selecting appropriate and enjoyable activities, and using strategies that promote consistency. Evidence-based practices, such as starting slowly, varying activities, and tracking progress, can increase motivation and long-term adherence.

As fitness plans are developed, it's essential to include all five health-related components: cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition. The FITT-VP principle (Frequency, Intensity, Time, Type, Volume, Progression) serves as a guide for structuring effective programs tailored to individual needs.

Physical activity should also be adapted to life stages and health conditions. Children, pregnant individuals, older adults, and people with chronic conditions or disabilities all benefit from movement, but safety and effectiveness depend on proper modifications. With thoughtful planning, support, and gradual progression, physical activity can be accessible, beneficial, and sustainable for everyone.

Test Your Understanding

1. Why is it important to include all five health-related components of fitness in your program, and how can the FITT-VP principle help achieve this balance?
2. What are some strategies that help maintain motivation and consistency in a personal fitness program over time?
3. How should physical activity be modified to support individuals at different life stages, such as children, pregnant individuals, or older adults?
4. What factors should be considered when choosing activities for a personal fitness plan to ensure long-term adherence and safety?
5. How can journaling or tracking tools support the effectiveness and sustainability of a fitness program?

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Chapter 7 Glossary

- **Activities of Daily Living (ADLs)**: Basic self-care tasks, such as bathing, dressing, and household chores, that physical activity can help older adults perform more easily and independently
- **American College of Sports Medicine [ACSM]**: A professional organization that provides guidelines and research on exercise science and sports medicine.
- **Chronic**: A disease or condition that usually lasts for 3 months or longer and may get worse over time.
- **Dypsnea**: commonly known as shortness of breath, is the subjective sensation of uncomfortable breathing, often described as difficult or labored breathing.
- **FITT-VP Principle**: An acronym for Frequency, Intensity, Time, Type, Volume, and Progression. It is a guideline used to structure and adjust exercise programs to ensure safety and effectiveness.
- **High-Intensity Interval Training (HIIT)**: A training technique that involves short bursts of intense exercise alternated with periods of low-intensity recovery.
- **Instrumental Activities of Daily Living (IADLs)**: Are more complex tasks that enable individuals to live independently in a community. They go beyond basic self-care (ADLs) and involve activities like managing finances, transportation, and meal preparation.
- **Macrosomia**: A condition where a baby is born significantly larger than average, a risk that maternal physical activity during pregnancy can help reduce.
- **Multicomponent Physical Activity**: A comprehensive exercise approach that combines aerobic, muscle-strengthening, and balance exercises, particularly beneficial for older adults to address multiple aspects of health and functional ability and reduce the risk of falls
- **Neuromotor Exercise**: Exercise that involves motor skills such as balance, coordination, gait, and agility (e.g., Tai Chi, yoga). It is primarily relevant for older adults
- **Periodization**: The phasic manipulation of training variables to optimize physiological outcomes while reducing the incidence of overtraining.
- **U.S. Department of Health and Human Services (USDHHS)**: A U.S. government department responsible for public health. It publishes guidelines like the Physical Activity Guidelines for Americans.

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8: NUTRITION



Figure 8.1: Nutrition is about color. (Macro Shot of vegetables; Dan Gold via Unsplash)

Introduction to Nutrition

Nutrition is a fundamental component of health and well-being, providing the energy and nutrients the body needs to function, grow, and repair itself. Understanding nutrition is essential for making informed choices about the foods we eat and the habits we develop, as these choices directly affect physical performance, cognitive function, and long-term health. This chapter explores the science of nutrition, breaking down key concepts that help individuals meet their daily energy and nutrient needs while maintaining a balanced diet. The roles of macronutrients and micronutrients are examined, and how the body uses food to sustain life. It then examines energy and nutrient requirements, highlighting how factors such as age, sex, activity level, and health status influence dietary needs. Subsequent sections focus on specific nutrients, including carbohydrates, proteins, lipids, vitamins, minerals, and water, explaining their functions, dietary sources, and recommended intakes. Practical applications are also emphasized, with guidance on understanding food labels to make healthier choices, as well as the relationship between nutrition and physical activity. By integrating evidence-based principles with actionable strategies, this chapter provides a comprehensive foundation for developing lifelong healthy eating habits and supporting overall wellness.

Learning Objectives

- Learn about the different sources of energy in a balanced diet.
- Discover the essential nutrients required for health and wellness.
- Differentiate between the three main types of macronutrients: carbohydrates, proteins, and lipids (fats)
- Learn about the role of micronutrients in the body's functioning
- Recognize the importance of water for health and wellness, and its role in body function
- Learn to read and understand food labels and use them to compare energy and nutrients in food choices
- Recognize the role of nutrition in physical activity.
- Determine personal energy intake needs and compare to recommended intakes.

8.1: Nutrition Basics

8.2: Energy and Nutrient Requirements

8.3: Carbohydrates

8.4: Protein
8.5: Lipids (Fats)
8.6: Vitamins and Minerals
8.7: Water
8.8: Understanding Food Labels
8.9: Nutrition and Physical Activity
8.10: Comprehension Check
8.11: Glossary
8.12: References

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8.1: Nutrition Basics



Figure 8.1.1: (A Wooden Crate Filled with Lots of Different Types of Vegetables; Skön Communication via UnSplash)

Introduction

The basic concepts of nutrition can sometimes feel overwhelming due to the wide variety of food choices and popular diets. However, having a clear understanding of fundamental nutrition principles is an essential first step toward supporting overall health and wellness. To function properly and maintain health, the human body requires a continuous supply of nutrients, substances obtained from food that are essential for growth, repair, and energy production. These dietary components fall into two broad categories: macronutrients and micronutrients. Macronutrients, which include carbohydrates, proteins, and fats, are needed in large quantities and serve as the body's primary sources of energy and structural building blocks. In contrast, micronutrients, such as vitamins and minerals, are required in much smaller amounts but are no less essential. They play critical roles in metabolic reactions, immune function, and overall physiological regulation. Another vital aspect of nutrition is energy balance, which refers to the relationship between the calories consumed through food and beverages and the calories expended through physical activity and basic body functions (such as breathing and digestion). Understanding how different nutrients contribute to both structure and energy production helps individuals make informed choices about their diets to support overall well-being, athletic performance, and disease prevention.

Essential Nutrients

Nutrients are substances found in food that the body needs to function properly, grow, and stay healthy. They provide energy, support bodily processes, and help build and repair tissues; since the body cannot produce all nutrients on its own, they must be obtained through the diet. Nutrients are usually divided into 6 classes, with two main categories: **macronutrients** and **micronutrients**. Water is also considered an essential nutrient because it is vital for nearly every bodily function, even though it does not provide energy.

In general, most foods have a mix of nutrients. For example, whole milk is an excellent example of a natural food that contains both macronutrients and micronutrients. It provides carbohydrates, high-quality protein, and healthy fats, along with essential micronutrients like calcium, vitamin D, vitamin B12, phosphorus, and riboflavin, all of which support bone health, muscle function, and overall growth. An egg is also naturally rich in essential nutrients. Eggs provide high-quality protein and healthy fats along with important micronutrients like vitamin D, B12, choline, selenium, and iron, making them a nutrient-dense whole food. Other foods are excellent choices for specific nutrients. For example, one medium orange contains about 70–90 mg of vitamin C, which meets or exceeds the recommended daily intake for most adults (75 mg for women, 90 mg for men). Other examples include red bell peppers and kiwis, which also offer more than 100% of the daily value in just one serving.

Macronutrients

Food is the body's primary source of fuel, providing the energy needed for movement, growth, and daily functions. Macronutrients, which include carbohydrates, proteins, and fats, are needed in large amounts and provide energy and structural components for the body. These nutrients provide calories, which need to be consumed in large amounts. Each type of macronutrient releases energy in the form of **Adenosine Triphosphate (ATP)**, but they do so with varying levels of efficiency. ATP powers every cell in the body. The number of calories in each also differs. In addition to providing calories, macronutrients supply essential components for growth, repair, and the proper functioning of body systems. Thus, a balance of micronutrients is best for overall health.

Table 8.1.1*: Macronutrients*

Nutrient Class	Energy	Major Functions	Major Sources
Carbohydrates	4 calories per gram	Serves as the body's main source of energy, fuels the brain and nervous system, spares protein from being used for energy, supports proper fat metabolism, and promotes digestive health through dietary fiber.	• Grains (bread, cereal, rice) • Vegetables • Fruits • Milk products
Protein	4 calories per gram	Building and repairing tissues, supporting immune function, producing enzymes and hormones, maintaining muscle mass, and serving as an energy source when carbohydrates and fats are insufficient.	• Meat • Poultry • Seafood • Milk product • Eggs • Legumes • Nuts
Fat	9 calories per gram	Provide a concentrated source of energy, support cell structure and function, help absorb fat-soluble vitamins (A, D, E, and K), insulate the body, protect vital organs, and play a key role in hormone	• Meat • Poultry • Fish • Milk Products • Eggs • Nuts • Seeds • Some Vegetables/Fruits

Micronutrients

Micronutrients, such as vitamins and minerals, are required in much smaller amounts but are essential for regulating body processes, supporting immune function, and promoting overall health. Although these nutrients are required in much smaller amounts than macronutrients, they are still vital for overall healthy body function. Micronutrients are naturally present in many foods, including fruits, vegetables, whole grains, dairy products, meat, fish, nuts, and seeds. However, they can also be found in many processed foods such as bread, cereal, orange juice, and milk. Processed foods that are "fortified" have added micronutrients. Although micronutrients do not provide calories, they contain essential compounds that help the body process and utilize energy and nutrients from macronutrients, vital for the body's everyday activities. Micronutrients, especially vitamins and minerals, act as **coenzymes** and **cofactors** that help trigger and regulate chemical reactions in the body, such as breaking down food for energy, building new tissues, and supporting metabolism.

Table 8.1.2: Micronutrients

Nutrient Class	Energy	Major Functions	Major Sources
Vitamins	N/A	Help regulate body processes, support immune function, aid in energy production, and are essential for growth, development, and overall health.	• Fruits • Vegetables • Grains
Minerals	N/A	Essential for building strong bones and teeth, maintaining fluid balance, supporting nerve and muscle function, and enabling various metabolic processes.	• Dairy Products • Meat • Poultry • Seafood • Vegetables • Fruits • Whole Grains • Legumes • Nuts • Seeds
Water	N/A	Essential for regulating body temperature, transporting nutrients and oxygen, removing waste, lubricating joints, and supporting nearly every cellular function. It also helps maintain fluid and electrolyte balance, making it vital for overall health and homeostasis.	• Water and other liquids • Fruits • Vegetables

Alcohol

Alcohol is a liquid that provides energy with 7 calories per gram, but it is not an essential nutrient.

- It provides "empty" calories: Each gram of alcohol contains 7 calories, but it offers no essential nutrients like vitamins, minerals, or protein.
- It can lead to weight gain as it is high in calories and often consumed with sugary mixers, so it can contribute to excess calorie intake and fat storage.
- Alcohol interferes with nutrient absorption; it can impair the absorption and use of important nutrients such as B vitamins, vitamin D, calcium, and zinc.
- Alcohol can negatively affect organ function, and excessive alcohol use can damage the liver, pancreas, brain, and heart over time.
- Alcohol may disrupt metabolism and recovery: Alcohol can impair muscle recovery, reduce energy levels, and interfere with the body's ability to burn fat efficiently.

Digestion

The body obtains these nutrients through the process of **digestion**. Digestion breaks down the food we eat into smaller molecules, allowing nutrients like carbohydrates, proteins, fats, vitamins, and minerals to be absorbed into the bloodstream. This process ensures that the body can use these nutrients for energy, growth, repair, and overall function. Figure 8.1.2 shows a diagram

of the human digestive system. Food enters the body through the mouth, where food is mechanically broken down by chewing and chemically processed by enzymes in saliva. These enzymes initiate the breakdown of complex molecules, preparing the food for further digestion in the gastrointestinal tract. When the food is swallowed, it passes through the esophagus to the stomach, where it is dissolved by stomach acid. It then moves into the **small intestine**, where most digestion and nutrient absorption occur. Enzymes from the **pancreas** and bile from the **liver** aid in breaking down fats, proteins, and carbohydrates. Nutrients are absorbed through the intestinal walls into the bloodstream. Next, any remaining undigested food passes into the **large intestine**, where water and electrolytes are absorbed, and beneficial bacteria help break down some of the remaining substances. Undigested food is concentrated in the colon and is eventually expelled from the body through the **rectum** and **anus.**

Figure 8.1.2: is a color-coded, labeled diagram of the human digestive system, shown from a frontal view. It visually represents the major organs involved in the digestion and absorption of food. The structures are stylized but follow the anatomical path food takes through the body, beginning at the mouth and ending at the anus. Each part of the digestive system is labeled with red lines pointing to specific organs or structures. This diagram is useful for understanding the flow and function of food through the digestive system, highlighting the key organs involved in digestion, absorption, and waste elimination. From the head to the bottom of the torso, Figure 8.1.2: is labeled salivary glands, tongue, epiglottis, esophagus, liver, stomach, gallbladder, duodenum, pancreas, ileum (small intestine), colon (large intestine), caecum, appendix, rectum, and anus.

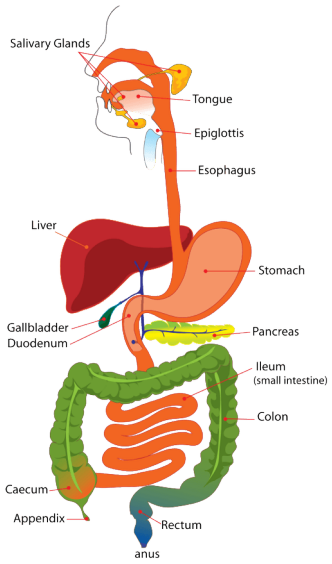


Figure 8.1.2: The gastrointestinal tract, also called the digestive tract, alimentary canal, or gut, is the system of organs within multicellular animals that takes in food, digests it to extract energy and nutrients, and expels the remaining waste. (Public Domain; Mariana Ruiz Villarreal via Wikimedia Commons)

Question

- Why is it important to eat a variety of foods from all the major food groups, rather than just focusing on a few?
- How does this support overall health and nutrient balance?

The Dietary Guidelines for Americans

The 2020-2025 **Dietary Guidelines for Americans (DGA)** provide four overarching guidelines that encourage healthy eating patterns at each stage of life and recognize that individuals will need to make shifts in their food and beverage choices to achieve a healthy pattern. The four goals discuss dietary patterns and nutrient density, which refer to:

- A **dietary pattern** is the combination of foods and beverages that constitutes an individual's complete dietary intake over time. This may be a description of a customary way of eating or a description of a combination of foods recommended for consumption.
- **Nutrient-dense** foods and beverages provide vitamins, minerals, and other health-promoting components and have little added sugar, saturated fat, and sodium. Vegetables, fruits, whole grains, seafood, eggs, beans, peas, and lentils, unsalted nuts and seeds, fat-free and low-fat dairy products, and lean meats and poultry—when prepared with no or little added sugars,

saturated fat, and sodium— are nutrient-dense foods.

The four overarching goals

1. **Follow a healthy dietary pattern at every life stage; it is never too early or too late to eat healthfully.**
2. **Customize and enjoy nutrient-dense food and beverage choices to reflect personal preferences, cultural traditions, and budgetary considerations**.
    - A healthy dietary pattern can benefit all individuals regardless of age, race, ethnicity, or current health status. The Dietary Guidelines provide a framework intended to be customized to individual needs and preferences, as well as the foodways of the diverse cultures in the United States.
3. **Focus on meeting food group needs with nutrient-dense foods and beverages, and stay within calorie limits.**
    - An underlying premise of the Dietary Guidelines is that nutritional needs should be met primarily from foods and beverages—specifically, nutrient-dense foods and beverages. Nutrient-dense foods provide vitamins, minerals, and other health-promoting components and have no or little added sugars, saturated fat, and sodium. A healthy dietary pattern consists of nutrient-dense forms of foods and beverages across all food groups, in recommended amounts, and within calorie limits. The core elements that make up a healthy dietary pattern include:
        - Vegetables of all types; dark green, red, and orange; beans, peas, and lentils; starchy; and other vegetables
        - Fruits, especially whole fruit
        - Grains, at least half of which are whole grains
        - Dairy, including fat-free or low-fat milk, yogurt, and cheese, and/or lactose-free versions, and fortified soy beverages and yogurt as alternatives
        - Protein foods, including lean meats, poultry, and eggs; seafood; beans, peas, and lentils; and nuts, seeds, and soy products
        - Oils, including vegetable oils and oils in food, such as seafood and nuts
4. **Limit foods and beverages higher in added sugars, saturated fat, and sodium, and limit alcoholic beverages.**
    - At every life stage, meeting food group recommendations—even with nutrient-dense choices—requires most of a person's daily calorie needs and sodium limits. A healthy dietary pattern doesn't have much room for extra added sugars, saturated fat, or sodium, or for alcoholic beverages. A small amount of added sugars, saturated fat, or sodium can be added to nutrient-dense foods and beverages to help meet food group recommendations, but foods and beverages high in these components should be limited. Limits are:
        - Added sugars - Less than 10 percent of calories per day starting at age 2. Avoid foods and beverages with added sugars for those younger than age 2.
        - Saturated fat - Less than 10 percent of calories per day starting at age 2.
        - Sodium - Less than 2,300 milligrams per day—and even less for children younger than age 14.
        - Alcoholic beverages - Adults of legal drinking age can choose not to drink, or to drink in moderation by limiting intake to 2 drinks or less in a day for men and 1 drink or less in a day for women, when alcohol is consumed. Drinking less is better for health than drinking more. Some adults should not drink alcohol, such as women who are pregnant.

Key Points

- Nutrients are essential for life. The body requires nutrients from food to grow, repair tissues, and produce energy. These nutrients fall into two main categories: macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals).
- Macronutrients provide energy and structure. Carbohydrates and proteins each supply 4 calories per gram, while fats provide 9. These macronutrients not only fuel the body but also support tissue growth, repair, and vital functions.
- Micronutrients regulate body functions. Although required in smaller amounts, vitamins and minerals play crucial roles in immune health, energy metabolism, bone strength, and other physiological processes. They do not provide energy but are essential for utilizing macronutrients efficiently.
- Water is a critical nutrient. Even though it provides no calories, water is vital for nearly every function in the body, including temperature regulation, nutrient transport, and waste removal.
- Energy balance is central to health. Maintaining a balance between the calories consumed and the calories used by the body is essential for managing body weight, preventing disease, and supporting physical performance.
- Alcohol provides calories but no essential nutrients. At 7 calories per gram, alcohol is a source of energy but lacks nutritional value. Excessive intake can interfere with nutrient absorption, organ function, and metabolism.
- Digestion makes nutrients available. Through mechanical and chemical processes, the digestive system breaks food into usable components that are absorbed and transported throughout the body for use in energy production, growth, and repair.
- Promote health and prevent disease: The Dietary Guidelines for Americans (DGA) aim to help individuals achieve and

maintain good health and reduce the risk of chronic diseases through healthy eating patterns across the lifespan.
- Support healthy dietary habits: The DGA emphasizes the importance of creating food and beverage patterns that meet nutritional needs, align with cultural preferences, and are accessible, affordable, and sustainable.

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8.2: Energy and Nutrient Requirements



Figure 8.2.1: (Wooden table topped with food; Snappr via Unsplash)

Introduction

Understanding how the body utilizes energy and nutrients is crucial for making informed decisions that promote overall health and wellness. Metabolism refers to the complex chemical processes that convert food into usable energy, powering functions such as breathing, thinking, movement, and tissue repair. This section examines how macronutrients fuel these metabolic processes, how energy needs vary based on factors like age, sex, and activity level, and why meeting nutrient requirements is crucial for maintaining health, preventing disease, and supporting daily functioning. It also explains the difference between nutrient-dense foods, those high in vitamins and minerals with relatively few calories, and energy-dense foods, which contain many calories but often few beneficial nutrients. To support healthy dietary planning, this section introduces and explains key acronyms, DRIs (Dietary Reference Intakes), RDAs (Recommended Dietary Allowances), and DVs (Daily Values), and examines nutritional goals for adults.

Metabolic Rate

Metabolism is all of the chemical processes that occur in the body to maintain its functioning, even when the body is at rest. The **metabolic rate** is the amount of energy consumed minus the amount of energy expended by the body. This is based on three factors: basal metabolic rate (BMR), dietary thermogenesis, and physical activity. The **basal metabolic rate (BMR)** describes the amount of daily energy expended by humans at rest, in a neutrally temperate environment, while in the postabsorptive state. It measures how much energy the body needs for normal, basic, daily activity. **Dietary thermogenesis** is the energy required from the digestion and processing of food, and physical activity is the combination of tasks of daily living and formal exercise. About 70 percent of all daily energy expenditure comes from the basic functions of the organs in the body. Another 20 percent comes from physical activity, and the remaining 10 percent is necessary for body thermoregulation or temperature control. **Resting Metabolic Rate (RMR)** refers to a combination of BMR and temperature regulation, so it is slightly higher than one's BMR. Metabolic rate increases with higher levels of physical activity and greater amounts of lean body mass. Basal metabolic rate (BMR) typically declines with age due to a reduction in lean muscle mass (Betts et al, 2022). [3]

The Calorie - Energy Derived from Nutrients

In a general sense, food is fuel for the body. Food becomes the energy needed for basic body functions and other physical activities. The amount of energy that is needed or ingested per day is measured in calories. The nutritional **Calorie** (C) or

kilocalorie (kcal) is a unit of energy commonly used to measure the amount of energy food provides. One calorie (or kilocalorie) is the amount of energy needed to raise the temperature of one kilogram (1 kg or 1000 g) of water by 1 °Celsius. This is different from the calorie (c) used in the physical sciences, which is the amount of heat it takes to raise 1g of water by 1 °C. When we refer to "calorie," we are referring to the nutritional calorie (Betts et al, 2022). [3]

On average, a person needs 1600 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 physical activity is a regular part of the day, the body requires more calories to meet increased energy demands. 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 a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns almost 100 calories (Betts et al, 2022). [3]

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. 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 determine the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything ingested, so when considering calorie intake, beverages must also be considered (Betts et al, 2022). [3]

Estimated Calorie Requirements for Adults

Table 8.2.1 and Table 8.2.2 indicate the estimated calorie requirements for adults at various age ranges and activity levels to maintain their current weight. Caloric intake depends on biological sex and activity level. People with higher resting metabolic rates and higher levels of physical activity require more calories. According to the Institute of Medicine, the different activity levels as per calorie recommendations are defined as follows:

- **Sedentary** means a lifestyle that includes only the physical activity of independent living.
- **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 activities of independent living.
- **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 activities of independent living.

As a person's daily activity level rises, their caloric needs increase accordingly, reflecting the body's basic principle of energy balance.

Table 8.2.1: Estimated Calorie Needs for Biological Females

Age	Sedentary	Moderately Active	Active
19-25	2,000	2,200	2,400
26-30	1,800	2,000	2,400
31-40	1,800	2,000	2,200
41-50	1,800	2,000	2,200
51-65	1,600	1,800	2,200
66-75	1,600	1,800	2,200
76 and up	1,600	1,800	2,000

Table 8.2.2: Estimated Calorie Needs for Biological Males

Age	Sedentary	Moderately Active	Active
19-20	2,600	2,800	3,000
21-35	2,400	2,800	3,000
36-40	2,400	2,600	2,800

Age	Sedentary	Moderately Active	Active
41-45	2,200	2,600	2,800
46-55	2,200	2,400	2,800
56-60	2,200	2,400	2,600
61-65	2,000	2,400	2,600
66-75	2,000	2,200	2,600
76 and up	2,000	2,200	2,400

Question

Consider your current diet and the calorie values of macronutrients and alcohol discussed earlier.

- Based on this information, where do you think the majority of your daily calories are coming from?
- Do you think the total amount of calories you eat each day aligns with the estimated energy intake needed for your age, sex, and activity level?



Figure 8.2.2: A colorful bowl of whole, plant-based food is packed with vitamins and energy that the body needs. (A bowl of vegetable salad; Anna Pelzer via Unsplash)

Nutrient Recommendations

Depending on factors including sex, age, weight, and activity level, most people require between 1,600 and 3,000 calories per day to maintain their current weight. However, it does vary greatly from person to person. The **Dietary Reference Intakes (DRIs)** are helpful for planning a healthy diet because they provide science-based guidelines for how much of each nutrient the body needs to function properly. DRIs help individuals avoid both deficiencies and excesses, supporting overall health, energy balance, and disease prevention. Understanding **Acceptable Macronutrient Distribution Ranges (AMDRs),** a subcomponent of the DRIs, is important because they guide what percentage of daily calories should come from carbohydrates, proteins, and fats to support overall health and reduce the risk of chronic diseases. By following these ranges, individuals can achieve a balanced intake of macronutrients that meets energy needs and supports proper metabolic function.

For certain nutrients, safe upper limits have been established, as excessive intake can be harmful, while other nutrients require a minimum intake to maintain health. The goal of the DRIs is to guide appropriate nutrient levels for individuals of all ages, helping to prevent both deficiencies and toxicities, and to reduce the risk of chronic diseases. An example of a macronutrient with a recommended upper range is fat. According to the AMDRs**,** fat should make up no more than 35% of total daily calories for most

adults. Consuming fat above this range, especially saturated and trans fats, can increase the risk of heart disease and other health issues. Several other nutritional acronyms relevant to this chapter can be found in Table 8.2.3.

Tracking food intake is a valuable tool for gaining insight into one's eating patterns and evaluating whether the diet aligns with recommended nutrient guidelines, such as the DRIs. By recording what and how much is eaten, individuals can better understand their intake of calories, macronutrients (carbohydrates, fats, and proteins), and essential vitamins and minerals. This practice helps identify nutritional gaps, excesses, or imbalances, and allows for more informed adjustments to support overall health, energy needs, and chronic disease prevention. It also encourages greater awareness and accountability, making it easier to develop lasting, healthier eating habits. The activity in Lab 8.2 can help analyze one's personal eating patterns and whether they align with the DRI recommendations. Track food on both weekdays and weekends, as eating patterns vary with schedule changes. Although daily energy intake naturally fluctuates, maintaining an average intake that meets the DRIs is crucial for overall nutritional balance (Mozaffarian et al, 2011). [15]

A diet that consistently deviates from the DRIs, even by small amounts, can lead to gradual weight gain over time. Consuming just a little more energy than the body needs each day, such as 50 to 100 extra calories, may not seem significant, but it adds up. Over the years, this slight surplus can result in noticeable weight gain. In fact, studies have shown that Americans gain an average of about one pound per year between the ages of 20 and 60, often without realizing it. Staying within DRI guidelines helps individuals maintain energy balance and avoid the slow accumulation of weight that can increase the risk of chronic conditions like heart disease and type 2 diabetes (Zheng et al, 2017). [34]

Table 8.2.3: Acronyms for Nutritional Guidelines

Acronym	
USDA United States Department of Agriculture	The government's agency that develops and implement affordable, and nutritious food supply while also suppor
DHHS Department of Health and Human Services	A government agency that strives to protect and promo prevention, and healthcare services through agencies li
FDA Food and Drug Administration	A government agency that strives to protect public heal cosmetics. It also oversees the regulation of vaccines, c
DGAC Dietary Guidelines Advisory Committee	A group of nationally recognized experts in nutrition, he Agriculture (USDA). Their primary role is to review curre for updating the Dietary Guidelines for Americans every up-to-date knowledge on nutrition and chronic disease
DGA Dietary Guidelines for Americans	The DGA is a science-based recommendation issued e Human Services (HHS) that guides healthy eating patte at every stage of life.
DRIs Dietary Reference Intakes	The goal of DRIs is to provide science-based guideline deficiencies, and reduce the risk of chronic diseases in

Acronym	
AMDRs Acceptable Macronutrient Distribution Ranges	A subset of DRIs that focuses on the recommended rar proteins, and fats. They are designed to provide enough
RDAs Recommended Dietary Allowances	These are the average daily intake levels of essential nu specific age and gender group. They are part of the Die
AIs Adequate Intakes	These are recommended average daily nutrient intake lev establish a Recommended Dietary Allowance (RDA). AIs a
UL Tolerable Upper Intake Levels	These are the highest average daily intakes of a nutrient may increase the risk of toxicity or adverse health effects
DVs Daily Values	These are numbers on food labels that show how much calories/day) They help guide healthy eating by showing
CDRR Chronic Disease Risk Reduction Levels	The CDRR is a type of Dietary Reference Intake (DRI) e level for a nutrient above which intake reduction is expe public health policies and dietary guidelines aimed at p
CRAP Calorie-Rich and Processed or • Carbonated drinks • Refined sugars • Artificial additives • Processed foods	CRAP refers to foods that are high in calories with very fats, and sodium, while lacking essential nutrients like f
UPFs Ultra-Processed Foods	UPFs refer to foods that have undergone extensive indus preservatives, sweeteners, and artificial flavors. Three typ essential nutrients.



Figure 8.2.3: Processed foods are very prevalent in our culture today. (Table topped with lots of food and drink; Adrian Infernus via source)

Energy-Dense and Nutrient-Dense

Making healthy food choices involves understanding the difference between nutrient-dense and energy-dense foods. **Nutrient-dense** foods are those that provide a high level of vitamins, minerals, fiber, and other beneficial nutrients for their calorie content. These foods support the body's needs without adding excess energy, making them ideal for maintaining a healthy weight and preventing chronic diseases. Examples include leafy greens, colorful fruits and vegetables, whole grains, lean meats, fish, legumes, nuts, seeds, and low-fat dairy products.

On the other hand, **energy-dense** foods are high in calories but often low in nutritional value. These foods typically contain large amounts of added sugars, unhealthy fats, and refined carbohydrates, while offering little in terms of essential nutrients. While some energy-dense foods, like nuts or avocados, also offer important nutrients and can be part of a balanced diet, many others contribute to excessive calorie intake without supporting overall health. Frequent consumption of these less healthy, energy-dense foods can lead to weight gain and increase the risk of heart disease, type 2 diabetes, and other health conditions (Zheng et al, 2017). [34]

To help people remember which foods to limit, nutrition educators sometimes use the acronym **CRAP**, which stands for "Calorie-Rich and Processed" or, even more specifically, "Carbonated drinks, Refined sugars, Artificial additives, and Processed foods**"**. These types of foods are typically high in energy density and low in nutrients. Examples include sugary sodas, candy, chips, fast food, and packaged snacks. Regularly consuming CRAP foods can crowd out more nutritious choices and contribute to nutrient deficiencies, poor energy levels, and long-term health problems. Reducing intake of CRAP foods and replacing them with whole, nutrient-dense options is a key step toward a healthier diet.

An article published in 2024 examines the association between **ultra-processed food (UPFs)** consumption and various health outcomes. The study synthesizes data from multiple research articles to provide a comprehensive understanding of the potential health risks associated with high intake of UPFs. The findings suggest that increased consumption of UPFs is linked to higher risks of obesity, cardiovascular diseases, and other chronic health conditions. The article emphasizes the importance of dietary patterns and the need for public health strategies to address the rising consumption of ultra-processed foods. This source provides valuable insights into the health implications of ultra-processed foods and supports the recommendation to prioritize nutrient-dense, minimally processed foods in a healthy diet (Lane & McCaffrey, 2024). [13]

Focusing on **nutrient-rich** eating not only supports physical health but also helps with energy balance, mental focus, and disease prevention. Choosing foods based on nutrient density, rather than just calorie content, ensures that the body gets what it needs to function well. By making informed decisions and being mindful of both quality and quantity, individuals can create a diet that supports wellness, maintains a healthy weight, and reduces the risk of diet-related illnesses over time.

The 2020-2025 Dietary Guidelines for Americans (DGA) recommend that individuals consume foods that are nutrient-dense

from each of the major food groups. Foods that are high in calories (i.e., foods that provide a large amount of energy for the body), but low in nutritional value, are referred to as “calorie-dense” foods. Conversely, foods that are high in nutrients (i.e., foods containing an abundance of vitamins or minerals) but are low in calories are referred to as “nutrient-dense.” The 2020-2025 Dietary Guidelines for Americans recommend that individuals consume foods that are nutrient-dense from each of the major food groups for optimal health (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

- **Vegetables** – Includes a variety of types: dark green, red and orange, legumes (beans and peas), starchy, and other vegetables.
- **Fruits** – Emphasizes whole fruits over juice whenever possible.
- **Grains** – Divided into whole grains (which are encouraged) and refined grains (which should be limited).
- **Dairy** – Includes fat-free or low-fat milk, yogurt, and cheese, as well as fortified soy beverages.
- **Protein Foods** – Includes lean meats, poultry, eggs, seafood, beans, peas, lentils, nuts, seeds, and soy products.

Additional Healthy Eating Behaviors Recommended by the DGA:

The Dietary Guidelines for Americans (DGA) set clear limits on certain nutrients and dietary components that are linked to major public health concerns in the United States. Specific quantitative recommendations for these limits are outlined in Table 8.2.3. In addition, the DGA provides broader general guidance to help individuals make healthier overall dietary and lifestyle choices.

Limit added sugars, saturated fat, and sodium

- Keep added sugars to less than 10% of daily calories.
- Limit saturated fat to less than 10% of daily calories.
- Keep sodium intake to less than 2,300 mg per day.

Avoid or minimize alcohol consumption

- If consumed, limit to 2 drinks or fewer per day for men, and 1 drink or fewer per day for women.

Focus on nutrient-dense foods

- Choose foods that provide vitamins, minerals, and other beneficial substances with relatively few calories.

Balance Energy intake with physical activity

- Maintain a healthy body weight through an appropriate balance of calories consumed and calories expended.

Cultural relevance and accessibility

- Encourage dietary patterns that are flexible, culturally appropriate, and affordable.

Lifelong approach

- Promote healthy eating at every life stage, from infancy through older adulthood.

These recommendations support a **holistic approach to healthy eating** that goes beyond nutrients to consider behavior, context, and sustainability.

Question

Can you list 35 nutrient-dense foods that you eat each week?

- If not, take a moment to expand upon your weekly food list.
- Make a list of the CRAP and UPFS that you consume each week.
- What are some nutrient-dense options to replace these foods?

Nutritional Goals for Adults

U.S. Department of Agriculture and U.S. Department of Health and Human Services published the "Dietary Guidelines for Americans, 2020-2025" in December of 2020. The goal is to provide science-based advice on what to eat and drink to promote health, reduce the risk of chronic disease, and meet nutrient needs. These guidelines are intended to help individuals make informed dietary choices across all life stages from birth to older adults. It also includes special recommendations for pregnant and lactating (postpartum) women by stage. Table 8.2.3 presents the recommendations for nutritional goals for adult males and females (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Table 8.2.3: Nutritional Goals by Age and Sex

Nutrient	Source of Recommendation	Females: Age 19-30	Males: Ages 19-30	Females: Age 31-50	Males: Ages 31-50	Females: Age 51+	Males: Age 51+
Calorie Level Assessed	N/A	2,000	2,400	1,800	2,200	1,600	2,000
Protein - Percent of kcals	AMDR	10% – 35%	10% – 35%	10% – 35%	10% – 35%	10% – 35%	10% – 35%
Protein - grams	RDA	46	56	46	56	46	56
Carbohydrates - Percent of kcals	AMDR	45% – 65%	45% – 65%	45% – 65%	45% – 65%	45% – 65%	45% – 65%
Carbohydrates - grams	RDA	130	130	130	130	130	130
Fiber (grams)	14g/1,000 kcal	28	25	22	34	31	28
Total Lipid (Fat) -Percent of kcals	AMDR	20% – 35%	20% – 35%	20% – 35%	20% – 35%	20% – 35%	20% – 35%
• Linoleic Acid 18:2	AI	12	17	12	17	11	14
• Linoleic Acid 18:3	AI	1.1	1.6	1.1	1.6	1.1	1.6
• Saturated Fats	DGA	Less than 10%	Less than 10%	Less than 10%	Less than 10%	Less than 10%	Less than 10%
Added Sugar**	DGA	Less than 10%	Less than 10%	Less than 10%	Less than 10%	Less than 10%	Less than 10%

As per the principle of individual differences, everyone will have different dietary needs to be healthy. Although no setup guidelines are completely comprehensive, the DGA presents expert reviews of nutritional research and is intended to provide information that maximizes health and reduces disease risk in the United States.

Here are the main takeaways from the Dietary Guidelines for Americans (DGA) 2020–2025 for building a healthy diet:

- Follow a healthy dietary pattern at every life stage, from infancy through older adulthood.
- Customize and enjoy nutrient-dense food and beverage choices to reflect personal preferences, cultural traditions, and budgetary considerations.
- Focus on nutrient-dense foods and beverages that provide vitamins, minerals, and other health-promoting components with little or no added sugars, saturated fat, and sodium.
- Limit added sugars to less than 10% of daily calories.
- Limit saturated fat to less than 10% of daily calories.
- Limit sodium intake to less than 2,300 mg per day for adults (lower for children).
- Limit alcoholic beverages, if consumed, to no more than 2 drinks per day for men and 1 for women.
- Stay within daily calorie needs to support a healthy body weight.

- Emphasize whole foods, such as vegetables, fruits, whole grains, lean proteins, dairy, and healthy fats.
- Encourage physical activity as part of a healthy lifestyle (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Key Points

- **Nutrients are essential for health.** The human body requires nutrients from food for energy, growth, tissue repair, and regulating bodily functions.
- **Nutrients fall into two main categories.** Macronutrients (carbohydrates, proteins, and fats) are needed in large amounts and provide energy, while micronutrients (vitamins and minerals) are required in smaller amounts but are vital for physiological function.
- **Water is an essential nutrient.** Although it provides no calories, water is necessary for nearly every bodily function, including temperature regulation, waste removal, and nutrient transport.
- **Food is the body's primary energy source.** Carbohydrates, proteins, and fats each supply calories and are used to produce ATP, the energy molecule that powers cells.
- **Micronutrients support metabolism and health.** Vitamins and minerals act as coenzymes and cofactors in the body's chemical processes and are found in both whole and fortified foods.
- **Some foods are nutrient-dense.** Whole milk, eggs, fruits, and vegetables provide a rich mix of macro- and micronutrients that support health.
- **Alcohol is not an essential nutrient.** While it provides calories, alcohol lacks nutritional value and can impair nutrient absorption and organ function.
- **Digestion enables nutrient absorption.** The digestive system breaks down food so nutrients can be absorbed and used by the body for energy, repair, and growth.

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8.3: Carbohydrates



Figure 8.3.1: (Breads on wicker basket; Mae Mu via Unsplash)

Introduction

Carbohydrates are one of the three main macronutrients that provide the body with energy, alongside protein and fat. Found in a wide variety of foods such as fruits, vegetables, grains, legumes, and dairy products, carbohydrates are the body's primary and preferred source of fuel. Chemically, carbohydrates are made up of carbon, hydrogen, and oxygen atoms, and they exist in several forms, primarily sugars, starches, and fiber. While some carbohydrates are quickly absorbed and provide rapid energy, others are digested more slowly and offer longer-lasting fuel. A balanced intake of carbohydrates is essential for supporting physical activity, brain function, and many metabolic processes.

Function

The major functions of **carbohydrates** are to:

- **Provide energy:** Carbohydrates are the body's primary and most efficient source of energy. During digestion, they are broken down into glucose, which cells use for fuel.
- **Fuel for the brain and nervous system:** The brain relies heavily on glucose for proper function. Inadequate carbohydrate intake can impair mental performance and focus.
- **Promote protein-sparing:** When sufficient carbohydrates are available, the body uses them for energy rather than breaking down muscle protein, preserving muscle tissue.
- **Aid in fat metabolism:** Carbohydrates are necessary for the complete breakdown of fats. Without enough carbs, fat metabolism is incomplete, leading to the production of ketones.
- **Support digestive health:** Certain carbohydrates, like dietary fiber, help maintain bowel regularity, support gut health, and may lower cholesterol levels.

Digestion and Breakdown of Carbohydrates

When carbohydrates are consumed, the digestive system begins breaking them down into simple sugars, primarily **glucose**, which the body can absorb and use for energy. This process starts in the mouth with the enzyme salivary amylase and continues in the small intestine, where enzymes further convert complex carbohydrates (starches and disaccharides) into monosaccharides. These sugars are then absorbed into the bloodstream and transported to cells, where they are used immediately for energy. When glucose is not immediately needed for energy, the body stores it for later use. First, it is converted into **glycogen** and stored in

the liver and skeletal muscles. However, these glycogen stores are limited. Once they are full, any excess glucose is converted into **triglycerides** (fat) through a process called **lipogenesis** and stored in **adipose (fat) tissue**. This stored energy can later be used when glucose levels are low, such as between meals or during physical activity. Excess consumption of carbohydrates, like any macronutrient, can lead to weight gain and increased body fat. **Fiber**, a type of carbohydrate that is not fully digested, plays a vital role in digestive health by aiding in bowel regularity and promoting satiety.

Simple Carbohydrates

Simple carbohydrates, also known as sugars, are the most basic form of carbohydrates. Chemically, they consist of one or two sugar molecules, making them quick to digest and absorb into the bloodstream. The two types of simple sugars are **monosaccharides**, like glucose and fructose, and **disaccharides**, such as sucrose (table sugar) and lactose (the sugar found in milk). Because of their small molecular structure, simple carbohydrates are rapidly broken down by the digestive system and quickly elevate blood glucose levels.

These types of carbohydrates are naturally present in a variety of nutritious foods. For example, fruit contains fructose, but also provides fiber, vitamins, and antioxidants, which help moderate the impact on blood sugar. Dairy products contain lactose along with protein and calcium, offering a more balanced nutritional profile. However, simple sugars are often added to foods during processing, preparation, and at the table. These **added sugars** are found in many processed foods and beverages, such as sodas, candy, pastries, and sweetened cereals. These products often provide calories without essential nutrients and are commonly referred to as **"empty calories."**

Sugar and Health

While the body uses simple sugars for quick energy, excessive intake of added sugars can contribute to weight gain, insulin resistance, and a higher risk of chronic diseases such as type 2 diabetes and heart disease (Carter et al, 2024). [5] Huang evaluated dozens of meta-analyses and found strong associations between high sugar consumption and multiple health outcomes, including obesity, cardiovascular conditions, metabolic dysfunction, neuropsychiatric issues, cancer, and other health issues (Huang et al, 2022). [8] The review specifically recommends limiting free or added sugars to below 25 g/day (about 6 teaspoons) and restricting sugar-sweetened beverage intake to less than one serving per week to reduce health risk (Huang et al, 2022). [8] Many Americans consume significantly more added sugars than recommended, often exceeding the Dietary Guidelines' suggested limit of less than 10% of daily calories (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30] The main sources of excess sugar include sugar-sweetened beverages, desserts, and processed snacks. For example, one regular 12-ounce soft drink (soda) has about 40 grams (10 teaspoons) of added sugars and 130 calories. For these reasons, health guidelines recommend limiting added sugars in the diet and focusing instead on whole foods that offer a mix of carbohydrates, fiber, and other nutrients. Understanding the role of simple carbohydrates and how they differ in natural versus processed sources helps support healthier food choices and balanced energy levels.

Natural Sugar

These natural sugars come with fiber, vitamins, and minerals that support overall health.

- **Fructose**: found in fruits like apples, oranges, berries, and mangoes
- **Glucose**: present in fruits, vegetables, and honey
- **Galactose**: found mainly in dairy products as part of lactose
- **Lactose**: the sugar naturally present in milk and dairy products
- **Sucrose**: naturally occurring in fruits and some vegetables like carrots and beets (a combination of glucose and fructose)

Added Sugar

These sugars are added during processing or preparation and contribute extra calories without providing significant nutrients.

- **Table sugar (sucrose)**: added to baked goods, candies, sauces, and beverages
- **High-fructose corn syrup (HFCS)**: commonly used in sodas, fruit drinks, processed snacks, and sweets
- **Honey**: used as a sweetener in cereals, granola bars, and some baked products
- **Maple syrup**: added to pancakes, waffles, desserts, and flavored drinks

- **Molasses**: found in baked goods, baked beans, gingerbread, barbecue sauces, and some candies
- **Agave nectar**: used in beverages, desserts, and some processed foods
- **Brown sugar**: added to cookies, cakes, sauces, and some cereals
- **Corn syrup**: used in candies, frostings, and processed desserts
- **Dextrose, glucose, fructose, lactose, maltose**: found individually or in combinations in processed foods
- **Glucose syrup**: often found in processed foods and candies
- **Fruit juice concentrate**: fruit snacks, flavored yogurts, juice boxes
- **Evaporated cane juice**: organic or "natural" packaged foods
- **Coconut sugar**: trendy snack foods, baked goods
- **Malt syrup**: flavored cereals, malted drinks

According to the 2020-2025 Dietary Guidelines for Americans, reducing added sugars helps:

- Lower calorie intake without sacrificing essential nutrients.
- Decrease risk of obesity, type 2 diabetes, heart disease, and dental cavities.
- Promote a more balanced diet that meets micronutrient and fiber needs (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Question

- How much sugar do you think you consume each day?
- Were you surprised to learn which common foods contain added sugars?
- How might this awareness influence your future food choices?

Complex Carbohydrates

Complex carbohydrates are long chains of sugar molecules that take longer to digest and absorb than simple carbohydrates. These carbohydrates are primarily found in plant-based foods such as **whole grains**, **legumes**, vegetables, and some fruits. The most common complex carbohydrate is starch, which is made up of many glucose units bonded together. Because of their longer and more complex structure, these carbohydrates provide a slower, more sustained release of energy compared to simple sugars. This makes them an important source of fuel for long-lasting physical and mental activity. Most starches are broken down into glucose during digestion, providing a quick source of energy for the body to use. However, some foods, such as legumes, contain resistant starches and more fiber, which slow digestion and aren't fully broken down in the small intestine. This leads to a slower rise in blood sugar and supports digestive health by feeding beneficial gut bacteria.

Another important form of complex carbohydrate is **dietary fiber**, which is found in the cell walls of plant foods. Unlike starches, fiber cannot be fully broken down by the human digestive system, but it plays a critical role in helping to regulate bowel movements, support healthy cholesterol levels, and promote a feeling of fullness. Foods high in fiber, such as brown rice, oats, beans, and vegetables, can also help manage blood sugar levels by slowing the absorption of glucose.

Including complex carbohydrates in the diet is associated with a variety of health benefits. They are typically more nutrient-dense, providing not just energy but also essential vitamins, minerals, and phytochemicals. Choosing whole and minimally processed complex carbohydrates over refined ones—like white bread or sugary snacks—can support better weight management, heart health, and blood sugar control.

Grains are a staple food in many diets worldwide and serve as an important source of carbohydrates, fiber, and various essential nutrients. They are edible seeds from certain types of grasses. Common types of grains include wheat, rice, oats, corn, barley, and rye. They can be consumed in many forms, from whole kernels to ground flour, and are used to make foods such as bread, pasta, cereal, and tortillas. Grains are a key source of energy and provide essential nutrients, including B vitamins, iron, magnesium, and selenium. Figure 8.3.2 depicts the wheat plant, with kernels located near the stem. Extending from each kernel are long, hair-like structures known as the beard.

Whole grains refer to grains that contain all three naturally occurring parts of the kernel: the **bran**, **germ**, and **endosperm**. Figure 8.3.3 illustrates the anatomy of the whole wheat grain and labels the bran, germ, and endosperm. The bran is the outer layer and is rich in fiber, antioxidants, and B vitamins. The germ is the nutrient-rich core that contains healthy fats, vitamins, and minerals. The endosperm is the largest part of the grain and contains mostly carbohydrates along with some protein. Because whole grains

contain all parts of the grain kernel, the bran, germ, and endosperm, they naturally provide more nutrients and dietary fiber than refined grains. Examples of whole grains include brown rice, whole wheat, quinoa, oats, bulgur, and millet.

When grains are refined, the bran and germ are removed, leaving only the starchy endosperm. This process gives the grain a finer texture and longer shelf life, but significantly reduces its nutritional value. Refined grains, like white rice, white bread, and many pastries, lose much of their fiber, vitamins, and minerals. Although some refined grains are “enriched” to add back certain nutrients (like iron and some B vitamins), they still lack the full nutritional benefits of whole grains. A diet rich in whole grains has been linked to better digestive health, reduced risk of heart disease, and improved blood sugar control, making them the preferred choice in a healthy eating pattern.

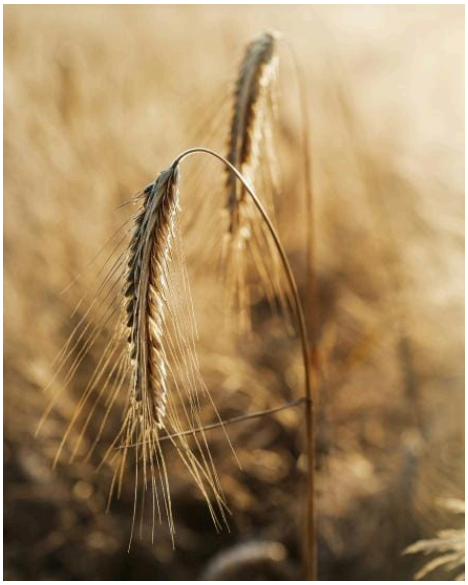


Figure 8.3.2: Wheat can be a primary source of carbohydrates for many people. (Close up of a wheat; Maksym Tymchyk via Unsplash)

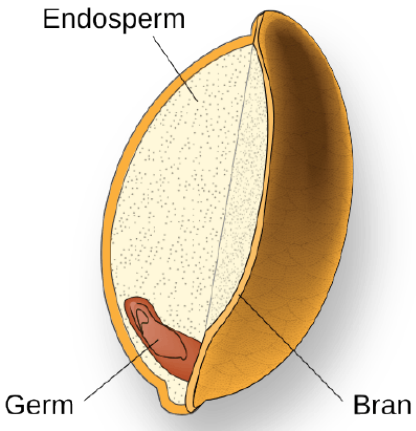


Figure 8.3.3: The anatomy of a wheat grain, including the bran, the outside or skin of the grain; the endosperm, which makes up the bulk of the grain; and the small germ within the endosperm. (CC BY-SA 3.0; Kittycataclysm via Wikimedia Commons)

Consuming more whole grains is specifically linked to better overall health due to their high content of dietary fiber, vitamins, minerals, and beneficial plant compounds. Research has shown that regular consumption of whole grains can reduce the risk of chronic diseases such as heart disease, type 2 diabetes, and certain types of cancer (Aune et al, 2016). [2] Their fiber content also supports digestive health and helps regulate blood sugar levels. Whole grains not only support better overall health, but they are also linked to less weight gain over time compared to diets high in simple carbohydrates.

The Glycemic Index

Glucose's counterpart is insulin. Insulin is a hormone made in the pancreas that is released to help the cells take up glucose and use it for energy and fat storage. The levels of insulin and glucose rise and fall after eating any type of carbohydrate. The more sugary the food, the greater the rise, and vice versa. The **glycemic index (GI)** is the measure of how a particular food affects blood glucose levels. It is a tool used to rank carbohydrate-containing foods based on how much and how quickly they raise blood glucose levels after consumption. Foods are scored on a scale from 0 to 100, with higher numbers indicating a faster rise in blood sugar. For example, white bread and sugary cereals have a high GI, while oats and most legumes have a low GI. Eating low-GI foods may help with blood sugar management, improve energy levels, and reduce the risk of type 2 diabetes and heart disease. While the glycemic index is a useful guideline, it's also important to consider overall nutrient content and portion sizes when making food choices (Townsend et al, 2021). [27]

Glycemic Ratings

- **Low-GI foods** (55 or less) are digested slowly and help maintain stable blood sugar levels. Examples include legumes, dairy, fruits, and barley.
- **Medium-GI foods** (56–69) cause moderate blood sugar increases, such as oatmeal, couscous, and whole wheat pasta.
- **High-GI foods** (70 and above) cause rapid spikes in blood glucose. Examples include white bread, white rice, and many processed snacks.

Table 8.3.1: Common Foods By Glycemic Index

Food	GI Value
Apple	44
Apple	44
Lentils	30
Chickpeas	33
Whole Milk	30
Barley	33
Yogurt (plain, no sugar)	21
Oatmeal	64
Couscous	62
Raisins	64
Whole wheat pasta	59
Banana (ripe)	51-56
White bread	75-83
Baked potato	85
Cornflakes	80
White jasmine rice	82
Pretzels	84

Table 8.3.1 indicates common goods rated by glycemic index as per ratings from *The International Glycemic Index (GI) Database* created by the University of Sydney (The University of Sydney, 2012). [25]

Question

- If complex carbohydrates offer greater nutritional benefits and help prevent chronic disease, why do so many people still rely heavily on simple sugars and refined carbs in their daily diets?
- Can you make half your grains whole? Try swapping out half of your refined grains with whole grains for a big health difference.

Fiber

Fiber is a type of carbohydrate that the body cannot digest. Unlike other carbohydrates that are broken down into sugar molecules, fiber passes through the digestive system mostly intact. Though it doesn't provide energy in the form of calories, fiber plays a critical role in maintaining digestive health, regulating blood sugar, and supporting heart health. It also helps individuals feel fuller for longer, which can assist in managing weight.

Dietary fiber refers specifically to the naturally occurring fibers found in plant-based foods such as fruits, vegetables, whole grains, legumes, nuts, and seeds. There are two main types of dietary fiber: soluble and insoluble. Soluble fiber dissolves in water and can help lower glucose levels and blood cholesterol. Insoluble fiber, on the other hand, does not dissolve in water and helps food move through the digestive system, promoting regular bowel movements.

In addition to its digestive benefits, fiber plays a protective role against several chronic diseases. Diets high in fiber have been associated with a lower risk of heart disease, type 2 diabetes, certain types of cancer, and obesity. Fiber also contributes to improved gut health by supporting beneficial bacteria in the microbiome, which in turn may enhance immune function and reduce inflammation (Fu et al, 2022). [7]

Despite its health benefits, most Americans fall short of the daily fiber recommendations. Increasing fiber intake is as simple as choosing whole-grain products over refined ones, eating more fruits and vegetables with the skin on, and including a variety of legumes and nuts in the diet. Understanding the importance of fiber is an essential step toward building healthier eating patterns and preventing nutrition-related health issues (Fu et al, 2022). [7]

Soluble (Viscous) Fiber

Soluble fiber is a type of dietary fiber that dissolves in water to form a gel-like substance in the digestive tract. This property allows it to slow down digestion, which can help regulate blood sugar levels and lower LDL ("bad") cholesterol. Soluble fiber also contributes to feelings of fullness, making it helpful for appetite control and weight management. Foods rich in soluble fiber include oats, barley, beans, lentils, apples, citrus fruits, strawberries, and carrots. Including these foods regularly in the diet can support heart health and improve metabolic function.

Insoluble fiber

Insoluble fiber is a type of dietary fiber that does not dissolve in water and passes through the digestive system largely intact. Its primary role is to add bulk to the stool and promote regular bowel movements, helping to prevent constipation and support overall digestive health. Insoluble fiber also helps maintain a healthy colon and may reduce the risk of developing certain digestive disorders, such as diverticulosis. Foods that are good sources of insoluble fiber include whole wheat flour, wheat bran, brown rice, nuts, seeds, and many vegetables like cauliflower, green beans, and potatoes. Including a variety of these foods in the diet helps ensure proper digestive function and contributes to long-term gut health.

Fiber Content in Food

Dietary fiber is found naturally in plant-based foods, including fruits, vegetables, whole grains, legumes, nuts, and seeds. It is an essential component of the plant cell wall and is typically concentrated in the outer layers of grains and the skins of fruits and vegetables. In addition to these natural sources, fiber can also be added to foods during processing to boost their fiber content. These added fibers, often referred to as "functional fibers," can be isolated from plants or synthesized and are commonly found in products like high-fiber cereals, granola bars, yogurts, and meal replacements. Both naturally occurring and added fibers contribute to total fiber intake and can offer health benefits, though whole food sources often provide a wider range of nutrients

along with the fiber.

According to the USDA's FoodData Central, fiber content in grams can be determined for many plant foods (USDA, 2019) [28] Table 8.3.2 depicts the fiber content in many grains, cereals, pasta, and rice by serviving size. Table 8.3.3 depicts the fiber content by serving size of a variety of vegetables, and Table 8.3.4 indicates the same for a variety of fruits. Table 8.3.5 lists the fiber content by serving size of a variety of legumes, and Table 8.3.6 depicts nuts and Table 8.3.7 depicts seeds. As a note, all of these foods listed have fewer than 200 calories per serving.

Table 8.3.2: Fiber Content in Grains, Pasta, Cereals, and Rice

Food	Serving Size
Whole wheat spaghetti (cooked)	1 cup
Brown rice (cooked)	1 cup
Quinoa (cooked)	1 cup
Barley, pearled (cooked)	1 cup
Oatmeal, rolled oats (cooked)	1 cup
Bulgur (cooked)	1 cup
Millet (cooked)	1 cup
Popcorn (air-popped)	3 cups
Whole wheat bread	1 slice
Whole grain cereal (e.g. bran flakes)	1 cup
Rye bread	1 slice
Steel-cut oats (cooked)	1 cup
Cornmeal (cooked)	1 cup
Amaranth (cooked)	1 cup



Figure 8.3.4: (Public Domain; via Wikimedia Commons)

Table 8.3.3: Fiber Content in Vegetables

Vegetable	Serving Size
Green peas	1 cup

Vegetable	Serving Size
Broccoli	1 cup
Brussels sprouts	1 cup
Sweet potato (with skin)	1 medium (about 150
Carrots	1 cup (raw, chopped)
Spinach (cooked)	1 cup
Kale (cooked)	1 cup
Collard greens (cooked)	1 cup
Artichoke (cooked)	1 medium
Acorn squash (baked)	1 cup
Turnip greens (cooked)	1 cup
Cauliflower	1 cup
Zucchini (with skin)	1 cup (cooked)
Beets	1 cup (cooked)
Corn (cooked)	1 cup
Cabbage (cooked)	1 cup
Onion (cooked)	1 cup
Pumpkin (cooked)	1 cup

Fiber content can vary slightly by preparation method and portion size. Cooking usually reduces fiber slightly per volume but increases digestibility.



Figure 8.3.5: (Public Domain; USDA via Wikimedia Commons)

Table 8.3.4: Fiber Content of Fruits

Fruit	Serving Size
Raspberries	1 cup (raw)
Pears (with skin)	1 medium

Fruit	Serving Size
Apples (with skin)	1 medium
Bananas	1 medium
Oranges	1 medium
Strawberries	1 cup (halved)
Avocado	½ fruit (medium)
Figs (dried)	¼ cup
Prunes	5 prunes
Guava	1 medium
Blueberries	1 cup
Blackberries	1 cup
Kiwi	1 medium
Medjool Dates	2 dates
Mango	1 cup (sliced)
Pomegranate Seeds	½ cup

Eating fruits with the skin on (like apples and pears) adds more fiber. Fresh, frozen, or dried forms all count—just watch for added sugars in dried options.



Figure 8.3.6: (Public Domain; USDA via Wikimedia Commons)

Table 8.3.5: Fiber Content in Legumes

Food	Serving Size
Lentils	1 cup
Black beans	1 cup
Chickpeas	1 cup
Kidney Beans	1 cup
Navy Beans	1 cup

Food	Serving Size
Split Peas	1 cup
Pinto beans	1 cup
Edamame	1 cup (cooked)
Baked beans (canned)	1 cup
Green peas	1 cup (cooked)

Legumes are among the most fiber-rich foods and also provide protein and minerals.



Figure 8.3.7: (CC BY-SA 4.0; Miomir Magdevski via Wikimedia Commons)

Table 8.3.6: Fiber Content in Nuts

Nut	Serving Size
Almonds	1 oz (about 23 nuts)
Pistachios	1 oz (about 49 nuts)
Pecans	1 oz (about 19 halve
Walnuts	1 oz (about 14 halve
Hazelnuts	1 oz (about 21 nuts)
Peanuts	1 oz (about 28 nuts)
Cashews	1 oz (about 18 nuts)
Brazil nuts	1 oz (about 6 nuts)



Figure 8.3.8: (CC BY-SA 4.0; Salil Kumar Mukherjee via Wikimedia Commons)

Table 8.3.7: Fiber Content in Seeds

Seed	Serving Size
Chia seeds	2 tbsp
Flaxseeds (whole)	2 tbsp
Pumpkin seeds	1 oz
Sunflower seeds	1 oz
Hemp seeds	3 tbsp
Sesame seeds	1 tbsp
Poppy seeds	1 tbsp

Chia and flax seeds are especially high in fiber and healthy fats.

Question

Make a list of 5-10 foods that are high in fiber that you enjoy.

- What changes could you make to your daily eating habits to help ensure you're getting enough fiber from whole food sources?

Nutritional Goals for Carbohydrates

The Dietary Guidelines for Americans (DGA) 2020–2025 provide specific nutritional goals for carbohydrate intake, with a strong emphasis on reducing added sugars to support overall health (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30] Here are the key carbohydrate-related goals:

- **Total Carbohydrate Intake**: **45–65% of total daily calories** should come from carbohydrates (as outlined in the AMDR). The DRIs recommend a minimum of 130 grams of carbohydrates for adults.
- **Emphasis on Nutrient-Dense Sources**: Prioritize carbohydrates from vegetables, fruits, whole grains, legumes, and low-fat dairy. These sources provide fiber, vitamins, minerals, and other beneficial compounds.
- **Limit Added Sugars**: Less than 10% of total daily calories should come from added sugars for individuals aged 2 years and older. For example, on a 2,000-calorie diet, that's no more than 200 calories from added sugars, or about 12 teaspoons (50

grams). Children under age 2 should avoid added sugars entirely.
- **Encourage Fiber Intake**: Consume adequate amounts of dietary fiber, mainly from whole grains, fruits, vegetables, and legumes, to support digestive health and reduce the risk of chronic diseases.

Key Points

- Carbohydrates are the body's main source of energy and play a central role in daily nutrition.
- A significant portion of daily calorie intake should come from carbohydrates.
- Choosing nutrient-dense carbohydrate sources supports overall health.
- Fruits, vegetables, whole grains, legumes, and low-fat dairy are recommended carbohydrate options.
- These foods provide essential nutrients such as fiber, vitamins, and minerals.
- Fiber from whole-food sources is especially important for digestive health.
- Higher fiber intake also reduces the risk of chronic diseases.
- Added sugars should be limited to avoid excess calorie intake and negative health effects.
- Reducing added sugars helps improve long-term metabolic and cardiovascular health.
- A balanced approach to carbohydrate intake promotes energy, wellness, and disease prevention.

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8.4: Protein



Figure 8.4.1: (Broccoli with meat on plate; Ella Olsson via Unsplash)

Introduction

Protein is one of the three essential macronutrients the body requires in large amounts to support health, growth, and bodily functions. Composed of building blocks called amino acids, protein plays a vital role in the structure, repair, and maintenance of body tissues, including muscles, skin, enzymes, and hormones. Unlike carbohydrates and fats, protein is not primarily used for energy unless the body is in a state of deprivation, because the body does not store protein in the same way it stores glycogen or fat. As a result, protein's structural and functional roles are especially critical, since using it for energy can compromise the body's ability to repair tissues and carry out essential physiological processes. Understanding the types of protein, their sources, and the body's needs is key to making informed dietary choices that promote wellness across the lifespan.

Protein

Proteins are made up of 20 different amino acids, which serve as the building blocks for tissues and various bodily functions. Of these, nine are classified as essential amino acids because the body cannot produce them and must obtain them through the diet. The remaining 11 are nonessential amino acids, meaning the body can synthesize them internally, even if they are not supplied by food.

Complete Protein

Complete proteins are those that contain all nine essential amino acids in sufficient amounts required by the body. The body cannot synthesize these amino acids and must be obtained through the diet. Complete proteins are most commonly found in animal-based foods such as meat, poultry, fish, eggs, and dairy products. These sources are considered high-quality proteins because they provide the full spectrum of essential amino acids in the right proportions for human health. A few plant-based foods, such as soy products (tofu, tempeh, edamame), quinoa, and buckwheat, are also considered complete proteins, making them valuable additions to vegetarian and vegan diets.

Adequate intake of complete proteins supports numerous physiological functions, including muscle maintenance and repair, immune system support, hormone production, and the synthesis of enzymes and other important molecules. For individuals who do not consume animal products, it's important to eat a variety of plant-based proteins throughout the day to ensure they obtain all essential amino acids. This can be achieved through complementary protein combinations like rice and beans, hummus and whole-grain bread, or lentils and quinoa. While individual meals do not need to contain all essential amino acids, the overall daily

intake should provide them in sufficient amounts to meet the body's needs.

Diets that lack complete proteins or fail to provide a balance of essential amino acids over time can lead to protein-energy malnutrition, muscle wasting, and weakened immunity. On the other hand, diets that regularly include high-quality protein sources, whether from animal or plant origins, have been linked to improved body composition, better metabolic health, and reduced risk of chronic diseases. Understanding the importance of complete proteins can help individuals make informed dietary choices that support both short-term energy needs and long-term health outcomes.

Incomplete Protein

Incomplete proteins are sources of protein that do not contain all nine essential amino acids in the amounts the body needs. These are typically found in plant-based foods such as grains, legumes, nuts, seeds, and vegetables. While they still contribute valuable amino acids to the diet, relying on a single source of incomplete protein may not provide sufficient quantities of all essential amino acids, especially for individuals with higher protein needs.

Combining plant-based proteins to make complete proteins is a concept known as **complementary protein pairing**. Most plant-based foods, such as legumes, grains, nuts, and seeds, are considered incomplete proteins because they lack one or more of the nine essential amino acids that the body cannot produce on its own. However, by eating a variety of these plant-based foods throughout the day, individuals can easily meet their amino acid needs (Mariotti & Gardner, 2019). [14]

Complementary Protein Pairings

- Grains and Legumes - An example is brown rice and beans.
- Nut/Seeds and Legumes - An example is hummus and pita bread.
- Grains and Nuts/Seeds - An example is whole wheat bread and peanut butter

For example, grains like rice, oats, or wheat are typically low in the amino acid lysine but high in methionine. Legumes such as beans, lentils, or peas, on the other hand, are high in lysine but low in methionine. When eaten together, like rice and beans, peanut butter on whole grain bread, or hummus with pita, they provide all the essential amino acids, forming a complete protein. Contrary to older nutrition myths, these complementary proteins do not need to be eaten at the same meal but rather within the same day to ensure adequate amino acid intake (Mariotti & Gardner, 2019). [14]

This method of protein complementation allows individuals following vegetarian or vegan diets to get the full range of essential amino acids without relying on animal products. Eating a varied, plant-rich diet is not only sufficient for meeting protein needs but can also offer added health benefits such as higher fiber intake and reduced saturated fat consumption (Mariotti & Gardner, 2019). [14]

Question

- How might understanding complementary food pairings, like combining grains and legumes, change the way you approach getting enough protein in your diet?

Animal v. Plant-Based Proteins

Both animal-based and plant-based proteins offer unique health benefits, and incorporating a balanced mix of the two can support overall nutritional needs depending on individual dietary preferences and health goals (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Animal-based proteins

Animal-based proteins such as lean meats, poultry, fish, eggs, and dairy are considered complete proteins, meaning they contain all nine essential amino acids in optimal ratios for human health. These foods are rich in bioavailable nutrients like iron (particularly heme iron), vitamin B12, zinc, and omega-3 fatty acids (especially in fatty fish). Including moderate amounts of lean animal proteins in the diet can support muscle repair, immune function, and the prevention of nutrient deficiencies. However,

excessive intake of red and processed meats has been linked to increased risks of cardiovascular disease, certain cancers, and other chronic health issues, especially when consumed in large quantities or prepared with high-sodium or high-fat methods (Lanham-New et al, 2017). [11]



Figure 8.4.2: (Raw meat on plate; Eiliv Aceron via Unsplash)

Table 8.4.2 depicts a variety of animal proteins that can be found in meat, poultry, and seafood sources. Table 8.4.2 lists various protein sources from dairy products and eggs. Both tables list the type of food, the serving size, calories per serving, protein in grams, and the amount of saturated fats according to the USDA's food list database (USDA, 2019). [28]

Table 8.4.1: Protein, Saturated Fat, and Energy Content in Select Meats, Poultry, and Seafood

Food	Serving Size	Calories (kcal)
Regular ground beef patty (30% fat)	1 patty	232
Extra Lean ground beef patty (5% fat)	1 patty	145
Roast beef, lean, fat trimmed	3 oz (85 g)	177
Steak, grilled, choice grade	3 oz (85 g)	215
Hot dog (beef/pork, regular)	1 link (~50 g)	150-180
Salami, sliced	3 oz (85 g)	323
Roasted chicken breast, skinless	3 oz (85 g)	142
Fried chicken breast (with skin)	3 oz (85 g)	218
Turkey breast, roasted, skinless	3 oz (85 g)	94
Salmon (cooked)	3 oz (85 g)	175
Tuna, canned in water, drained	3 oz (85 g)	109
Shrimp (cooked)	3 oz (85 g)	84



Figure 8.4.3: (Assorted drinks on white commercial refrigerator; Kenny Eliason via Unsplash)

Table 8.4.2: Energy, Protein, Saturated Fat Content in Selected Dairy Products and Eggs

Food	Serving Size	Calories (kcal)
Egg	1 large	78
Cheddar cheese	1 oz (28 g)	114
Low-Fat Cheddar Cheese	1 oz (28 grams)	49
Milk, whole	1 cup (240 mL)	149
Milk, 1%	1 cup (240 mL)	118
Milk, non-fat (skim)	1 cup (240 mL)	85
Yogurt, plain non-fat	8 oz (170 g)	100
Yogurt with fruit, low-fat	8 oz (170 g)	230
Greek Yogurt (plain, whole)	8 oz (170 g)	220

Table 8.4.1 and Table 8.4.2 values can vary slightly depending on the brand and exact fat content, but this is a standard estimate based on data from the USDA FoodData Central (USDA, 2019). [28]

Plant-based Protein Sources

Plant-based protein sources such as beans, lentils, tofu, quinoa, nuts, and seeds tend to be lower in saturated fat and cholesterol-free. They are also typically higher in dietary fiber, antioxidants, and phytochemicals that promote long-term health. Diets high in plant-based proteins have been associated with lower risks of heart disease, type 2 diabetes, hypertension, and obesity. While individual plant proteins may lack one or more essential amino acids, a varied plant-based diet can provide complete protein nutrition when consumed throughout the day.

Soy products are plant-based but considered complete proteins. This means they contain all nine essential amino acids in sufficient amounts needed by the human body. This makes soy unique among most plant-based proteins, as many other legumes and grains lack one or more essential amino acids. Because of this, soy is a valuable protein source for vegetarians and vegans. Soy products are high-quality, concentrated plant proteins with relatively low saturated fat.

Examples of complete soy-based proteins:

- Tofu

- Tempeh
- Edamame (young soybeans)
- Soy milk
- Soy protein isolate (used in protein powders and meat substitutes)

Legumes, grains, nuts, and seeds are incomplete proteins and require a daily complementary protein pairing to be used by the body as a complete protein.

- Legumes (beans, lentils, chickpeas) deliver both protein and fiber, with little saturated fat.
- Grains (whole wheat, brown rice) contribute both protein and fiber and are low in saturated fats.
- Nuts and seeds provide moderate plant protein and healthy fats, though they also contain some saturated fat; portion control is helpful for calorie balance.

Table 8.4.3 depicts the approximate energy, protein in grams, and saturated fat in grams for select plant-based protein sources. This data is based on the USDA food list database (USDA, 2019). [28]



Figure 8.4.4: (Sliced vegetables in clear glass bowl; Yoav Aziz via Unsplash)

Table 8.4.3: Energy, Protein, and Saturated Fat Content of Selected Plant-Based Protein Sources

Food	Serving Size	Calories (kcal)	Prot
Tempeh	1 cup (~166 g)	320	30
Seitan	3.5 oz (~100 g)	120	25
Edamame	1 cup (cooked)	189	18
Firm tofu	1 cup (~248 g)	350	20
Lentils (cooked)	½ cup (~98 g)	115	18
Black beans (cooked)	½ cup (~86 g)	120	8
Pinto beans (cooked)	½ cup (~82 g)	135	8
Kidney beans (cooked)	1/2 (~130 g)	110	7.5
Garbanzo beans (canned)	1/2 cup (~130 g)	130	6
Hummus (plain)	2 oz (4 tablespoons)	140-160	4-5
Whole wheat bread	1 slice	70-80	4-5
Flour tortilla	8 inch	120-130	3-4

Food	Serving Size	Calories (kcal)	Prot
Peanut butter	1 oz (2 tablespoons)	188	9
Almonds	1 oz (28 g)	170	6
Pistachios	1 oz (28 g)	160	6
Sunflower seeds	1 oz (28 g)	165	6
Pumpkin seeds	1 oz (28 g)	158	9
Chia seeds	1 oz (28 g)	138	5
Flax seeds	1 oz (28 g)	150	6
Hemp seeds	1 oz (28 g)	155	8.8

In summary, animal proteins offer high-quality amino acids and essential nutrients, while plant-based proteins provide additional health-protective compounds and are generally more heart-friendly. A diverse, balanced diet that includes both sources, if not limited by dietary restrictions or ethical choices, can offer the benefits of each while reducing potential health risks.

Questions

- How much protein do you think you consume daily?
- Do you think you are eating too much or too little?
- Do you think a strategy like "Meatless Mondays" would help you reduce your intake of animal-based proteins and increase plant-based sources?



Figure 8.4.5: Proteins can be found in animal and plant-based varieties. (CC BY-SA 4.0; via Wikimedia Commons)

Nutritional Goals for Protein

The nutritional goals for protein intake are outlined in the Dietary Guidelines for Americans (DGA) 2020–2025 and are supported by the Acceptable Macronutrient Distribution Range (AMDR) and Recommended Dietary Allowances (RDA) established by the National Academies of Sciences (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Here are the key protein-related goals:

- **Total Protein Intake**: 10–35% of total daily calories should come from protein (as outlined in the AMDR). For a 2,000-calorie

diet, this equals roughly 50–175 grams of protein per day.
- **RDA for Protein (Minimum Daily Intake)**: The RDA is based on 0.8 grams of protein per kilogram of body weight per day to meet the needs of nearly all healthy adults.
- **Choose a variety** of protein foods from both animal and plant-based protein sources.
- **Shift intake toward more plant-based protein** sources for health and sustainability.
- **Limit intake of processed and high-saturated-fat protein foods** (e.g., fried meats, processed deli meats).

Key Points

- Protein is an essential macronutrient made of amino acids that supports growth, repair, and maintenance of body tissues like muscle, skin, enzymes, and hormones.
- Unlike carbohydrates and fats, protein is not primarily stored for energy, making its structural and functional roles critical for health.
- The body requires 20 amino acids, nine of which are essential and must be obtained through the diet.
- Complete proteins contain all nine essential amino acids and are found in animal foods and some plant sources like soy, quinoa, and buckwheat.
- Incomplete proteins lack one or more essential amino acids but can be combined through complementary pairings, such as rice and beans, to form complete proteins.
- Adequate protein intake supports muscle maintenance, immune health, hormone production, and enzyme function, while deficiencies may cause muscle wasting and weakened immunity.
- Animal-based proteins provide complete amino acids and important nutrients like iron, vitamin B12, and omega-3s, but excess processed or fatty meats increase chronic disease risk.
- Plant-based proteins offer fiber, antioxidants, and heart-protective benefits; although most are incomplete, variety ensures complete amino acid intake.
- Soy products are unique plant-based proteins that are naturally complete and valuable for vegetarian or vegan diets.
- Nutritional goals recommend that protein make up 10–35% of daily calories, with adults consuming at least 0.8 grams of protein per kilogram of body weight each day, focusing on varied, high-quality sources.

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8.5: Lipids (Fats)



Figure 8.5.1: (CC BY-SA 4.0; via Wikimedia Commons)

Introduction

Lipids, also known as fats, are one of the three essential macronutrients that the body needs in relatively large amounts to function properly. While fats have long been misunderstood and even feared in some dietary trends, they play vital roles in the body, including providing a concentrated source of energy, supporting the absorption of fat-soluble vitamins (A, D, E, and K), insulating and protecting organs, and contributing to cell structure and hormone production. There are several types of dietary fats: saturated, unsaturated, and trans fats, each with different effects on health. Consuming healthy fats in limited amounts is beneficial, while consuming unhealthy fats can increase the risk of cardiovascular diseases and type 2 diabetes. Eating too much fat of any type leads to weight gain, as is the case with both carbohydrates and proteins. Understanding the types and sources of fat is crucial for making informed dietary choices that support long-term health and well-being.

Types of Fats

Lipids found in food are composed of smaller units called **fatty acids**, which determine the type and health impact of the fat. Fatty acids are classified based on their chemical structure, particularly the presence and number of double bonds between carbon atoms. The main types include saturated fatty acids (no double bonds), monounsaturated fatty acids (one double bond), and polyunsaturated fatty acids (multiple double bonds). Trans fats are another category, often artificially produced through a process called hydrogenation. Each type of fat behaves differently in the body; some support heart health, while others may contribute to disease risk. Understanding the structure and function of these fatty acids helps explain why some fats are encouraged in the diet while others are limited.

Saturated Fatty Acids

Saturated fatty acids are a type of fat in which all the carbon atoms are bonded to hydrogen atoms, leaving no double bonds in their structure. This can be seen in Figure 8.5.2, where the two carbon atoms are in the center depicted by a capital "C" with four hydrogen atoms attaching to the carbon, depicted with an capital "H". Saturated fatty acids are a type of fat in which all the carbon atoms are bonded to hydrogen atoms, leaving no double bonds in their structure. This chemical composition makes them solid at room temperature and more stable during cooking. Saturated fats are commonly found in animal-based foods such as fatty cuts of meat, butter, cheese, and whole milk, as well as some tropical oils like coconut and palm oil. While the body needs small amounts of saturated fat for hormone production and cell membrane integrity, excessive intake has been linked to elevated LDL

(bad) cholesterol levels and an increased risk of heart disease. For this reason, dietary guidelines recommend limiting saturated fat to less than 10% of daily caloric intake. This chemical composition makes them solid at room temperature and more stable during cooking.

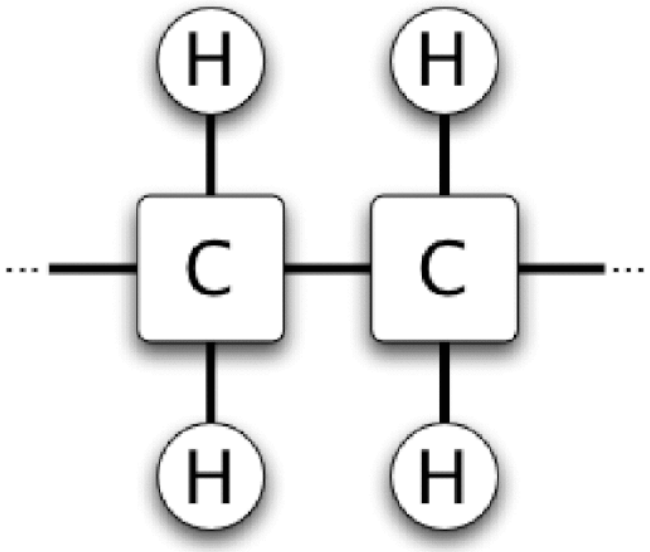


Figure 8.5.2: The molecular structure of a saturated fatty acid made up of two carbon atoms and four hydrogen atoms. (Public Domain; Colin Henein via Wikimedia Commons)

Trans Fatty Acids

The U.S. Food and Drug Administration (FDA) revoked the GRAS (Generally Recognized as Safe) status of **partially hydrogenated oils (PHOs)**, the main source of industrial trans fats, in June 2015. PHOs were once common in processed foods like margarine, baked goods, and fried fast foods. Manufacturers were required to stop adding PHOs to foods by June 18, 2018, though products containing them could remain on shelves through January 1, 2021, due to extended transition periods (U.S. Food and Drug Administration, 2015). [31]



Figure 8.5.3: Fries were a large source of PHOs due to the frying process. (A tray of fries with dips; henry perks via Unsplash)

Sources of Saturated Fatty Acids

Animal-Based Sources

- Fatty cuts of beef (e.g., ribeye, ground beef)
- Pork (e.g., bacon, sausage, ribs)
- Lamb
- Poultry skin (e.g., chicken or turkey with skin)
- Lard
- Butter
- Cream
- Whole milk and 2% milk
- Cheese (especially full-fat varieties like cheddar, brie, and cream cheese)
- Ice cream

Processed and Prepared Foods

- Baked goods (e.g., cookies, cakes, pastries)
- Packaged snacks (e.g., crackers, microwave popcorn, some granola bars)
- Pizza (especially with processed meats and cheese)
- Fast food (e.g., burgers, fried chicken, breakfast sandwiches)
- Cream-based sauces and soups

Plant-Based Sources (Naturally High in Saturated Fat)

- Coconut oil
- Palm oil
- Palm kernel oil
- Coconut milk and cream
- Cocoa butter (found in chocolate)

Question

Think about a typical breakfast, lunch, or dinner you eat.

- Are there any ingredients high in saturated fat?
- What could you swap in for a healthier option?

Unsaturated Fatty Acids

Unsaturated fats are a vital component of a healthy diet and are considered beneficial fats due to their positive impact on heart health and overall well-being. Unlike saturated fats, which are solid at room temperature and commonly found in animal products, unsaturated fats remain liquid and are primarily derived from plant and fish sources. These fats help to reduce low-density lipoprotein (LDL) cholesterol levels in the blood, which lowers the risk of cardiovascular disease. They also provide essential fatty acids that the body cannot synthesize on its own, making them crucial for maintaining healthy cell membranes, supporting hormone production, and aiding in the absorption of fat-soluble vitamins like A, D, E, and K. There are two main types of unsaturated fats: monounsaturated fats (MUFA) and polyunsaturated fats (PUFA).



Figure 8.5.4: Avocados are high in unsaturated fats. (An avocado cut in half; Rens D via Unsplash)

Monounsaturated Fats

Monounsaturated fats have one double bond in their fatty acid chain and are liquid at room temperature. They are found in foods such as olive oil, avocados, nuts (like almonds and cashews), and seeds. These fats have been linked to reduced inflammation and improved blood cholesterol levels, both of which are important for heart health. Diets rich in monounsaturated fats, such as the Mediterranean diet, have been associated with lower rates of heart disease and stroke. Figure 8.5.5 depicts the molecular structure of a monounsaturated fatty acid. It is a type of fatty acid that has a single double bond within its carbon chain, represented by two capital C's joined by two lines, while the remaining carbon atoms are linked by single bonds. There are two hydrogen atoms depicted by the capital "H" connected with a single line (bond) to the carbon atoms. This structure gives monounsaturated fats their name; "mono" meaning one (double bond) and "unsaturated" referring to the presence of at least one double bond in place of a hydrogen-saturated single bond.

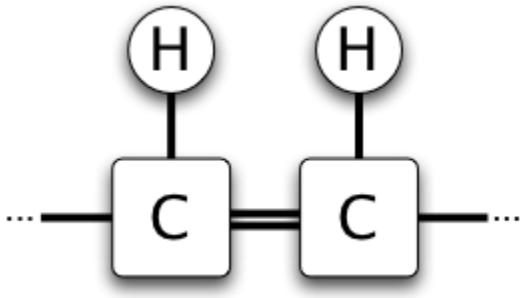


Figure 8.5.5: The molecular structure of a monounsaturated fatty acid made up of two carbon atoms connected by a double bond with one hydrogen atom attached with a single bond ot each carbon atom. (Public Domain; Colin Henein via Wikimedia Commons)

Sources of Monounsaturated Fats

Oils:

- Olive oil
- Canola oil
- Peanut oil
- Safflower oil (high-oleic variety)
- Avocado oil
- Sesame oil

Nuts and Seeds:

- Almonds
- Peanuts and peanut butter
- Cashews
- Hazelnuts
- Pumpkin seeds

Fruits

- Avocados
- Olives

Other:

- Dark chocolate

These fats are considered heart-healthy and are a key part of dietary patterns like the Mediterranean diet.

Polyunsaturated Fats

Polyunsaturated fats have more than one double bond in their chemical structure and are further categorized into two essential types: **omega-3** fatty acids and **omega-6** fatty acids, meaning they must be obtained from the diet. **Linoleic acid (18:2)** is classified as an omega-6 polyunsaturated fat because its first double bond is located at the sixth carbon from the omega (methyl) end of the chain. **Alpha-linolenic acid (18:3)** is an omega-3 polyunsaturated fat due to its first double bond occurring at the third carbon. These labels, omega-3 and omega-6, help identify the type and function of polyunsaturated fats in the diet. Omega-3 fatty acids, found in fatty fish (like salmon, mackerel, and sardines), flaxseeds, chia seeds, and walnuts, have well-established anti-inflammatory properties. They play a crucial role in brain health and have been shown to reduce the risk of heart disease, especially when they replace saturated fats in the diet. Omega-6 fatty acids are also essential and are found in vegetable oils like soybean, sunflower, and corn oil. However, while both are necessary, an imbalance, too much omega-6 and too little omega-3, can promote inflammation, so it's important to maintain a balanced intake.

Table 8.5.1: Essential Polyunsaturated Fatty Acids

Fatty Acid	Structure	Omega Type
Linoleic acid (LA)	18:2	Omega-6
Alpha-linolenic acid (ALA)	18:3	Omega-3

Table 8.5.1: Essential Polyunsaturated Fatty Acids by Danielle Altman is licensed under CC-BY SA 4.0



Figure 8.5.6: (Grilled fish with cooked vegetables; Caroline Attwood via Unsplash)

Sources of Polyunsaturated Fats

Omega-3 Fatty Acid Sources:

Fatty fish

- Salmon
- Mackerel
- Sardines
- Herring
- Anchovies
- Trout

Plant-based sources

- Flaxseeds and flaxseed oil
- Chia seeds
- Walnuts
- Hemp seeds
- Soybeans and soybean oil
- Canola oil
- Algal oil (vegan DHA source)

Omega-6 Fatty Acid Sources:

Vegetable oils:

- Corn oil
- Safflower oil
- Sunflower oil
- Soybean oil
- Cottonseed oil

Nuts and seeds:

- Walnuts

- Pumpkin seeds
- Sesame seeds

Other:

- Tofu
- Eggs (especially from chickens fed omega-6-rich diets)



Figure 8.5.7: (CC BY-SA 4.0; Ivar Leidus via Wikimedia Commons)

The Dietary Guidelines for Americans (DGA) 2020–2025 include Linoleic Acid (Omega-6) and Alpha-Linoleic Acid (Omega-3) as essential nutrients in the nutritional goals by age and sex (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020). [30] Including unsaturated fats in your diet in place of saturated or trans fats is a key strategy for promoting long-term cardiovascular health and reducing the risk of chronic diseases. They provide essential nutrients, contribute to feelings of fullness, and improve lipid profiles when consumed in moderation. The Dietary Guidelines for Americans recommend shifting fat consumption toward unsaturated sources, reinforcing their role as a cornerstone of healthy eating patterns.

Question

- What kinds of fats do you usually eat in a day, saturated or unsaturated?
- Can you name some foods where these fats come from in your diet?

Comparison of Dietary Fats

Figure 8.5.8 is a comparative chart of dietary fat composition in various oils and fats, showing the percentage breakdown of different types of fatty acids. The chart lists 14 common fats and oils, including (from the top) canola oil, safflower oil, flaxseed oil, sunflower oil, corn oil, olive oil, soybean oil, peanut oil, cottonseed oil, lard, palm oil, butter, and coconut oil. Along the vertical axis, with corresponding percentages of saturated, monounsaturated, and polyunsaturated fats indicated by color-coded horizontal bars. The chart is color-coded by type of fat:

- **Saturated Fat (pink)**: Typically considered less heart-healthy, these fats are solid at room temperature and dominate in animal fats like butter and coconut oil.
- **Polyunsaturated Fat: omega-6 (yellow)**: Associated with improved heart health, this fat type is prevalent in olive oil and canola oil.
- **Polyunsaturated Fat: omega-3 (blue)**: Includes essential omega-3 and omega-6 fatty acids; high in oils like corn and soybean oil.
- **Monounsaturated Fat - Oleic (light green)**: Artificial trans fats (from hydrogenation) are known to raise LDL cholesterol

and lower HDL; minimal in most modern products due to regulations.

Figure 8.5.8 provides a clear visual comparison of fat types across various oils and spreads, helping to evaluate their health implications based on fatty acid composition. Concentrations of saturated fat, polyunsaturated fat, and monounsaturated fat are compared with a breakdown of polyunsaturated fat provided between Omega-3 and Omega-6 for several types of oil. These oils include canola, safflower, flaxseed, sunflower, corn, olive, soybean, peanut, cottonseed, lard, palm, butter, and coconut. Table 8.5.1 provides the data in a more accessible way.

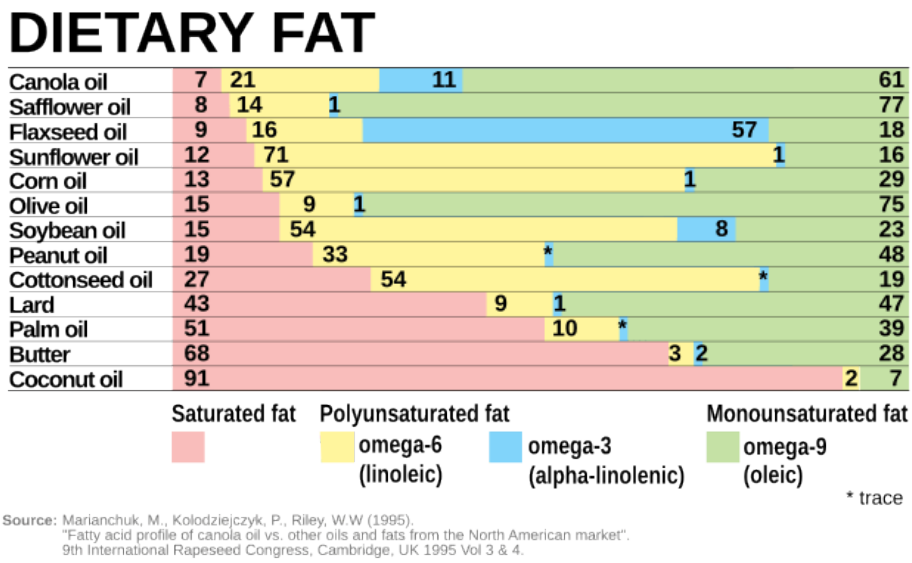


Figure 8.5.8: A color-coded chart comparing the fat composition of various oils. (CC BY-SA 4.0; via Wikimedia Commons)

Table 8.5.1: Accessible Dietary Fats Information

Food Source	Saturated fat %	Omega-6 %	Omega-3 %	Omega-9 %
Canola oil	7	21	11	61
Safflower oil	8	14	1	77
Flaxseed oil	9	16	57	18
Sunflower oil	12	71	1	16
Corn oil	13	57	1	29
Olive oil	15	9	1	75
Soybean oil	15	54	8	23
Peanut oil	19	33	Trace	48
Cottonseed oil	27	54	Trace	19
Lard	43	9	1	47
Palm oil	51	10	Trace	39
Butter	68	3	2	28
Coconut oil	91	2	0	7

Figure 8.5.9 illustrates a set of nine color-coded pie charts comparing the types of fats found in various common fats and oils. Each chart breaks down the total fat content of a food item into three categories:

- Monounsaturated fat (green)
- Polyunsaturated fat (blue)
- Saturated fat (orange)

The foods analyzed are:

- Butter
- Margarine
- Mayonnaise
- Canola Oil
- Olive Oil
- Peanut Oil
- Safflower Oil
- Sesame Oil
- Sunflower Oil

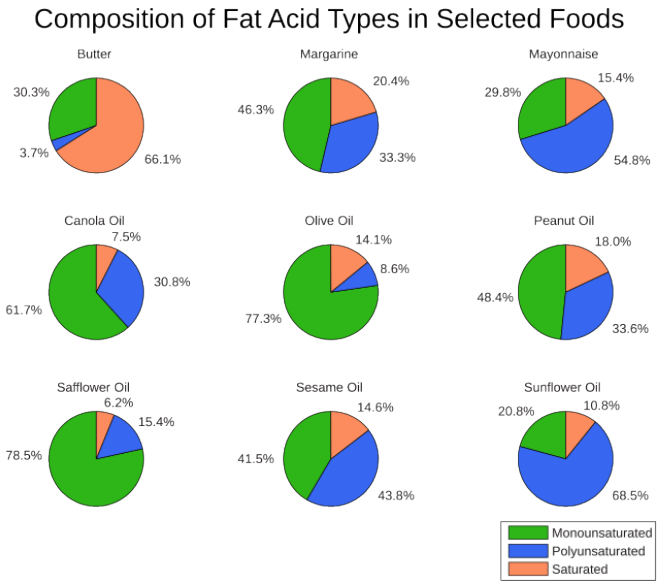


Figure 8.5.9: Nine pie charts of common foods with high fat, indicating the percentages of monounsaturated, polyunsaturated, and saturated fats. (CC BY-SA 3.0; Xyzzy n via Wikimedia Commons)

Percentages are provided in each segment to show how much of each type of fat is present in that item. The percentage breakdowns by food are as follows:

- Butter is primarily saturated fat (66.1%), with smaller portions of monounsaturated (30.3%) and very little polyunsaturated fat (3.7%).
- Margarine contains more monounsaturated fat (46.3%) and polyunsaturated fat (33.3%) than saturated fat (20.4%).
- Mayonnaise is highest in polyunsaturated fat (54.8%), with moderate monounsaturated (29.8%) and lower saturated fat (15.4%).
- Canola Oil has a high monounsaturated fat content (61.7%), followed by polyunsaturated (30.8%) and low saturated fat (7.5%).
- Olive Oil is mostly monounsaturated fat (77.3%), with lower saturated (14.1%) and polyunsaturated fat (8.6%).
- Peanut Oil has a nearly even split between monounsaturated (48.4%) and polyunsaturated (33.6%) fats, with some saturated fat (18.0%).
- Safflower Oil is predominantly polyunsaturated fat (78.5%), with smaller amounts of monounsaturated (15.4%) and saturated fat (6.2%).
- Sesame Oil has a more even mix of polyunsaturated (43.8%) and monounsaturated fats (41.5%), with 14.6% saturated fat.
- Sunflower Oil is largely polyunsaturated fat (60.5%), with some monounsaturated (20.8%) and saturated fat (10.8%).

The image uses a clear legend in the bottom right to indicate the colors used for each fat type, making it easy to compare health profiles across these common fats and oils.

Question

- How confident are you in your ability to identify healthy vs. unhealthy fats in your meals or snacks?

Cholesterol

Dietary cholesterol is a waxy, fat-like substance that plays a vital role in the body's structure and function. It is an essential component of cell membranes, a precursor for vitamin D, and necessary for the production of certain hormones and bile acids that aid in digestion. While the body produces all the cholesterol it needs, mainly in the liver, it is also found in animal-based foods such as meat, eggs, and dairy. Understanding the balance between dietary intake, the body's cholesterol production, and how cholesterol travels through the bloodstream is key to maintaining cardiovascular health and preventing disease. Blood cholesterol refers to the cholesterol that circulates in the bloodstream, carried by lipoproteins, and its levels are influenced by both dietary intake and the body's production

Cholesterol is often labeled as "good" or "bad" based on how it is transported in the blood. **Low-density lipoprotein (LDL) cholesterol** is considered "bad" because high levels can lead to plaque buildup in the arteries, increasing the risk of heart disease, while **high-density lipoprotein (HDL) cholesterol** is considered "good" because it helps remove excess cholesterol from the bloodstream and transport it to the liver for excretion.

Low-Density Lipoproteins (LDL)

LDLs, often labeled as "bad cholesterol," are lipoproteins that transport cholesterol from the liver to tissues throughout the body. When LDL levels are too high, cholesterol can build up in the walls of arteries, leading to plaque formation, which narrows the arteries and increases the risk of atherosclerosis, heart attack, and stroke. Diets high in saturated and trans fats can raise LDL cholesterol levels, making it important to manage intake of these fats to support heart health.

High-Density Lipoproteins (HDL)

HDLs are commonly referred to as "good cholesterol" because they help remove excess cholesterol from the bloodstream by transporting it back to the liver for processing and elimination. High levels of HDL are associated with a lower risk of cardiovascular disease, as they play a protective role by preventing cholesterol buildup in arteries. Regular physical activity, not smoking, and eating healthy fats, such as those from nuts, seeds, and fish, can help maintain or increase HDL levels. Increasing HDL (high-density lipoprotein) can help reduce LDL (low-density lipoprotein) because HDL helps remove excess cholesterol from the bloodstream and transport it to the liver for excretion, lowering the risk of LDL buildup in the arteries.

Phytosterols:

Phytosterols are plant-based compounds structurally similar to cholesterol that naturally occur in foods like vegetable oils, nuts, seeds, and whole grains. Because of their similar structure, phytosterols compete with dietary cholesterol for absorption in the digestive tract, effectively lowering the amount of cholesterol that enters the bloodstream. Consuming phytosterol-enriched foods or including more plant-based foods in the diet may help reduce LDL cholesterol levels and support overall cardiovascular health.

Question

- Have you ever checked your cholesterol levels?
- If so, were you aware of how your diet may have affected them?

Table 8.5.2: Food Substitution to Lower Total Fat and Dietary Cholesterol Intake

Instead of...	Try this instead...	Why..?
Whole milk	Low-fat (1%) or fat-free milk	Reduces saturated fat and cholesterol
Butter or stick margarine	Olive oil, canola oil, or avocado spread	Healthy unsaturated fats

Instead of...	Try this instead...	Why..?
Cream cheese	Cottage cheese, Low-fat ricotta, hummus, or mashed avocado	Lower-fat, plant-based alternatives
Sour cream	Plain Greek yogurt or low-fat sour cream	Less saturated fat, added protein
Fried chicken	Baked, grilled, or air-fried chicken breast	Reduces saturated fat
Fatty cuts of beef (e.g., ribeye)	Lean cuts like sirloin, round, or tenderloin	Lower in saturated fat and cholesterol
Pork sausage	Turkey sausage, veggie sausage, or beans	Less saturated fat and cholesterol
Cheese (full-fat varieties)	Reduced-fat cheese, or small portions of strong cheeses	Cuts fat, keeps flavor
Ice cream	Frozen yogurt, sorbet, or banana-based “nice cream.”	Less saturated fat, fewer calories
Regular mayonnaise	Avocado, mustard, or light mayo	Plant-based fats and fewer calories
Egg yolks (many per week)	Use egg whites or a cholesterol-free egg substitute	No cholesterol, high protein
Commercial pastries (donuts, cakes)	Homemade or lower-fat baked goods with oil/applesauce swap	Control fat content
Potato chips	Air-popped popcorn, baked chips, or veggie sticks + hummus	Less saturated fat and more fiber
Fast food burgers	Turkey burger, veggie burger, or grilled chicken sandwich	Less cholesterol and saturated fat
Cream-based soups	Broth-based soups or pureed veggie soups	Fewer calories and saturated fat

Instead of...	Try this instead...	Why..?
Shortening or lard in baking	Unsweetened applesauce, mashed banana, or vegetable oil	Replaces saturated fat with healthier or lower-fat options

Table 8.5.2: Essential Polyunsaturated Fatty Acids by Danielle Altman is licensed by CC-BY SA 4.0

Question

- What's one small change you could make this week to improve the quality of fats in your diet?

Nutritional Goals for Fats

The Dietary Guidelines for Americans (DGA) 2020–2025 provide specific nutritional goals for lipid (fat) intake, with a strong emphasis on reducing saturated fats to support overall health (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). [30]

Here are the key fat-related goals:

- **Total Lipid (fat) intake: 20% to 35%** of total daily calories should come from lipids (fat). For adults on a 2,000-calorie diet, this equals roughly 44 to 78 grams of fat per day.
- **Unsaturated Fats (Encouraged)**, such as monounsaturated and polyunsaturated fats (found in foods like fish, nuts, seeds, avocados, and vegetable oils) are the preferred sources of dietary fat.
- **Saturated Fat** should be limited to less than 10% of total daily calories. That's less than 22 grams per day on a 2,000-calorie diet. Replace saturated fats with unsaturated fats, especially polyunsaturated fats.
- **Avoid trans fats entirely:** Although partially hydrogenated oils (PHOs) are no longer generally recognized as safe (GRAS) by the FDA and have been largely removed from the food supply, trace amounts may still occur in processed foods.

Key Points

- Lipids (fats) are essential macronutrients that provide energy, support vitamin absorption, protect organs, and contribute to cell and hormone function.
- Dietary fats are classified as saturated, unsaturated (monounsaturated and polyunsaturated), and trans fats, each with different health effects.
- Saturated fats, found mainly in animal products and tropical oils, should be limited due to their link with elevated LDL cholesterol and heart disease risk.
- Trans fats, once common in processed foods, are no longer recognized as safe and have been largely removed from the food supply.
- Unsaturated fats, especially from plant oils, nuts, seeds, and fish, support heart health, reduce LDL cholesterol, and provide essential fatty acids.
- Monounsaturated fats (e.g., olive oil, avocados, nuts) and polyunsaturated fats (omega-3s and omega-6s) play key roles in reducing inflammation, supporting brain health, and lowering chronic disease risk.
- A balance of omega-3 and omega-6 fatty acids is important, as too much omega-6 without enough omega-3 may promote inflammation.
- Cholesterol, made by the body and found in animal foods, is necessary for cell structure, hormones, and vitamin D but must be balanced to avoid cardiovascular disease.
- LDL cholesterol is considered "bad" due to its role in plaque buildup, while HDL cholesterol is "good" because it helps remove excess cholesterol.
- Nutritional guidelines emphasize 20–35% of daily calories from fats, prioritizing unsaturated fats, limiting saturated fat to under 10%, and avoiding trans fats.

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8.6: Vitamins and Minerals



Figure 8.6.1: (Flat lay photography of sliced pomegranate, lime, and lemon; Bruna Branco via Unsplash)

Introduction

Vitamins and minerals are considered micronutrients and are essential nutrients that the body requires in small amounts to support vital physiological functions, including growth, immune function, energy production, and bone health. Unlike macronutrients, which provide energy in the form of calories, micronutrients do not supply energy, but they are crucial for the proper functioning of nearly every system in the body. The two main categories of micronutrients are vitamins and minerals, each with distinct roles in maintaining health.

Even though micronutrients are needed only in trace or moderate amounts, deficiencies can lead to serious health issues, ranging from anemia and weakened immunity to impaired cognitive development and chronic disease. At the same time, excessive intake, especially from supplements, can also be harmful. Understanding the sources, functions, and recommended intake of micronutrients is key to developing a balanced diet that supports both short-term wellness and long-term disease prevention. Throughout this chapter, we will explore the different types of vitamins and minerals, their food sources, and how they interact with one another and the body.

Vitamins

Vitamins are essential organic compounds that support a wide range of biological functions, including energy metabolism, immune defense, and bone health. Vitamins are involved in numerous physiological processes, including mineral and bone metabolism, cellular and tissue growth, and energy metabolism, where they often function as cofactors. Among all vitamins, the B-complex vitamins play the most significant role in metabolic activity. Most vitamins are obtained through dietary sources, although some can be synthesized from precursors absorbed during digestion. For instance, the body converts β-carotene from orange vegetables like carrots and sweet potatoes into vitamin A (Betts et al, 2022). [3] Vitamins are classified as either fat-soluble or water-soluble. Fat-soluble vitamins include vitamins A, D, E, and K, which are absorbed in the intestine along with lipids via chylomicrons. Vitamin D is also synthesized in the skin in response to sunlight exposure. Because these vitamins are stored in body fat, excessive intake can lead to **hypervitaminosis,** which can cause symptoms such as nausea, headaches, liver damage, nerve problems, or bone pain. Water-soluble vitamins, including the eight B vitamins and vitamin C, are absorbed with water in the digestive tract. They circulate easily in the body's aqueous environments and are not stored in significant amounts; excess amounts are typically excreted in urine, making toxicity rare except in cases of excessive supplementation (Betts et al, 2022). [3]

Vitamin intake recommendations are based on standards established by expert scientific committees, primarily through the

Dietary Reference Intakes (DRIs) developed by the National Academies of Sciences, Engineering, and Medicine in the United States (National Academies of Sciences, Engineering, and Medicine, 2023). [18] The DRIs include several key values: the Recommended Dietary Allowance (RDA), which is the average daily intake sufficient for nearly all (97–98%) healthy individuals in a specific age and gender group; the Adequate Intake (AI), used when an RDA cannot be determined; and the Tolerable Upper Intake Level (UL), which is the maximum daily amount unlikely to cause harmful effects. In public health and food labeling, the Daily Value (DV) is also commonly used to indicate how much a nutrient in a serving of food contributes to the total daily diet. These standards are regularly reviewed and updated based on emerging scientific evidence. These Nutritional Guideline Acronyms can also be found in detail in Table 8.6.3: Acronyms for Nutritional Guidelines.

Most healthy adults can meet their vitamin needs by consuming a varied and balanced diet that includes a wide range of whole foods. Nutrient-dense foods, such as fruits, vegetables, whole grains, lean proteins, dairy products, and healthy fats, naturally provide essential vitamins in forms that are easily absorbed and used by the body. For example, leafy greens are rich in folate and vitamin K, citrus fruits supply vitamin C, dairy and fortified plant-based milks offer vitamin D, and nuts and seeds contribute vitamin E and B vitamins. Eating a diverse diet ensures adequate vitamin intake, provides beneficial fiber, antioxidants, and phytochemicals that supplements do not.

While dietary supplements can help in specific cases, such as for individuals with limited diets, certain health conditions, or nutrient absorption issues, most healthy adults do not need them if they consistently eat well. In fact, overuse of supplements may increase the risk of vitamin toxicity, especially with fat-soluble vitamins like A and D, which are stored in the body. Emphasizing food-based sources of nutrients helps reduce this risk and supports overall health more effectively, as nutrients in whole foods often work together in complex ways that enhance their absorption and function.

Fat-Soluble Vitamins

Fat-soluble vitamins are absorbed along with dietary fat and stored in the liver and fatty tissues. These vitamins are vital for functions such as vision (vitamin A), calcium regulation and bone health (vitamin D), antioxidant protection (vitamin E), and blood clotting (vitamin K). Unlike water-soluble vitamins, fat-soluble vitamins can accumulate in the body, so excessive intake, particularly from supplements, can lead to toxicity. For example, too much vitamin A can cause liver damage and birth defects, while excess vitamin D can result in dangerously high blood calcium levels.

Table 8.6.1: Fat-Soluble Vitamins: Sources, Functions and Recommended Intakes for Adults

Vitamin and Alternative Name	Source of Goal	Sources	Recommended Daily Intake	Function	Problems Associated with Deficiency
Vitamin A retinal or β-Carotene (mcg RAE)	RDA	Yellow and orange fruits and vegetables, dark green leafy vegetables, eggs, milk, liver	Females: 700 μg Males: 900 μg	Eye and bone development, immune system function	Immune system deficiency, night blindness, epithelial changes
Vitamin D (IU)	RDA	Dairy products, egg yolks, fortified foods; also synthesized in the skin from exposure to sunlight	Females (14-70): 15 μg or 600 IU Females (71+): 20 μg or 800 IU Males (14-70): 15 μg or 600 IU Males (71+): 20 μg or 800 IU	Aids in calcium and phosphorus absorption; promotes the growth of healthy bones and teeth; supports healthy cellular metabolism	Cognitive impairment, rickets, bone pain, muscle weakness, increased risk of death from cardiovascular disease, asthma in children, and cancer

Vitamin and Alternative Name	Source of Goal	Sources	Recommended Daily Intake	Function	Problems Associated with Deficiency
Vitamin E (mg AT)	RDA	Seeds, nuts, vegetable oils, avocados, whole grains, wheat germ, dark green leafy vegetables	Females: 15 mg Males: 15 mg	An antioxidant that protects cells from damage by free radicals; may help prevent chronic disease	Anemia
Vitamin K (mcg)	AI	Dark green leafy vegetables, broccoli, Brussels sprouts, cabbage, soy, asparagus, green beans	Females: 90 μg Males: 120 μg	Blood clotting, bone health, and metabolism	Impaired blood clotting; excessive bleeding, easy bruising, nosebleeds, or heavy menstrual bleeding; increased risk of osteoporosis; hemorrhagic disease of newborn infants

Table 8.6.1 is adapted from the Dietary Guidelines for Americans, 2020-2025 (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020) [30] and indicates the vitamin (and alternative name), the source of the recommended goal, food (and other) sources, and recommended dietary intake. Functions in the body and problems associated with deficiency are also included (Betts et al, 2022). [3] The following measurements are used for recommended daily intakes of certain vitamins:

- **mcg** and **μg**: both indicate a microgram, which is a unit of mass equal to one millionth of a gram. (1 µg = 0.000001 grams)
- **RAE**: Retinol Activity Equivalents
- **mg** = milligrams (0.001 gram)
- **AT** = alpha-tocopherol, the most biologically active form of vitamin E in the human body

Water-Soluble Vitamins

Water-soluble vitamins include the B-complex group and vitamin C. These vitamins dissolve in water and are not stored in the body in significant amounts, which means they must be consumed regularly through the diet. Water-soluble vitamins are absorbed into the bloodstream during digestion, and any excess is typically excreted in urine, as they are not stored in large amounts by the body. They play key roles in energy production, red blood cell formation, nervous system function, and antioxidant defense. Because excess amounts are typically excreted in urine, the risk of toxicity is low; however, very high doses, especially from supplements, can still cause adverse effects, such as nerve damage from too much B6 or gastrointestinal upset from excessive vitamin C.

Table 8.6.2: Water-Soluble Vitamins: Sources, Functions and Recommended Intakes for Adults

Vitamin and Alternative Name	Source of Goal	Sources	Recommended Daily Intake	Function	Problems Associated with Deficiency
B_1 - Thiamin (mg)	RDA	Whole grains, enriched and fortified foods, leafy green vegetables, nuts, legumes, and organ meats	Females: 1.1 mg Males: 1.2 mg	Carbohydrate and protein metabolism	Beriberi; Wernicke-Korsakoff syndrome

Vitamin and Alternative Name	Source of Goal	Sources	Recommended Daily Intake	Function	Problems Associated with Deficiency
B_2 - Riboflavin (mg)	RDA	Brewers yeast, almonds, milk, organ meats, legumes, broccoli, asparagus, enriched breads, and cereals	Females: 1.1 mg Males: 1.3 mg	Energy metabolism; production of red blood cells and other cellular processes	Fatigued, slowed growth, digestive problems, light sensitivity, epithelial problems like cracks in the corner of the mouth
B_3 - Niacin	RDA	Meat, fish, poultry, whole grain and enriched breads and cereals, leafy green vegetables, potatoes, peanuts	Females: 14 mg Males: 16 mg	Energy metabolism	Fatigue and weakness, mental health issues (anxiety and irritability), Pellagra (cracked scaly skin, dementia, and diarrhea)
B_5- Pantothenic Acid	AI	Meat, poultry, shellfish, whole grains, potatoes, oats, tomatoes, broccoli, egg yolks, legumes, enriched grains, and cereals	Females: 5 mg Males: 5 mg	Energy metabolism, synthesis of fats, neurotransmitters, hormones, and hemoglobin	Rare: Symptoms may include fatigue, insomnia, depression, and irritability.
B_6 - Pyridoxine	RDA	Potatoes, bananas, beans, seeds, nuts, meat, poultry, fish, eggs, dark green leafy vegetables, soy, organ meats, whole grains, fortified products	Females (19-50): 1.3 mg Females (51+): 1.5 mg Males (19-50): 1.3 mg Males (51+): 1.7 mg	Sodium and potassium balance, red blood cell synthesis, amino acid metabolism, and glycogen metabolism.	Confusion, irritability, depression, mouth and tongue sores
B_7 - Biotin	AI	Egg yolks, legumes, nuts, seeds, cereals, yeast, liver; smaller amounts in fruits and meats; also synthesized by intestinal bacteria	Females: 30 μg Males: 30 μg	Cell growth, metabolism of fatty acids, synthesis of fats, glycogen, and amino acids, red blood cell synthesis	Rare: Symptoms may include dermatitis, hair loss, loss of muscular coordination
Folate (mcg **DFE**)	RDA	Dark green leafy vegetables, broccoli, asparagus, legumes, liver, citrus fruits, beets, whole grains, and enriched breads and cereals	Females: 400 μg Males: 400 μg	DNA and protein synthesis, metabolism of DNA, RNA, and amino acids; synthesis of new cells, prevents one form of anemia	Poor growth, gingivitis, appetite loss, shortness of breath, gastrointestinal problems, mental deficits

Vitamin and Alternative Name	Source of Goal	Sources	Recommended Daily Intake	Function	Problems Associated with Deficiency
B_{12} - Cyanocobalamin (mcg)	RDA	Dairy products (milk and yogurt), eggs, fish and seafood, meat, poultry	Females: 2.4 μg Males: 2.4 μg	Synthesis of amino acids, DNA, red blood cells; fatty acid oxidation, support for nervous system functioning, red blood cell production	Pernicious anemia, leading to nerve cell damage
Vitamin C - Ascorbic Acid	RDA	Most vegetables and fruits: citrus fruits, berries, peppers, tomatoes, broccoli, dark leafy green vegetables, potatoes	Females: 75 mg Males: 90 mg	Necessary to produce collagen for the formation of connective tissue and teeth; promotes healing (wounds), aids in iron absorption; an antioxidant that protects cells from damage by free radicals	Dr hair, gingivitis, bleeding gums, dry and scaly skin, slow wound healing, easy bruising, compromised immunity; can lead to scurvy
Choline	AI	Milk, eggs, liver, pork, fish, soy milk, peanuts	Females: 425 mg Males: 550 mg	Maintenance of cell membranes; precursor for acetylcholine, a neurotransmitter involved in muscle control, memory, and other functions	Non-alcoholic fatty liver disease (NAFLD), muscle damage, liver damage and dysfunction, neurological impairment; memory and brain function

Table 8.6.2 is adapted from the Dietary Guidelines for Americans, 2020-2025 (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020) [30] and the National Institute of Health *Dietary Supplement Fact Sheet* (National Institute of Health, 2023) [19] and indicates the vitamin (and alternative name), the source of the recommended intake goals, food (or other) sources, and recommended dietary intake. It also includes their functions in the body and problems associated with deficiency (Betts et al, 2022). [3]

The following measurements are used for recommended daily intakes of certain vitamins:

- **mcg** and **μg**: both indicate a microgram, which is a unit of mass equal to one millionth of a gram. (1 µg = 0.000001 grams)
- **DFE (Dietary Folate Equivalent):** A unit to account for the different rates of absorption between folate (naturally found in food) and Vitamin B9 - Folic Acid found in supplements and fortified foods.
- **mg** = milligrams (0.001 gram)
- **AT** = alpha-tocopherol, the most biologically active form of vitamin E in the human body

Minerals

Minerals in food are inorganic compounds that work with other nutrients to ensure the body functions properly. Minerals are essential nutrients that play vital roles in nearly every physiological function, from building strong bones and teeth to supporting nerve transmission, muscle contraction, fluid balance, and immune health. Major minerals like calcium, potassium, magnesium, and sodium are required in larger amounts, while trace minerals such as iron, zinc, selenium, and iodine are needed in smaller quantities, but all are crucial to overall health. Fortunately, most healthy adults can meet their mineral needs through a well-rounded diet that includes a variety of whole foods. 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 (Betts et al, 2022). [3]

Because the body cannot produce minerals on its own, they must be obtained from the diet. A variety of whole foods, such as dairy products, leafy green vegetables, nuts, legumes, whole grains, seafood, and lean meats, are all excellent sources of minerals. In addition, drinking water, especially tap water that contains naturally occurring minerals or is fortified, can contribute to the daily intake of calcium, magnesium, and fluoride. By eating a diverse mix of minimally processed foods and staying hydrated, most adults can obtain sufficient minerals without the need for supplements. However, those with certain medical conditions, dietary restrictions, or absorption disorders may require individualized support. Most healthy adults can meet their mineral needs through a balanced, nutrient-rich diet without the need for supplementation.

The most common minerals in the body are calcium and phosphorus, both of which are stored in the skeleton and are 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 (Betts et al, 2022). [3]

Major Minerals

Table 8.6.3 is a summary of major minerals, the source of the recommendation (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020) [22] (National Institute of Health, 2023) [15], and their function in the body and problems associated with deficiencies (Betts et al, 2022). [3]

Table 8.6.3: Major Minerals: Sources, Functions and Recommended Intakes for Adults

Minerals	Source of Goal	Sources	Recommended Daily Intake
Potassium	AI	Fruits and vegetables, especially leafy greens, cantaloupe, bananas, oranges, mushrooms, potatoes, tomatoes, legumes, dairy products, nuts, fish, and meats	Females: 2,600 mg Males: 3,400 mg
Sodium	CDRR	Table salt, soy sauce, milk, beets, celery, processed foods with added salt, such as lunch meats, canned soups, processed cheese, salty snacks	Females: 2,300 mg Males: 2,300 mg
Calcium (mg)	RDA	Dairy products, dark leafy greens, vegetables, nuts, brewer's yeast, blackstrap molasses, broccoli, some fish, fortified orange juice	Females: 1,000 mg Females (51+): 1,200 mg Males: 1,000 mg Males (71+): 1,200 mg
Phosphorus (mg)	RDA	Milk and other dairy products, fish, seeds, whole grains, meat, poultry	Females: 700 mg Males: 700 mg

Minerals	Source of Goal	Sources	Recommended Daily Intake
Magnesium (mg)	RDA	Nuts, seeds, whole grains, legumes, leafy green vegetables, nuts, soy milk, yogurt	Females (19-30): 310 mg Females (31-50+): 320 mg Males: 400 mg Males (31-50+): 420 mg
Chloride (mg)	DRI/DV	Most foods, table salt, vegetables, seaweed, tomatoes, lettuce, celery, olives	Females: 2,300 mg Males: 2, 300 mg

RDA: There are no differences between the RDA values used by the DGA (Dietary Guidelines for Americans) and the NIH (National Institutes of Health), because both rely on the same authoritative source. The RDA (Recommended Dietary Allowance) and UL (Tolerable Upper Intake Level) values for vitamins and minerals are consistent across the NIH and DGA.

Trace Minerals

Table 8.6.4 is a summary of trace minerals, the source of the recommendation (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020) [30] (National Institute of Health, 2023) [19], and their function in the body and problems associated with deficiencies (Betts et al, 2022). [3] There are some trace minerals, such as sulfur and cobalt, for which there is no DV or AI because they are prevalent in many food sources or other vitamins, and deficiencies are extremely rare.

Table 8.6.4: Trace Minerals: Sources, Functions and Recommended Intakes for Adults

Mineral	Source of Goal	Sources	Recommended Daily Intake
Iron (mg)	RDA	Meat, poultry, fish, seafood, legumes, nuts, seeds, whole grains, dark leafy vegetables, fortified grain products, pumpkin seeds	Females (19-50): 18 mg Females (51+): 8 mg Males: 8 mg
Zinc (mg)	RDA	Whole grains, meat, fish, poultry, cheese, seafood, especially oysters, eggs	Females: 8 mg Males: 11 mg
Copper (μg)	DRI/DV	Seafood, organ meats, nuts, legumes, chocolate, enriched breads and cereals, come fruits and vegetables	Females: 900 μg Males: 900 mg

Mineral	Source of Goal	Sources	Recommended Daily Intake
Iodine (*µg*)	RDA	Fish, shellfish, garlic, lima beans, sesame seeds, soybeans, dark leafy green vegetables	Females: 150 *µg* Males: 150 *µg*
Fluoride	RDA	Fluorinated water, tea, and certain fish eaten with bones	Females: 3 mg Males: 4 mg
Chromium	AI	Whole grains, lean meats, cheese, black pepper, thyme, brewer's yeast	Females (19-50): 25 *µg* *Females (51+): 20 µg* Males (19-50): 35 *µg* *Males: (51+): 30 µg*
Manganese (mg)	RDA	Nuts, seeds, whole grains, legumes	Females: 1.8 mg Males: 2.3 mg
Selenium (*µg*)	RDA	Brewer's yeast, wheat germ, butter, seafood, whole grains, meat, eggs	Females: 55 *µg* Males: 55 *µg*
Sulfur	None	Dietary protein: eggs, meats, poultry, legumes and nuts, garlic, onions, and cruciferous vegetables	None
Cobalt	None	Fish, nuts, leafy green vegetables, and whole grains	None
Molybdenum (*µg*)	DRI	Legumes, whole grains, nuts	Females: 45 *µg* Males: 45 *µg*

Tolerable Upper Intake Level (UL)

Consuming excessive amounts of certain vitamins and minerals, especially through supplements, can lead to toxicity or harmful side effects, a condition known as **hypervitaminosis** or **mineral toxicity**. Fat-soluble vitamins like A, D, E, and K are more likely

to accumulate in the body because they are stored in fat tissues, increasing the risk of overdose. For instance, too much vitamin A can cause liver damage, headaches, and birth defects during pregnancy. High doses of vitamin D may lead to elevated calcium levels, resulting in kidney stones or cardiovascular problems.

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. Minerals such as iron, selenium, and calcium also pose health risks when consumed in excessive amounts. Iron overload can damage organs like the liver and heart, while too much selenium may cause symptoms like hair loss, fatigue, and nerve damage. High calcium intake from supplements, rather than food, has been linked to kidney stones and impaired absorption of other minerals. To prevent these risks, it's important to follow the established Tolerable Upper Intake Levels (ULs) and consult healthcare providers before taking high-dose supplements.

Table 8.6.5 is a list of vitamins and minerals with established Tolerable Upper Intake Levels (ULs) for adults (19–50 years), directly based on the Institute of Medicine/National Academies DRIs (Institute of Medicine, 2002). [9] The ULs represent maximum daily intake unlikely to cause adverse effects for nearly all healthy adults. ULs apply to total intake from food, water, and supplements, unless otherwise specified. Excess intake, especially via supplementation or fortified products, increases the likelihood of adverse effects. The primary health risks when ULs are exceeded are also indicated.

Table 8.6.5: Tolerable Upper Intake Level (UL) for Adults for Selected Vitamins and Minerals

Nutrient (Adults 19–50)	Primary Health Risks When Exceeded
Vitamin A (preformed)	3,000 µg RAE (10,000 IU)	Liver toxicity, birth defects, blurred vision, and bone loss
Vitamin C	2,000 mg	Diarrhea, kidney stones, gastrointestinal issues (stomach upse
Vitamin C	2,000 mg	Diarrhea, kidney stones, gastrointestinal issues (stomach upset)
Vitamin D	100 µg (4,000 IU) 50 µg (2,000 IU) - Supplement Intake	Hypercalcemia, kidney damage, soft tissue calcification
Vitamin E (a-tocopherol)	1,000 mg	Bleeding risk, especially with anticoagulants
Vitamin K	None	May interfere with blood-thinning medications
Vitamin B_3 (Niacin)	35 mg (nicotinic acid) - Supplement Intake	Skin flushing, liver damage, gastrointestinal discomfort, and dist
Vitamin B_6	100 mg	Nerve damage (neuropathy), irreversible neuropathy, sensory ne coordination
Folate (Folic Acid)	1,000 µg	Masks B_{12} deficiency; leads to neurological impairment
Folate (Folic acid)	1,000 µg	Masks B_{12} deficiency, leads to neurological impairment

Nutrient (Adults 19–50)	Primary Health Risks When Exceeded
Calcium	Kidney stones, impaired absorption of other minerals
Phosphorus	May impair bone mineralization when the calcium-phosphorus ra
Magnesium (supplements)	Diarrhea, nausea, abdominal cramping (from non-food sources c
Fluoride	Skeletal and dental fluorosis
Iron	Gastrointestinal distress, organ damage, especially in people wi
Copper	Liver damage, gastrointestinal symptoms
Selenium	Hair and nail brittleness/loss, GI upset, neurological damage (se
Iodine	Thyroid dysfunction (hyper/hypothyroidism), goiter
Zinc	Impaired immune function, copper malabsorption, gastrointestii
Manganese	Neurological symptoms at very high intakes
Molybdenum	Gout-like symptoms, joint pain

- ULs apply to total daily intake from food, water, and supplements unless otherwise specified (e.g., magnesium UL applies only to supplemental forms, not food).
- For some minerals like potassium and sodium, ULs are not set the same way, but Chronic Disease Risk Reduction (CDRR) levels are used instead.
- Risk of toxicity is greatest when supplements are taken in excess, often unintentionally with multivitamins or fortified foods.

Antioxidants

Vitamins and minerals contain compounds known as **antioxidants,** which are substances that help protect the body's cells from damage caused by unstable molecules called **free radicals**. Free radicals are produced naturally in the body during normal metabolic processes, such as when the body breaks down food or is exposed to environmental factors like pollution, radiation, or tobacco smoke. While free radicals are a normal part of cellular activity, an excess of them can cause oxidative stress, which contributes to the aging process and is linked to the development of chronic diseases like cancer, cardiovascular disease, and neurodegenerative conditions. The main function of antioxidants is to neutralize free radicals before they can cause harm to cells and tissues. They do this by donating an electron to the free radicals without becoming unstable themselves, essentially breaking the chain of cellular damage.

Antioxidants are important to healthy nutrition because they support the immune system, help reduce inflammation, and may lower the risk of many chronic diseases. For example, vitamin C aids in immune defense and wound healing, while vitamin E helps protect cell membranes from oxidative damage. A diet rich in antioxidant-containing foods can improve overall health, support recovery from physical stress, and potentially protect against age-related decline in health. Common dietary antioxidants include vitamin C, vitamin E, and beta-carotene (a form of vitamin A), as well as selenium, a trace mineral. Other plant-based compounds, such as **flavonoids** and **polyphenols,** also have antioxidant properties and are found in colorful fruits, vegetables, teas, and whole grains.

In addition to vitamins and minerals, **phytochemicals,** natural compounds found in plants, also act as powerful antioxidants. These include flavonoids, carotenoids, and polyphenols, which are abundant in fruits, vegetables, tea, coffee, whole grains, nuts, and legumes. Phytochemicals help neutralize free radicals and may offer additional health benefits, such as reducing inflammation, supporting the immune system, and lowering the risk of chronic diseases. Although they are not classified as essential nutrients, phytochemicals play a valuable role in maintaining health and are a key reason why plant-rich diets are strongly recommended.

While antioxidant supplements are widely available, most health experts recommend obtaining antioxidants from a balanced diet rich in whole foods rather than relying on high-dose supplements. This is because the body absorbs nutrients better from food sources, and excessive intake of certain antioxidant supplements has been linked to potential health risks. Eating a variety of

fruits, vegetables, nuts, and whole grains is one of the most effective ways to ensure the body receives a full range of antioxidants to promote long-term health. Including a variety of colors in the diet helps ensure a broad range of antioxidants and other health-supportive phytochemicals.

Red (Rich in lycopene and anthocyanins)

- Tomatoes
- Red bell peppers
- Strawberries
- Raspberries
- Cherries
- Red grapes
- Watermelon

Orange (High in beta-carotene and other carotenoids)

- Carrots
- Sweet potatoes
- Butternut squash
- Cantaloupe
- Mangoes
- Apricots
- Pumpkin

Yellow (Contain lutein, zeaxanthin, and flavonoids)

- Corn
- Yellow peppers
- Pineapple
- Yellow squash
- Lemons
- Bananas

Green (Rich in lutein, zeaxanthin, isothiocyanates, and chlorophyll)

- Spinach
- Kale
- Broccoli
- Green tea
- Avocados
- Brussels sprouts
- Green grapes
- Kiwi

Blue/Purple (High in anthocyanins and resveratrol)

- Blueberries
- Blackberries
- Purple grapes
- Plums
- Eggplant (skin)
- Purple cabbage
- Red Wine

White/Brown (Contains allicin and other sulfur-containing compounds)

- Garlic
- Onions
- Cauliflower
- Mushrooms
- Potatoes
- Parsnips
- Coffee
- Tea

Current nutrition recommendations emphasize obtaining antioxidants primarily from whole food sources rather than supplements or fortified processed foods. Whole fruits, vegetables, legumes, nuts, and whole grains provide not only antioxidants like vitamins C and E, selenium, and carotenoids, but also a wide range of beneficial phytochemicals and fiber that work synergistically to support health. Research suggests that antioxidant supplements do not offer the same protective benefits as naturally occurring antioxidants in food, and in some cases, high-dose supplements may even pose health risks. Vitamin supplements and fortified foods do not help a diet based on highly processed foods (CRAP); some may even promote loss of vitamins and minerals from the body. Whole foods also provide a more balanced intake without the potential for excessive or isolated nutrient consumption. Therefore, a diverse, plant-rich diet is considered the most effective and safest way to support the body's antioxidant defenses (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020) [30] (National Institute of Health, 2023). [19]

Question

- Is the antioxidant content in wine, such as resveratrol, enough to justify its health benefits despite the calories and risks associated with alcohol consumption?

Key Vitamins and Minerals to Monitor

Vitamin D, calcium, potassium, and sodium are all essential nutrients of particular concern to overall health in the United States. Most Americans do not consume enough Vitamin D, calcium, or potassium. However, regarding sodium, most Americans consume too much. In Table 8.6.1 and Table 8.6.3, the major functions, sources, and problems associated with deficiency are listed.

Vitamin D is considered a critical nutrient of concern due to the high prevalence of deficiency and its wide-ranging effects on health. Unlike many vitamins, vitamin D is unique because the body can synthesize it through skin exposure to sunlight. However, factors such as limited sun exposure, darker skin pigmentation, aging, and living in northern latitudes can impair this natural production, making dietary intake and supplementation more important. Vitamin D plays a vital role in calcium absorption and bone health, helping to maintain strong bones and prevent conditions such as rickets in children and osteomalacia or osteoporosis in adults. It also contributes to immune system function, inflammation regulation, and may play a role in reducing the risk of certain chronic diseases. Deficiency in vitamin D is common worldwide and is especially concerning in populations with limited sun exposure or low dietary intake. Because symptoms of deficiency can be subtle or delayed, such as fatigue, bone pain, or frequent infections, it is often underdiagnosed, emphasizing the need for public health awareness and appropriate intake recommendations (National Institute of Health, 2024). [20]

Sodium and potassium are two essential minerals that play key roles in maintaining fluid balance, nerve function, and muscle contractions. Their relationship is particularly important in regulating blood pressure. Sodium helps control the amount of fluid in and around cells, and it is a major component of extracellular fluid. Excess consumption can raise blood pressure, contributing to hypertension, an established risk factor for heart attack, stroke, and kidney disease. Potassium, on the other hand, is the principal intracellular electrolyte and works to counterbalance the effects of sodium. A diet high in sodium and low in potassium can lead to water retention, increased blood volume, and elevated blood pressure, which, over time, raises the risk for cardiovascular disease. The DASH (Dietary Approaches to Stop Hypertension) diet emphasizes fruits, vegetables, whole grains, and low-fat dairy, which are rich in potassium, calcium, and magnesium, nutrients that help lower blood pressure by reducing sodium and saturated fat intake while increasing nutrient-dense foods. The DASH diet supports heart health and overall well-being. (See Chapter 9 for details on the DASH diet).

The suggested UL for sodium intake is 2,300 mg per day, but the average intake is closer to 3,500 mg/day. For middle-aged and older adults and African Americans, an even lower intake of 1,500 mg/day is recommended. Potassium has a recommended intake of 4,700 mg per day, but the average intake is only around 2,400 mg for females and 3,200 mg for males. Some strategies for making changes include limiting the amount of salty foods consumed and reading nutritional labels for sodium content. Decreasing processed foods and increasing consumption of whole foods is the healthiest option

Recommendations for Specific Groups

Different life stages, lifestyles, and health conditions can significantly influence a person's nutrient needs. Special populations, such as women of childbearing age, older adults, athletes, and those following restrictive diets, often require tailored dietary strategies to support optimal health. Understanding these unique nutritional needs helps ensure proper nutrient intake to prevent deficiencies. Table 8.6.5 depicts special nutritional recommendations for certain populations, including women of childbearing age, smokers, adults 50 and over, vegetarians, vegans, and athletes participating in high-intensity exercise programs, and the various nutrient recommendations that differ from the DRIs of the average, healthy adult (National Academies of Sciences, Engineering, and Medicine, 2023). [18]

Table 8.6.6: Dietary Reference Intake Adjustments for Special Populations

Population Group	Nutritent(s) of Concern	Recommended Intake / Notes
Women of childbearing age	Folic Acid (Vitamin B9) and Folate	Consume an additional 400-600 µg occurring folate in foods to prevent
	Iron	18 mg/day due to menstrual loss
	Calcium and Vitamin D	Supports bone health and pregnanc
	Iodine	150 µg/day for thyroid and fetal brai
	Choline	25 mg/day; important during pregna
Smokers	Vitamin C	+35 mg/day more than non-smokers
Adults over 50	Vitamin B12	2.4 µg/day from fortified foods/supp
	Calcium	Females: 1,200 mg/day Males: 1,000-1,200 mg/day
	Vitamin D	600–800 IU/day (15–20 µg)
	Fiber	Females: 21 g/day Males: 30 g/day
Vegetarians	Iron	1.8 x RDA (~32 mg/day for premenop
	Vitamin B12	Fortified foods or supplements requ
	Zinc	8–11 mg/day; needs may be higher
	Omega-3 (ALA)	Flaxseeds, walnuts, chia, and fortifie
	Protein	Diverse plant sources to meet amino
Vegans	Vitamin B12	Must supplement or consume fortifi
	Calcium & Vitamin D	Fortified plant milks or supplements
	Iron & Zinc	Same as vegetarians; attention to ab
	Iodine	Use iodized salt or supplements
	Omega-3 (DHA/EPA)	Algal supplements recommended
Athletes (high intensity)	Carbohydrates	5-10 g/kg/day for energy and glycog
	Protein	1.2–2.0 g/kg/day for muscle repair a
	Iron	Increased need, especially in female

Population Group	Nutritent(s) of Concern	Recommended Intake / Notes
	Electrolytes (Na, K, Mg)	Replenish after heavy sweat loss
	Vitamin D & Calcium	Critical for muscle and bone functio
	Water	Before exercise: Drink ~16-20 oz (5 During exercise: Drink every 15-20 n After exercise: Replace fluids based

Supplements

Choosing and using dietary supplements requires careful consideration, especially since supplements are not regulated as strictly as prescription medications. While they can help fill nutrient gaps in the diet, particularly for people with specific deficiencies or increased needs, most healthy individuals can meet their nutritional requirements through food alone. Whole foods offer not only vitamins and minerals but also fiber and beneficial phytochemicals that supplements cannot fully replicate. When supplements are necessary, such as during pregnancy, for vegans, or older adults, they should be selected based on evidence-based recommendations and ideally with guidance from a healthcare provider.

It's also important to be aware of the potential risks of over-supplementation. Taking high doses of certain vitamins or minerals, especially fat-soluble ones like vitamins A, D, E, and K, can lead to toxicity. Interactions with medications, underlying health conditions, or the presence of other nutrients in the diet can affect how a supplement works. Choosing reputable brands that are third-party tested for purity and accuracy in labeling can help reduce risks. Ultimately, supplements should be used to complement, not replace, a balanced, nutrient-rich diet.

Key Points

- Vitamins and minerals are essential micronutrients required in small amounts to support growth, immune function, energy metabolism, bone health, and nearly all physiological processes, although they do not provide calories like macronutrients.
- Inadequate intake of vitamins or minerals can lead to health problems such as anemia, weakened immunity, or bone disorders, while excessive intake, particularly from supplements, can result in toxicity and other harmful effects.
- Vitamins are organic compounds that assist in energy metabolism, tissue growth, and immune defense. They are classified as fat-soluble (A, D, E, and K), which are stored in the body's fat and can accumulate to toxic levels, or water-soluble (B-complex and C), which are excreted in urine and rarely cause toxicity.
- Nutrient intake recommendations are established by Dietary Reference Intakes (DRIs), which include the Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable Upper Intake Level (UL), and Daily Value (DV) used on food labels to guide safe and adequate consumption.
- Most healthy adults can meet their vitamin and mineral needs by consuming a varied diet that includes fruits, vegetables, whole grains, lean proteins, dairy, nuts, and seeds, which also provide fiber and beneficial phytochemicals that supplements cannot replicate.
- Minerals are inorganic nutrients that play critical roles in maintaining healthy bones, supporting nerve transmission, regulating fluid balance, enabling muscle contraction, and transporting oxygen. Major minerals, such as calcium, potassium, magnesium, and sodium, are required in larger amounts, while trace minerals, such as iron, zinc, selenium, and iodine, are needed in smaller quantities but remain essential for health.
- Tolerable Upper Intake Levels (ULs) have been established to indicate safe maximum intakes of vitamins and minerals, as excessive consumption—particularly of fat-soluble vitamins and certain minerals like iron, selenium, and calcium—can result in adverse health effects.
- Vitamins, minerals, and plant-based compounds, such as flavonoids, carotenoids, and polyphenols, act as antioxidants by neutralizing free radicals. These antioxidants help prevent oxidative stress, reduce inflammation, and lower the risk of chronic diseases, supporting long-term health and healthy aging.
- Some nutrients are of particular concern in the United States, where many people do not consume enough vitamin D, calcium, or potassium, while sodium intake is often too high, increasing the risk of hypertension and cardiovascular disease.
- Nutrient needs vary depending on life stage, lifestyle, and health status, including pregnancy, aging, athletic activity, or restrictive diets. While supplements can help fill nutrient gaps in certain cases, whole foods are generally preferred, and excessive supplementation can increase the risk of toxicity.

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8.7: Water



Figure 8.7.1: (Blue and white water splash; Daniel Sinoca via Unsplash)

Introduction

Water is an essential nutrient that plays a vital role in nearly every function of the human body. From regulating body temperature and transporting nutrients to removing waste and lubricating joints, water plays a crucial role in maintaining overall health. Unlike other nutrients, water has no caloric value, but it is just as important, if not more so, than macronutrients and vitamins. Because the body cannot store water in large amounts, it must be replenished regularly through beverages and food. This section examines the significance of water in the diet, the amount of fluid the body requires, factors that impact hydration, and the signs and consequences of dehydration.

Water

Water makes up a significant portion of the human body, at approximately 60% of an adult male's body weight and about 50–55% of an adult female's, due to generally higher fat composition in women. This fluid is distributed across intracellular and extracellular compartments and is essential for nearly every physiological process. Water helps regulate body temperature, cushions organs and joints, transports nutrients and oxygen, and removes waste products through urine, sweat, and feces. Because the body constantly loses water through respiration, perspiration, urination, and bowel movements, it must be replenished daily through fluid intake and water-rich foods. Unlike food, which the body can go without for several weeks, survival without water is limited to just a few days, typically around three to five, depending on the environment and individual health status. Replenishing fluids daily is crucial to maintaining health and preventing dehydration, which can quickly lead to serious complications. Maintaining proper water balance is also critical for preventing dehydration, supporting metabolism, and sustaining cellular function.

Question

- Do you know how long the human body can survive without replenishing water compared to how long it can go without food?
- What does this tell you about the importance of hydration?



Figure 8.7.2: Staying hydrated is an all-day project. (Person holding clear drinking glass; engin akyurt via Unsplash)

Sources of Water

Water needs are met not only through beverages but also from many of the foods we eat. While plain drinking water is the most direct and effective way to stay hydrated, a significant portion of daily water intake can come from nutrient-rich foods. Fruits and vegetables are among the best nutritional sources of water. Foods such as cucumbers, lettuce, celery, zucchini, and radishes are composed of over 90% water. Watermelon, strawberries, oranges, and cantaloupe are also excellent choices that are both hydrating and high in essential vitamins and antioxidants.

In addition to fruits and vegetables, soups and broths made with water-based stock can contribute meaningfully to hydration, especially when low in sodium. Dairy products like milk and yogurt also contain a high water content and offer the added benefits of calcium, protein, and vitamin D. Similarly, fortified plant-based beverages—such as soy or almond milk—can support hydration while also providing key nutrients. While caffeinated beverages like coffee and tea do contribute to fluid intake, they should be consumed in moderation, especially if they contain added sugars or are used in place of water.

Overall, the best nutritional sources of water are those that not only hydrate but also contribute valuable nutrients to the diet. Choosing a variety of water-rich foods along with regular consumption of plain water helps support fluid balance, body temperature regulation, digestion, and the transport of nutrients throughout the body.

Nutritional Goals for Water Intake

Although water is not included on the Nutrition Facts label, it plays a vital role in overall health. Data from 2015 to 2018 show that children and adolescents in the U.S. consumed an average of 23 ounces of plain water per day, while adults averaged 44 ounces. While there is no set guideline for how much plain water should be consumed daily, the Institute of Medicine (IOM) provides recommendations for total daily water intake from all sources, including beverages and food. For men, the recommended total intake is 3.7 liters per day, equivalent to about 125 ounces or 13 cups. For women, the recommendation is 2.7 liters per day, approximately 91 ounces or 9 cups.

Tabe 8.7.1: Recommended Beverages and Beverages to Avoid or Limit

Recommended Options	Beverages to Avoid or Limit
Plain water (primary hydration source)	Sugar-sweetened beverages (e.g., soda, fruit drinks), sweetened tea
Fat-free or low-fat (1%) milk or fortified plant-based milk	Alcohol (limit: ≤1 drink/day women, ≤2 drinks/day men)

Recommended Options	Beverages to Avoid or Limit
100% fruit juice (in moderation) — ≤4 oz/day as part of fruit intake	Low- or no-calorie sweetened beverages (if not beneficial long-term)

Top Beverages in American Diets

- **Plain water (bottled + tap)**: consumed by over 88% of adults and accounts for about half of all beverage volume.
- **Coffee (mostly unsweetened)**: consumed by ~49% of adults daily. In recent years, ~14% of daily beverage volume is coffee.
- **Soda/soft drinks (calorically sweetened)**: consumed by ~46% of adults, making up roughly 10–13% of total beverage intake by volume.
- **Milk (low-fat mostly)**: daily consumption around 20%, accounting for ~4–7% of overall beverage intake.
- **Tea (unsweetened and sweetened**): consumed by ~15% of adults each day; contributes about 5–9% of total beverage intake.
- **Alcoholic beverages**: consumed by about 23% of adults daily and contributes roughly 7–8% of volume intake .
- **Fruit juices (100% fruit or mixed)**: consumed by about 26% of adults; ~2–3% of beverage intake by volume

Question

- How can you tell if you are drinking enough water?
- Do you rarely feel thirsty?

Key Points

- Water is an essential nutrient crucial for nearly all body functions, including temperature regulation, nutrient transport, waste removal, and joint lubrication.
- The human body is composed of 50–60% water, with distribution across intracellular and extracellular compartments.
- Daily water must be replenished through beverages and water-rich foods, as the body cannot store large amounts.
- Fruits, vegetables, dairy, soups, and fortified plant-based beverages are excellent sources of dietary water.
- Recommended total daily water intake is approximately 3.7 liters for men and 2.7 liters for women, including fluids from food and beverages.
- Plain water is the best hydration source, while sugar-sweetened beverages and excessive alcohol should be limited.

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8.8: Understanding Food Labels



Figure 8.8.1: Reading labels is an acquired skill and is important to understanding what is in a product. (Cream-o-land lowfat milk; Shannon VanDenHeuvel via Unsplash)

Introduction

Understanding how to read and interpret food labels is a key skill in making healthier dietary choices. In today's food environment, packaged foods come with detailed labels that provide essential information about calories, nutrients, ingredients, and serving sizes. Learning how to navigate these labels empowers individuals to compare products, manage specific dietary needs, and make informed decisions that support long-term health. This section will explore the components of a food label, explain how to use this information effectively, and highlight recent updates that reflect evolving nutrition science.

Food Labels

Food labels serve as a valuable tool to help consumers better understand the nutritional content of the foods they select. By gaining insight into this information, individuals can make more informed dietary choices that support their overall health and well-being. Over time, nutrition labels have evolved in response to advancing scientific knowledge, updated nutrition research, and public input. The most recent changes to food labeling requirements were introduced in 2016 and were fully implemented in 2020 (U.S. Food and Drug Administration, 2016). [32] Figure 8.8.2 depicts both the original label on the left and the new label on the right. These standardized labels allow for quick and easy comparisons between food products, helping individuals evaluate their options and make decisions based on nutritional value.

Original Label

Nutrition Facts
Serving Size 2/3 cup (55g)
Servings Per Container 8

Amount Per Serving

Calories 230	Calories from Fat 70
	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**12%**
Dietary Fiber 4g	**16%**
Sugars 12g	
Protein 3g	
Vitamin A	10%
Vitamin C	8%
Calcium	20%
Iron	45%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Value may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

New Label

Nutrition Facts
8 servings per container
Serving size **2/3 cup (55g)**

Amount per serving
Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

* The % Daily Value (DV) 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.

Figure 8.8.2: The original nutrition facts label (right) and the new nutritional facts label (left). (Public Domain; FDA via FDA.gov)

Table 8.8.1: Old verses New Nutrition Labels

Line Item	Old Label	New Label
Title	"Nutrition Facts" in extra large size, bold font	"Nutrition Facts" in extra large size, bold font
Line 1	"Serving Size 2/3 cups (55 grams)" in medium size, regular font	"8 Servings Per Container" in large size, regular font
Line 2	"8 Servings Per Container" in medium size, regular font	Serving Size 2/3 Cup (55 Grams) in large size, bold font
Line 3	"Amount Per Serving" in small size, bold font	"Amount Per Serving" in medium size, bold font
Line 4	"Calories" in medium size, bold font, "230" in medium size, regular font (on left side) "Calories from Fat 70" in medium size, regular font (on right side)	"Calories" in extra large size, bold font (on left side) "230" in extra large size, bold font (on right side)
Line 5	"% of Daily Value*" in extra small size, bold font (on right side of line as the title for the items in lines 6-10)	"% of Daily Value*" in small size, bold font (on right side of line as the title for the items in lines 6-10)
Line 6	"Total Fat" in medium size, bold font, "8g" in medium size, regular font (on left) "12%" in medium size, bold font (on right)	"Total Fat" in medium size, bold font, "8g" in medium size, bold (on left) "10%" in medium size, bold font (on right)
Line 7	"Saturated Fat 1g" in medium size, regular font (indented slightly on left side)	"Saturated Fat 1g" in medium font, regular font (indented slightly on left side)
Line 8	"*Trans* Fats 0g" in medium size, regular font (indented slightly on left side)	"*Trans* Fats 0g" in medium size, regular font (indented slightly on left side)

Line Item	Old Label	New Label
Line 9	"Cholesterol" in medium size, bold font, "0mg" in medium size, regular font (on left) "0%" in medium size, bold font (on right)	"Cholesterol" in medium size, bold font, "0mg" in medium size, regular font (on left) "0%" in medium size, bold font (on right)
Line 10	"Sodium" in medium size, bold font, "160mg" in medium size, regular font (on left) "7%" in medium size, bold font (on right)	"Sodium" in medium size, bold font, "160mg" in medium size, regular font (on left) "7%" in medium size, bold font (on right)
Line 11	"Total Carbohydrates" in medium size, bold font and "37g" in medium size, regular font (on left) "12%" in medium size, bold font (on right)	"Total Carbohydrates" in medium size, bold font and "37g" in medium size, regular font (on left) "12%" in medium size, bold font (on right)
Line 12	"Dietary Fiber 4g" in medium size, regular font (slightly indented on left) "16%" in medium size, bold font (on right)	"Dietary Fiber 4g" in medium size, regular font (slightly indented on left) "14%" in medium size, bold font (on right)
Line 13	"Sugars 12g" in medium size, regular font (slightly indented on left)	"Total Sugars 12g" in medium size, regular font (slightly indented on left)
Line 14	No Content	"Includes 10g Added Sugars" in medium size, regular font (slightly more indented on left) "20%" in medium size, bold font (on right)
Line 15	Protein 3g (on left)	Protein 3g
Line 16	Vitamin A (on left) 10% (on right)	"Vitamin D 2mcg" in medium size, regular font (on left side) "10%" in medium size, regular font (on right side)
Line 17	Vitamin C (on left) 8% (on right)	"Calcium 260mg" in medium size, regular font (on left side) "20%" in medium size, regular font (on right side)

Line Item	Old Label	New Label
Line 18	Calcium (on left) 20% (on right)	"Iron 8mg" in medium size, regular font (on left side) "45%" in medium size, regular font (on right side)
Line 19	Iron (on left) 45% (on right)	"Potassium 240mg" in medium size, regular font (on left side) "6%" in medium size, regular font (on right side)
Line 20	* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Value may be higher or lower depending on your calorie needs.	* The % Daily Value (DV) 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
Line 20 - 26 Comprises a table on the old table Line 20: Titles for each column	Column one: Blank Column two: Calories Column three: 2,000 Column four: 2,500	No content
Line 21:	Column one: Total Fat Column two: Less than Column three: 65g Column four: 80g	No content
Line 22	Column one: Sat Fat Column two: Less than Column three: 20g Column four: 25g	No content
Line 23	Column one: Cholesterol Column two: Less than Column three: 300mg Column four: 300mg	No content

Line Item	Old Label	New Label
Line 24	Column one: Sodium Column two: Less than Column three: 2,400mg Column four: 2,400mg	No Content
Line 25	Column one: Total Carbohydrates Column two: Blank Column three: 300g Column four: 375mg	No Content
Line 26	Column one: Dietary Fiber Column two: Blank Column three: 25g Column four: 30g	No Content

Table 8.8.1: Depicts the line-by-line content on both the old and new food labels as is indicated in the example from Figure 8.8.2.

The United States Food and Drug Administration (FDA) developed a new design for the Nutrition Facts labels, based on current scientific evidence linking components of the diet, such as added sugars or saturated fats, to chronic diseases such as obesity and heart disease (U.S. Food and Drug Administration, 2018). [33] The new label is intended to assist consumers in making healthier nutritional choices. This rule required updates such as: inclusion of added sugars, required declaration of vitamin D and potassium, revised serving sizes, and removal of “calories from fat”.

Question

Look at Figure 8.8.2 and compare the original label content (left) with the new label content (right) OR look at Table 8.8.1 and compare the content of the "Old Label" and the "New Label".

- Do you think the new food label makes it easier to understand what you’re eating and how it might affect your health and nutrition choices?

How to Read and Understand Food Labels

Here is how to better understand and break down the information provided in the new Nutritional Facts Label as depicted on the right in Figure 8.8.2:

- Find the nutritional label for a food that you regularly consume or want to eat.
- If you bought something at the grocery store, it likely has a food label on the grocery store's website.
- If you are choosing a food from a restaurant, you can usually find the food label online or use an online database like CalorieKing, MyFitnessPal, Nutritionvalue.org, or try Food Data Central.
- Take a moment to review the Interactive Nutrition Facts Label website to familiarize yourself with the information on the

label.
- Review the food label as you read this section to better apply these instructions.

Servings

At the top of a nutrition label, information is provided about the number of servings per container and the size of each serving. All of the nutritional data listed on the label is based on the stated serving size. It is essential for individuals to first determine how many servings they are consuming, as consuming multiple servings requires multiplying the listed values accordingly. The serving size is intended to reflect the amount of food typically consumed at one time, not necessarily how much a person should eat. Before 2016, many people considered serving sizes on older food labels to be unrealistic. For instance, a 12-ounce can of soda was previously labeled as 1.5 servings, but under the updated labeling guidelines, it is now listed as a single serving.

Question

Evaluate the serving size and number of servings on your food label.

- How many servings do you eat?
- Did the serving size surprise you?

Calories

Following the serving size, the next item listed on a food label is the calorie content. Calories indicate the amount of energy a food or beverage provides. The human body requires this energy to sustain life and maintain normal organ function. Energy from calories supports essential activities such as keeping the heart beating, breathing, digesting food, daily movement, physical activity, and athletic performance. For the recommended calorie intake based on age and sex, refer to the tables in section 8.2.

When examining the calories on a food label about the recommended daily caloric intake, it is important to consider energy balance. Energy balance refers to the relationship between calories consumed through food and beverages and calories expended through daily activities and physical exercise. Consuming more calories than are used throughout the day results in the excess energy being stored as body fat for later use. Conversely, consuming fewer calories than are expended causes the body to use stored fat as an energy source.

Nutrients

This section introduces the composition of food, focusing on the nutrients provided to the body upon consumption. Nutrients are generally categorized into two groups: macronutrients and micronutrients. On food labels, macronutrients are listed first, followed by micronutrients.

Macronutrients include carbohydrates, fats, proteins, and water, while micronutrients consist of vitamins and minerals. When examining food labels, variations in listed nutrients may be observed. Labels are required to display total fat, saturated fat, trans fat, cholesterol, sodium, total carbohydrates, dietary fiber, total sugars, added sugars, protein, vitamin D, calcium, iron, and potassium. Additional nutrients that may appear include monounsaturated fat, polyunsaturated fat, soluble and insoluble fiber, sugar alcohols, various vitamins (such as biotin, choline, folate, niacin, pantothenic acid, riboflavin, thiamin, and vitamins A, B6, B12, C, E, and K), and minerals (including chloride, chromium, copper, iodine, magnesium, manganese, molybdenum, phosphorus, selenium, and zinc).

Nutrients are further classified as essential or nonessential. Essential nutrients must be obtained through diet because the body cannot produce them, while nonessential nutrients can be synthesized by the body and do not necessarily need to be consumed. Among the essential nutrients, fats, carbohydrates, and proteins provide energy (calories). Alcohol also supplies calories, but is not considered an essential nutrient. Other nutrients, although they do not directly provide calories, support the body's energy production and utilization processes.

Percent Daily Value

For each nutrient listed on the food label, the **Percent Daily Value** (%DV) indicates how much that nutrient in a serving

contributes to the total daily recommended intake. This percentage helps to understand the food's role in meeting daily nutritional needs. It is important to note that the %DV values do not add up to 100% because they do not represent the proportion of nutrients within the food itself, but rather how much the food contributes toward the recommended daily intake. For example, if the %DV for sodium is 50%, it means the food provides half of the daily recommended amount of sodium. The %DV makes it easier to compare the nutrient content of different foods.

A practical way to use %DV is to gauge whether a serving of food is low or high in a particular nutrient. Generally, 5% DV or less per serving is considered low, while 20% DV or more per serving is considered high. The %DV values are calculated based on the Dietary Reference Intakes (DRIs), which reflect the latest scientific understanding of nutrient requirements for healthy populations. Some DRIs are expressed as specific amounts, such as grams, while others are based on the proportion of energy they provide within the overall diet. The Acceptable Macronutrient Distribution Ranges (AMDRs) guide the recommended intake of macronutrients, fats, proteins, and carbohydrates, based on the percentage of total daily calories. According to the AMDRs, carbohydrates should provide 45–65% of daily calories, fats should supply 20–35%, and protein should account for 10–35%. These breakdowns can be found in detail in section 8.2.

Lipids (Fats)

The first nutrients listed on the food label are fats. Fats, also known as lipids, are essential for the body, but excessive amounts of both fats and cholesterol can negatively affect health. Fats serve several important functions: they provide energy, supplying 9 calories per gram, making them a high-energy nutrient. Additionally, fats act as long-term energy storage, allowing the body to use stored fat when dietary energy is insufficient.

Beyond energy, fats are necessary for various bodily functions, including the synthesis of cell membranes, supporting growth and development, maintaining healthy skin and hair, aiding blood clotting, supporting nervous system function, reproduction, immune response, and facilitating the absorption of fat-soluble vitamins (A, D, E, and K). Fats also enhance the taste of food and promote satiety. They are present in foods from both plant and animal sources.

The food label lists several types of fats that may be present in foods: saturated fats, trans fats, and unsaturated fats.

Saturated fats are found in higher amounts in animal products and are usually solid at room temperature. Common sources include animal fats, baked goods, condiments, gravies, dairy products (such as whole and 2% reduced-fat milk), desserts, meats and poultry (including processed varieties), pizza, salad dressings, sandwiches, snack foods, spreads, sweets, tropical plant oils, and vegetable shortening.

Trans fats can be natural or artificial. Small amounts of natural trans fats occur in dairy products, beef, and lamb. Artificial trans fats, typically found in foods containing hydrogenated oils, have been largely removed from the food supply since 2018 due to their harmful health effects. These artificial trans fats were previously common in baked goods, coffee creamers, ready-to-use frostings, snack foods, and stick margarines.

Unsaturated fats are divided into monounsaturated and polyunsaturated fats on the food label. These fats are more abundant in plant-based sources and are usually liquid at room temperature. Common sources include avocados, fish, mayonnaise, and oil-based salad dressings, nuts, olives, seeds, soft margarines, and various vegetable oils.

Cholesterol

On a food label, cholesterol refers to the amount of cholesterol present in a serving of the food. Cholesterol is a type of fat-like substance found in animal-based foods such as meat, dairy products, eggs, and seafood. The body also produces cholesterol naturally, which is essential for building cell membranes, producing hormones, and supporting other vital functions. However, consuming high amounts of dietary cholesterol can contribute to increased blood cholesterol levels in some individuals, potentially raising the risk of heart disease. Therefore, the cholesterol content on a food label helps consumers monitor their intake and make informed dietary choices to support heart health. Cholesterol is often viewed negatively, but it is not always harmful. The body, particularly the liver, produces cholesterol because it is necessary for building cell membranes and assisting in the synthesis of vital substances such as steroid hormones, bile acids, and vitamin D.

Evidence indicates that diets high in saturated fat and trans fat are linked to increased levels of total cholesterol and low-density lipoprotein (LDL or "bad") cholesterol, which are associated with a higher risk of developing cardiovascular disease. Cardiovascular disease remains the leading cause of death for both men and women in the U.S. According to the Dietary Guidelines for Americans, many foods high in dietary cholesterol also tend to be high in saturated fat. Since diets rich in saturated

fat are connected to an increased risk of cardiovascular disease, it is recommended to limit dietary cholesterol intake while maintaining a healthy diet. Due to the relationship between saturated fats and elevated LDL levels, the Dietary Guidelines advise consuming less than 10% of daily calories from saturated fat.



Figure 8.8.3: Some foods don't come with a label, but could have large amounts of cholesterol, sodium, and sugar. (Brown and white cupcakes; Jeswin Thomas via Unsplash)

Question

Evaluate the fats on your food label.

- What does the food label tell you about the fats you are consuming?
- Is this a high or low-fat food?
- What types of fats are in the food item?
- Would you consider this to be a good source of fat?
- How much does this food item contribute to the AMDR for fat?

Tips for Consuming Fats

- It is important to pay attention to the % Daily Value (%DV) of fats on food labels, particularly saturated and trans fats.
- Observing the total %DV for fats can help individuals stay within the Acceptable Macronutrient Distribution Range (AMDR), which recommends consuming 20-35% of calories from fats.
- Replacing saturated fats with unsaturated fats when possible is advised, while artificial trans fats should be avoided.
- Choosing lean cuts of meat and poultry, trimming or draining fat before or after cooking, and removing poultry skin before eating can reduce fat intake.
- Incorporating seafood and plant-based protein sources, such as soy products and unsalted nuts and seeds, can serve as alternatives to some meats and poultry.
- Substituting whole and 2% reduced-fat dairy products with fat-free or 1% low-fat dairy or fortified plant-based beverages (e.g., soy, rice, almond milk) is recommended.
- Using liquid oils like canola and olive oil for cooking and baking instead of solid fats such as butter, lard, or shortening supports healthier fat intake.
- Cooking methods such as baking, broiling, grilling, and steaming are preferred since they do not add extra fat.
- Limiting consumption of baked goods, desserts, fried fast foods, and snack foods helps control unhealthy fat intake.
- When dining out, individuals should inquire about the types of fats used in meal preparation and request nutrition information when available to make informed choices.

Sodium

Although the terms “sodium” and “salt” are often used interchangeably, sodium is a mineral found in salt. It is an essential nutrient required by the human body for key functions such as maintaining fluid balance, supporting muscle contractions, and enabling proper nervous system activity. However, excessive sodium intake is linked to an increased risk of high blood pressure, which in turn raises the likelihood of heart attacks, heart failure, stroke, kidney disease, and vision loss. Sodium primarily enters the diet through the consumption of food. Research indicates that the majority of sodium in the average diet comes from packaged or prepared foods, including restaurant and fast-food meals. In addition to enhancing the flavor of food, sodium is often used to cure meats and preserve perishable items.

The Dietary Guidelines for Americans recommend limiting sodium intake to less than 2,300 milligrams (mg) per day, which is roughly equivalent to one teaspoon of salt. However, most Americans consume approximately 3,400 mg of sodium daily, well above the recommended level. To assess sodium intake, individuals can examine the Nutrition Facts label on food packaging. A food that provides more than 20% of the Daily Value (%DV) for sodium per serving is considered a high source, while a food providing less than 5% DV is considered a low source.



Figure 8.8.4: Fries being salted by sprinkling table salt. (Person sprinkling salt on fries; Emmy Smith via Unsplash)

Question

Evaluate the Sodium on your food label.

- What does the food label tell you about the sodium you are consuming?
- Is this a high or low-sodium food?

Tips for Consuming Sodium

- Select packaged foods labeled as “light,” “low sodium,” “reduced sodium,” or “no-salt-added.”
- Prepare meals at home when possible to better control sodium content and limit the use of packaged sauces and flavored products such as rice and pasta mixes or instant noodles.
- Season foods with herbs, spices, or no-salt seasoning blends instead of adding salt during cooking, baking, or at the table.
- Choose fresh meats, poultry, and seafood rather than processed varieties. Check the packaging to see if fresh meats or poultry have been enhanced with saltwater or saline solutions.
- Purchase fresh, frozen (without sauces or seasoning), low-sodium, or no-salt-added canned vegetables.
- Rinse sodium-containing canned foods—such as beans, tuna, and vegetables—under water before consuming to reduce sodium content.
- Use light or reduced-sodium condiments, and consider using oil and vinegar for salads instead of bottled dressings. Use only

part of the flavoring packets when preparing packaged foods.
- Choose low-sodium or no-salt-added varieties of snack foods like nuts, seeds, chips, and pretzels—or opt for fresh alternatives like carrot and celery sticks.
- Limit portion sizes or frequency of foods and beverages high in sodium.
- When dining out, request meals prepared without added salt, and ask for sauces or dressings on the side to help control the amount used. Request nutrition information, if available, to make informed, lower-sodium choices.

Carbohydrates (Starches, Fiber, and Sugar)

Carbohydrates, often referred to as "carbs," are listed next on the Nutrition Facts label. They are one of the body's main types of nutrients and serve as the most important source of energy. Each gram of carbohydrate provides 4 calories, which is less than half the amount of energy provided by one gram of fat. Carbohydrates are the body's primary energy source, supplying fuel to cells, tissues, and organs—especially the brain and muscles. When carbohydrates are consumed, the body breaks them down into glucose, a simple sugar that enters the bloodstream and provides immediate energy. If the glucose is not used right away, it is stored in the liver and muscles for future use.

Question

How many teaspoons of sugar would you need to scoop into a glass to equal the amount of sugar in a Frappuccino?

- Based on the nutritional information, a Grande Caramel Frappuccino® Blended Beverage has 54 grams of sugar.
- To help you solve this challenge, you first need to know that one teaspoon of sugar equals 4 grams of sugar.
- You would need to scoop 13.5 teaspoons of sugar into a glass to equal the amount of sugar in a Grande Frappuccino.

The *Dietary Guidelines for Americans* recommend limiting calories from added sugars to less than 10% of total calories per day. If you are on a 2,000-calorie diet, this would mean less than 50 grams per day of added sugars per day, which is less than one Caramel Frappuccino from Starbucks.

On the food label, the total carbohydrate content is listed, along with a breakdown into dietary fiber and sugars. Carbohydrates are composed of three components: fiber, starch, and sugars. Fiber and starch are classified as complex carbohydrates, while sugars are considered simple carbohydrates. Complex carbohydrates provide more nutrients, are digested more slowly, and contribute to satiety, making them a healthier option compared to simple carbohydrates.

Question

Evaluate the carbohydrates on your food label.

- What does the food label tell you about the carbs you are consuming?
- Is this a high or low-carb food?
- What types of carbs are in the food item, and are they processed/refined?
- Would you consider this to be a good source of carbs?
- How much does this food item contribute to the AMDR for carbs?

Tips for Consuming Carbohydrates

- Use the Nutrition Facts label to determine whether a food is high or low in carbohydrates based on the Percent Daily Value (%DV).
- Note the total %DV for carbohydrates to help meet the Acceptable Macronutrient Distribution Range (AMDR), which recommends 45–65% of daily calories come from carbohydrates.
- Choose more whole grains such as brown rice, bulgur, couscous, and quinoa.
- Select whole-grain versions of commonly consumed foods like bread, cereal, pasta, and rice.
- Look for options lower in added sugars, saturated fats, and sodium, such as bread instead of croissants, English muffins instead of biscuits, or plain popcorn instead of buttered
- Choose whole fruits (fresh, frozen, dried, or canned in 100% juice) as snacks and desserts. Use fruit as toppings for foods

like cereal, yogurt, oatmeal, and pancakes.
- Keep raw, cut-up vegetables on hand for easy snacks—prioritize colorful vegetables like broccoli florets, carrots, and red peppers.
- Add beans, peas, or unsalted nuts and seeds to salads, soups, and side dishes for extra fiber and protein.
- Select unsweetened or no-sugar-added fruit products (e.g., applesauce) and choose plain, fat-free, or 1% low-fat yogurt.
- Choose beverages like water and fat-free or 1% low-fat milk more often.
- Limit consumption of high-calorie beverages with few nutrients, such as energy drinks, fruit drinks, soft drinks, and sports drinks.
- Reduce portion sizes of foods and beverages high in added sugars, or consume them less frequently.



Figure 8.8.5: (Hamburger with vegetables and meats; Haseeb Jamil via Unsplash)

Protein

The human body requires protein from food sources to supply energy (calories) and to build, maintain, and repair bones, muscles, skin, and other tissues. Protein is present in every cell and nearly all bodily fluids. It plays a crucial role in various body processes, including blood clotting, fluid balance, immune function, vision, and the production of hormones, antibodies, and enzymes. Most individuals in the United States consume adequate amounts of protein to meet their nutritional needs. Like carbohydrates, protein provides 4 Calories of energy per gram. Protein is found in both plant-based and animal-based foods. Common dietary sources include meat, dairy products, nuts, beans, and certain grains.

Proteins are made up of smaller building blocks called amino acids. 20 different amino acids can be combined in different ways to form all of the proteins used by the body. Of these 20 amino acids, 9 are considered essential, meaning they must be obtained through food because the body cannot produce them. The remaining 11 are classified as non-essential, as the body is capable of synthesizing them. A protein that contains all 9 essential amino acids in adequate amounts is known as a complete protein. Complete proteins are primarily found in animal-based foods such as meat, poultry, seafood, dairy products, and eggs. Soy is a notable exception, as it is a plant-based food that also provides complete protein.

Incomplete proteins are foods that lack one or more of the essential amino acids or do not contain enough of one to meet the body's needs. Most plant-based foods—such as grains, legumes (beans, peas, and lentils), nuts, seeds, and vegetables—are incomplete protein sources. However, by combining certain plant-based foods that complement each other's amino acid profiles, individuals can create what are known as complementary proteins. For example, grains are typically low in the amino acid lysine, while legumes are low in methionine. When eaten together—such as rice with beans or peanut butter on whole grain bread—these combinations provide all essential amino acids and form a complete protein.

Question

Evaluate the Proteins on your food label.

- What does the food label tell you about the protein you are consuming?
- Is this a high or low-protein food?
- What types of protein are in the food item, plant or animal sources?
- Would you consider this to be a good source of protein?
- How much does this food item contribute to the AMDR for protein?

Tips for Consuming Protein

- The Daily Value (DV) for protein is 50 grams per day, based on a 2,000-calorie diet. Individual protein needs may vary depending on total calorie requirements.
- The %DV on a Nutrition Facts label can help determine whether a food is high or low in protein.
- Paying attention to the total %DV for protein can support individuals in meeting the Acceptable Macronutrient Distribution Range (AMDR), which recommends that 10–35% of daily calories come from protein.
- A varied intake of protein-rich foods is encouraged. Examples include beans and peas, eggs, fat-free or 1% low-fat dairy products, lean meats and poultry, seafood, soy products, and unsalted nuts and seeds.
- Replacing some meat and poultry with seafood or plant-based sources of protein—such as tofu, legumes, and unsalted nuts—can improve overall dietary quality.
- Beans and peas may be added to salads, soups, and side dishes, or served as a main entrée.
- Substituting whole and 2% reduced-fat dairy products with fat-free or 1% low-fat dairy options and fortified plant-based beverages (e.g., soy, almond, rice milk) helps reduce saturated fat intake.
- Choosing fresh meats, poultry, and seafood rather than processed versions can reduce sodium and saturated fat intake.
- Trimming or draining visible fat from meats and removing poultry skin before eating reduces overall fat content.
- Using cooking methods such as baking, broiling, grilling, or steaming helps avoid the addition of unnecessary fats during meal preparation.

Vitamins and Minerals

At the bottom of the Nutrition Facts label, select vitamins and minerals are listed. Both vitamins and minerals play essential roles in maintaining health. Each nutrient contributes uniquely to the proper functioning of the body, and a balanced intake of these nutrients is important for overall well-being. While most Americans meet the recommended intake for many vitamins and minerals, there are several that are commonly under-consumed. Vitamin D, calcium, iron, and potassium are considered “nutrients of public health concern” because insufficient intake is linked to potential health risks. Vitamins are organic compounds naturally found in various plant and animal foods. In contrast, minerals are inorganic elements found in soil and water, which are absorbed by plants and consumed by animals, making their way into the human diet.



Figure 8.8.6: (Sliced vegetables and fruits on black ceramic; Frames For Your Heart via Unsplash)

There are 14 vitamins and 14 minerals that may be listed on food labels. These include:

Vitamins:

- Commonly listed vitamins include vitamins A, C, D, E, K, and the B-complex group (thiamine, riboflavin, niacin, pantothenic acid, biotin, B6, B12, and folate).
- Water-soluble vitamins include vitamin C and the B vitamins.
- Fat-soluble vitamins include vitamins A, D, E, and K.
- Most vitamins are essential, meaning they must be obtained through the diet, although the body can produce small amounts of some vitamins, such as vitamin D, choline, and biotin.

Minerals:

- Key minerals that may appear on food labels include calcium, chloride, chromium, copper, iodine, iron, magnesium, manganese, molybdenum, phosphorus, potassium, selenium, sodium, and zinc.

Question

- Evaluate the Vitamins and Minerals on your food label.
- What does the food label tell you about the vitamins and minerals you are consuming?
- Does this food item contribute a lot or a little to the essential vitamins and minerals?
- What types of vitamins and Minerals are in the food item?
- Would you consider this to be a good source of vitamins and minerals?

Tips for Consuming Vitamins and Minerals

- Look at your food label to understand how the food you are eating is providing you with vitamins and minerals, especially focusing on Vitamin D, Iron, Calcium, and Potassium. What percentage of your Daily Value does the food provide?
- Eat a variety of colorful vegetables (such as fresh, frozen, canned, and dried) and 100% vegetable juices. Buy frozen (without butter or sauce) and low-sodium or no-salt-added canned vegetables. Try vegetables as snacks, salads, side dishes, and as part of main dishes.
- Focus on whole fruits (such as fresh, frozen, dried, and canned in 100% fruit juice). Try fruits as snacks and desserts, and add fruits to salads, side dishes, and to top foods like cereal, pancakes, and yogurt.
- Make at least half your grains whole grains. Look for foods with a whole grain listed as the first or second ingredient after water. Try whole grains (such as brown rice, couscous, and quinoa) as side dishes and switch from refined to whole grain versions of commonly consumed foods (such as breads, cereals, pasta, and rice).

- Vary your protein routine. Try beans and peas, fat-free or 1% low-fat dairy products, eggs, lean meats and poultry, seafood, soy products, nuts, and seeds. Choose seafood and plant sources of protein (such as beans and soy products) in place of some meats and poultry. Add beans or peas to salads, soups, and side dishes, and try unsalted nuts or seeds as snacks.
- Substitute fat-free or 1% low-fat dairy products and fortified plant-based beverages (such as soy, rice, and almond) for whole and 2% reduced-fat dairy products.

Ingredient List

The final section of the Nutrition Facts label is the ingredient list. This section provides insight into the specific components of the food product. Ingredients are listed in descending order by weight, meaning the items appearing first are present in the largest amounts. For instance, if sugar is one of the first ingredients listed, it indicates that the product is likely high in sugar.

For individuals aiming to consume more whole grains, it is helpful to look for ingredients such as *whole grain*, *whole wheat*, or *whole oat* listed among the first few items. In contrast, if the first ingredients include refined grains, various types of sugar, or hydrogenated oils, the product is likely to be less nutritious. Becoming familiar with the different names used for common ingredients, especially added sugars, can help consumers make more informed decisions. Added sugars may appear under many different names, including:

- Types of sugar: beet sugar, brown sugar, buttered sugar, cane sugar, caster sugar, coconut sugar, date sugar, golden sugar, invert sugar, muscovado sugar, organic raw sugar, raspadura sugar, evaporated cane juice, and confectioner's sugar.
- Types of syrup: carob syrup, golden syrup, high-fructose corn syrup, honey, agave nectar, malt syrup, maple syrup, oat syrup, rice bran syrup, and rice syrup.
- Other added sugars: barley malt, molasses, cane juice crystals, lactose, corn sweetener, crystalline fructose, dextran, malt powder, ethyl maltol, fructose, fruit juice concentrate, galactose, glucose, disaccharides, maltodextrin, and maltose.

By reviewing ingredient lists and recognizing these terms, individuals can better evaluate the nutritional quality of packaged foods.

Question

Evaluate the ingredient list on your food label.

- What are the first five ingredients listed?
  - Knowing that the ingredients are listed in order from most to least, what do the ingredients tell you about the food item?
- Are there ingredients listed that you are not familiar with?
  - If so, take a few minutes to look up the ingredient to identify what it is.

Organic and GMO (bioengineered)

When reviewing food packages, consumers may also encounter statements such as "organic" or "Non-GMO." Understanding the meaning of these labels can help individuals make more informed food choices.



Figure 8.8.7: (Red strawberries in brown box; Eduardo Sánchez via Unsplash)

Organic Labeling

Organic products must be produced using agricultural production practices that foster resource cycling, promote ecological balance, maintain and improve soil and water quality, minimize the use of synthetic materials, and conserve biodiversity.

There are four organic labels:

100 Percent Organic

- Used to label any product that contains 100 percent organic ingredients (excluding salt and water, which are considered natural)
- Most raw, unprocessed, or minimally processed farm crops can be labeled "100 percent organic."

Organic

- Any product that contains a minimum of 95 percent organic ingredients (excluding salt and water).
- Up to 5 percent of ingredients may be nonorganic agricultural products and/or nonagricultural products on the National List (nonorganic agricultural products and several nonagricultural products on the National List may only be used if they are not commercially available as organic)

Made with Organic _____

- Product contains at least 70 percent organically produced ingredients (excluding salt and water), with several detailed constraints regarding ingredients that comprise the nonorganic portion.

Specific Organic Ingredient Listings

- Specific organic ingredients may be listed in the ingredient statement of products containing less than 70 percent organic content, for example, "Ingredients: water, barley, beans, organic tomatoes, salt." (U.S. Department of Agriculture, n.d.). [29]

Genetically Modified Foods (Bioengineered)

The terms "Bioengineering," "Genetically Modified Organism," "GMO," and "Genetic Engineering" are often used interchangeably for marketing purposes, but "Bioengineered" is the appropriate term under the law. The National Bioengineered Food Disclosure Law, passed by Congress in July of 2016, directed the USDA to establish a national mandatory standard for disclosing foods that are or may be bioengineered. The standard defines bioengineered foods as those that contain detectable genetic material that has been modified through certain lab techniques and cannot be created through conventional breeding or found in nature.

More to Explore

- Curious what types of food are genetically modified or bioengineered?
  - Check out this List of bioengineered foods

Key Points

- Understanding food labels helps individuals make informed dietary choices, compare products, and manage specific nutrition needs.
- Nutrition Facts labels have evolved, with the latest updates fully implemented in 2020, reflecting current scientific evidence.
- The new label includes added sugars, revised serving sizes, vitamin D, and potassium, and removes “calories from fat” to improve clarity.
- Calories indicate the energy a food provides, which supports body functions and energy balance.
- Nutrients are categorized as macronutrients (carbs, fats, proteins) and micronutrients (vitamins, minerals), some essential and some nonessential.
- Percent Daily Value (%DV) shows how a serving contributes to daily nutritional requirements, helping identify high or low nutrient content.
- Fats are listed first; saturated and trans fats should be limited, while unsaturated fats are healthier and support bodily functions.
- Sodium, if consumed in excess, increases the risk of high blood pressure and cardiovascular disease; checking %DV helps manage intake.
- Protein provides energy, supports tissue repair, and includes essential amino acids; combining plant-based foods can form complete proteins.
- The ingredient list, organic, and bioengineered (GMO) labels help consumers assess food quality, nutrient content, and production practices.

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8.9: Nutrition and Physical Activity



Figure 8.9.1: Hydration and nutrition are essential for athletic performance at high levels. (Man Drinking; Mina Rad on Unsplash)

Introduction

A healthy diet and proper intake of essential nutrients are critical for physical activity performance. This section will include a brief overview of the literature regarding the importance of adequate hydration and consumption of carbohydrates, proteins, and fats for optimal physical activity.

As previously discussed, water is an essential nutrient that plays a central role in both health and physical performance. It supports temperature regulation, cardiovascular function, nutrient transport, joint lubrication, and metabolic processes. During physical activity, these functions are placed under greater demand, making hydration a key component of nutrition for active individuals.

Total body water typically accounts for about 60% of body weight in males and about 50% in females, with differences largely reflecting variations in lean body mass (Rawson et al, 2026). [21] Hydration needs vary considerably among individuals and are influenced by body size, habitual diet, physical activity level, and environmental conditions.

General daily fluid intake recommendations for healthy adults (ages 19 and older) are approximately 3.7 liters per day for males and 2.7 liters per day for females under typical environmental conditions. These values represent baseline intake requirements and do not account for additional losses associated with exercise, heat exposure, or high sweat rates. (National Academies of Sciences, Engineering, and Medicine, 2005). [17] Importantly, these values represent total water intake, which includes fluids consumed as beverages as well as water obtained from foods.

These recommendations are intended for generally healthy populations under normal living conditions and do not account for additional fluid losses that occur with exercise, heat exposure, or high sweat rates. As a result, physically active individuals often require substantially more fluid intake than these baseline values.

Fluid Loss During Exercise

Exercise increases metabolic heat production, and the body relies primarily on sweating and evaporation to regulate internal temperature. Sweat rates vary widely among individuals and are influenced by factors such as exercise intensity, environmental conditions, clothing, acclimatization status, and individual physiology (Sawka et al., 2007). [24] During prolonged or high-intensity exercise, particularly in warm or humid environments, sweat losses can be substantial and may exceed 2–3 liters per hour in some

individuals (Sawka et al., 2007). [24] When fluid intake does not adequately replace these losses, a state of dehydration develops.

Even mild dehydration can negatively affect exercise performance and physiological function. Decreases in body water are associated with reduced endurance capacity, increased cardiovascular strain, elevated core temperature, greater perceived exertion, and impaired cognitive performance (Sawka et al., 2007). [24] As dehydration becomes more severe, these effects intensify and can contribute to a higher risk of heat-related illness, particularly during prolonged exercise in hot environments (Roberts et al., 2023). [22]

In addition to water loss, sweating also results in the loss of electrolytes, particularly sodium. Electrolytes play a critical role in maintaining fluid balance, supporting nerve transmission, and enabling muscle contraction (Sawka et al., 2007). [24] Significant electrolyte losses without adequate replacement may contribute to fatigue, performance decrements, and, in extreme cases, disturbances in fluid balance (Roberts et al., 2023). [22]

More recent expert consensus emphasizes that hydration management should consider both the risks of dehydration and overhydration. Excessive fluid intake without sufficient electrolyte replacement may lead to exercise-associated **hyponatremia**, a potentially dangerous condition characterized by low blood sodium levels (Roberts et al., 2023). [22]

Hydration, Electrolytes, and Performance

Carbohydrate-electrolyte beverages are commonly used during exercise because they replace both fluids and key electrolytes while also providing energy. Commercial sports drinks, such as Gatorade, are designed to support hydration and maintain performance during prolonged activity.

Research consistently shows that appropriate fluid intake during exercise helps maintain blood volume, supports thermoregulation, and delays fatigue. Both water and carbohydrate-electrolyte beverages can be effective, with the optimal choice depending on exercise duration, intensity, and environmental conditions.

Hydration Planning for Physical Activity

Hydration is one of the most important and most individualized components of sports nutrition. Because sweat rates, environmental conditions, and exercise demands vary widely, effective hydration cannot rely on a single universal guideline. Instead, athletes and physically active individuals should use evidence-based principles to plan, monitor, and adjust fluid intake before, during, and after exercise (Sawka et al., 2007) [24] (Roberts et al., 2023). [22]

ACSM Hydration Principles

To support performance and safety, the American College of Sports Medicine recommends the following fluid replacement strategies:

- Begin exercise in a well-hydrated state.
- Drink fluids regularly during exercise, especially during prolonged activity.
- Use small, frequent fluid intake to improve comfort and absorption.
- Consider carbohydrate-electrolyte beverages during prolonged exercise (generally >60 minutes).
- Replace fluids after exercise to restore normal hydration status and body mass.

These strategies are designed to maintain performance while reducing physiological strain associated with dehydration.

Balancing Hydration and Safety

Current ACSM expert consensus also emphasizes that hydration must balance two risks:

- **Dehydration**, which can impair performance, reduce thermoregulation, and increase cardiovascular strain
- **Overhydration**, which can dilute blood sodium levels and lead to **exercise-associated hyponatremia**, a potentially serious condition (Roberts et al., 2023). [22]

This means athletes should avoid both insufficient fluid intake and excessive fluid consumption, especially during long-duration endurance events.

Practical Hydration Monitoring Tools

Fluid needs are highly individualized, so any individual or athlete can use simple, practical tools to guide hydration decisions:

- Body mass changes: A decrease in body weight before and after exercise typically reflects fluid loss
- Urine color: A general indicator of hydration status (lighter color typically reflects better hydration)
- Thirst: A useful but imperfect internal cue
- Symptoms: Watch for dizziness, headache, fatigue, or declining performance

Applied Hydration Strategy (Three Phases)

Before exercise: Begin activity well hydrated by consuming fluids in the hours leading up to exercise to establish a normal fluid balance.

During exercise: Replace fluids at regular intervals based on sweat rate, exercise intensity, environmental conditions, and individual tolerance. Carbohydrate-electrolyte beverages may be beneficial during prolonged or high-intensity activity.

After exercise: Restore fluid and electrolyte balance by replacing losses until body weight and hydration status return to baseline. Sodium-containing foods or beverages can enhance rehydration.

Energy Intake and Physical Activity

Adequate energy intake is fundamental to supporting both basic physiological function and the demands of physical activity. Energy balance, or the relationship between energy consumed through food and energy expended through metabolism and activity, plays a central role in maintaining health, supporting recovery, and optimizing performance. When energy intake is appropriately distributed among macronutrients (carbohydrates, proteins, and fats), individuals are better able to support body composition goals and sustain physical activity across a range of intensities (Thomas et al., 2016). [26]

Macronutrient Distribution

For generally healthy adults, the acceptable macronutrient distribution ranges (AMDR) guide balanced energy intake:

- **Carbohydrates:** 45–65% of total energy intake
- **Fats:** 20–35% of total energy intake
- **Protein:** 10–35% of total energy intake (National Academies of Sciences, Engineering, and Medicine, 2005) [17]

These ranges are intended for the general population and should be adjusted based on individual goals, training demands, and overall health status. Physically active individuals often modify macronutrient intake to better support exercise performance, recovery, and training adaptations.

Carbohydrates and Physical Activity

Carbohydrates are the body's primary and most readily available fuel source for both aerobic and anaerobic exercise. They play a critical role in supporting brain function and high-intensity physical activity due to their efficient metabolic pathways and rapid energy availability (Burke et al, 2011) [4] (Thomas et al, 2016). [26]

Metabolic pathways for carbohydrates are very efficient, and the body utilizes carbohydrates as a fuel for both anaerobic (e.g., intermittent high-intensity exercises) and aerobic exercise (e.g., endurance races) (Rawson et al, 2026). [21] During moderate to high-intensity exercise, carbohydrates are the preferred fuel source because they can be metabolized quickly to meet energy demands. As a result, carbohydrate intake is an important consideration before, during, and after exercise to support performance and glycogen restoration. Recommendations for athletes indicate that up to 50-60% of the diet may be derived

from carbohydrates (Rawson et al, 2026). [21] However, adhering to a carbohydrate-rich diet may result in decreased intake of important macronutrients such as proteins or fats; therefore, monitoring and adapting dietary habits may be necessary.

In physically active individuals, carbohydrate intake is often increased to match training demands. Rather than focusing on a single percentage, current sports nutrition guidelines emphasize aligning carbohydrate intake with training load, duration, and intensity (Thomas et al, 2016). [26]

Protein and Physical Activity

Protein plays a minimal role as a direct energy source under normal dietary conditions. Instead, it is primarily responsible for tissue repair, muscle protein synthesis, enzyme production, immune function, and structural maintenance of cells.

During prolonged endurance exercise or periods of low carbohydrate availability, small amounts of protein may contribute to energy production; however, this is not its primary function (Thomas et al, 2016). [26] Under normal conditions, the body prioritizes carbohydrates and fats for energy use and conserves protein for essential physiological processes. It is crucial to note that protein is usually utilized as a fuel source only when carbohydrate and fat stores are depleted (i.e., starvation). The body is best served by preserving protein for essential functions (i.e., cell signaling, maintenance of muscle and cell structure, etc.).

For physically active individuals, protein intake becomes particularly important for recovery and adaptation to training. The general Recommended Dietary Allowance (RDA) for adults is approximately 0.8 g/kg/day, which is sufficient to prevent deficiency but may not fully support athletic training adaptations. Current sports nutrition research suggests that higher intakes, approximately 1.6–2.2 g/kg/day, may better support strength development, muscle protein synthesis, and recovery in resistance-trained individuals (Jäger et al, 2017) [10] (Thomas et al, 2016). [26]

Fats and Physical Activity

Dietary fat serves as a major energy source at rest and during low- to moderate-intensity exercise. Fat metabolism is slower than carbohydrate metabolism but provides a large energy yield, making it particularly important for prolonged, lower-intensity activity and overall energy balance.

Fats also play essential roles in hormone production, cellular structure, and the absorption of fat-soluble vitamins. For the general population, fats should contribute approximately 20–35% of total daily energy intake (National Academies of Sciences, Engineering, and Medicine, 2005). [17] This range also supports athletic populations, although specific dietary strategies may vary depending on training goals and sport demands.

Integrating Energy Intake for Physical Activity

Optimal nutrition for physical activity is not defined by a single macronutrient or fixed percentage distribution, but rather by a balanced and individualized approach. Carbohydrates primarily support exercise performance, protein supports recovery and adaptation, and fats contribute to long-term energy availability and physiological function. Together, these macronutrients work synergistically to support health, training, and performance outcomes in physically active individuals.

More to Explore

Further information describing the interplay between nutrition and physical activity is available within the **ACSM Position Stand: Nutrition and Athletic Performance**.

Key Points

- Optimal hydration is not about drinking more or less fluid; it is about drinking appropriately for the individual and the conditions. Effective hydration planning supports performance, reduces fatigue, and helps prevent both dehydration and overhydration-related complications.
- Adequate hydration and energy intake are essential for supporting physiological function, exercise performance, recovery,

and overall health.

- Daily fluid needs vary by individual, but general Adequate Intake levels are approximately 3.7 L/day for males and 2.7 L/day for females, with higher needs for physically active individuals.
- Exercise increases fluid loss through sweating, which can exceed 2–3 liters per hour in some conditions, making individualized hydration strategies necessary.
- Both dehydration and overhydration negatively impact performance and health; excessive fluid intake without adequate sodium replacement may lead to exercise-associated hyponatremia.
- Carbohydrates are the primary fuel source for moderate- to high-intensity exercise and should be matched to training demands to support performance and glycogen restoration.
- Protein supports muscle repair, recovery, and adaptation, with higher needs for active individuals (approximately 1.6–2.2 g/kg/day for resistance training goals) compared to the general RDA.
- Dietary fats provide energy at rest and during lower-intensity exercise while also supporting hormone production, cell function, and vitamin absorption.
- Optimal nutrition for physical activity requires an individualized, balanced approach in which carbohydrates, proteins, fats, and fluids work together to support performance, recovery, and health outcomes.

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8.10: Comprehension Check

Summary

Nutrition relies on three essential nutrient groups: macronutrients, micronutrients, and water. Macronutrients, carbohydrates, proteins, and fats, supply energy and build tissues, while micronutrients (vitamins and minerals) regulate key body processes. Water, though calorie-free, is vital for nearly every function.

Carbohydrates are the body's main fuel, best obtained from whole foods rich in fiber, which supports digestion and lowers disease risk. Proteins, made of amino acids, repair and maintain tissues; complete sources include meat, eggs, soy, and quinoa, while varied plant proteins can also meet needs. Fats provide energy, aid vitamin absorption, and support hormones and cell structure; unsaturated fats promote heart health, while excess saturated and trans fats raise disease risk. Cholesterol plays essential roles but requires balanced LDL and HDL levels.

A diet emphasizing nutrient-dense foods, variety, and hydration builds the foundation for lifelong health and wellness.

Test Your Understanding

1. What is the primary difference between macronutrients and micronutrients in terms of the amount required by the body and the roles they play in supporting health? Provide an example of each.
2. Why is energy balance important for overall health, and how does alcohol contribute calories differently from other macronutrients? Explain why alcohol is considered a nonessential nutrient.
3. According to the Dietary Guidelines for Americans, what are two key recommendations for building a healthy dietary pattern, and why is focusing on nutrient-dense foods emphasized?
4. What three factors make up total metabolic rate, and approximately what percentage of daily energy expenditure comes from each?
5. How many calories equal roughly one pound of body weight, and what would be the expected weight gain if someone consumes 200 extra calories per day for one year without increasing activity?
6. Explain the difference between nutrient-dense and energy-dense foods. Give one example of each, and describe why the Dietary Guidelines for Americans emphasize nutrient-dense choices.
7. Explain the major functions of carbohydrates in the body. How do carbohydrates support both brain function and fat metabolism?
8. What is the difference between simple and complex carbohydrates in terms of structure, digestion, and effect on blood sugar? Give one example of a food source for each.
9. Describe the roles of soluble and insoluble fiber in digestive and overall health. Provide two food examples for each type of fiber.
10. What makes a protein "complete," and why are complete proteins considered higher quality than incomplete proteins? Provide two food examples of each.
11. Compare the nutritional benefits and potential health risks of animal-based proteins versus plant-based proteins. How might someone balance these in their diet for long-term health?
12. What are the main differences between saturated, unsaturated (monounsaturated and polyunsaturated), and trans fats in terms of chemical structure, food sources, and health effects?
13. Explain the roles of LDL ("bad") and HDL ("good") cholesterol in the body. How can diet and lifestyle choices influence their levels?

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Chapter 8 Glossary

- **Acceptable Macronutrient Distribution Ranges (AMDRs):** One of the standards that make up the Dietary Reference Intakes; recommended intake ranges for protein, fat, and carbohydrates as percentages of total daily calories.
- **Added Sugars**: Sugars and syrups that are added to foods or beverages during processing or preparation. This includes ingredients like table sugar, honey, syrups, and sweeteners added during cooking, baking, or manufacturing.
- **Adipose (Fat) tissue**: A type of connective tissue that stores energy in the form of fat and provides insulation and cushioning for the body. It also functions as an endocrine organ by releasing hormones that influence metabolism and appetite.
- **Adequate Intakes (AIs)**: Recommended average daily nutrient intake levels based on observed or experimentally determined estimates of nutrient consumption when scientific evidence is insufficient to establish a Recommended Dietary Allowance (RDA). They are used as a guide to ensure nutritional adequacy.
- **Alcohol**: Ethanol, the intoxicating ingredient in beer, wine, and spirits that provides 7 calories per gram. It is not essential for health, and excessive intake can lead to serious health problems.
- **Animal-based protein**: Protein that comes from foods such as meat, poultry, fish, eggs, and dairy products. These proteins are considered “complete” because they contain all nine essential amino acids the body needs.
- **Antioxidants**: Compounds that protect the body’s cells from damage caused by free radicals, which can contribute to aging and disease. Common dietary antioxidants include vitamins C and E, beta-carotene, and selenium.
- **Anus**: The terminal opening through which feces are expelled from the body.
- **Alpha-linolenic acid (18:3)**: An essential omega-3 fatty acid found mainly in plant sources such as flaxseed, chia seeds, walnuts, and canola oil. The body cannot produce ALA, so it must come from the diet and can be partially converted into other omega-3 fats like EPA and DHA.
- **Adenosine Triphosphate (ATP)**: The primary energy carrier in cells, fueling essential biological processes like muscle contraction, nerve signaling, and metabolism. It releases energy when its high-energy phosphate bonds are broken.
- **Basal Metabolic Rate**: The amount of energy the body requires at rest to maintain essential life functions such as breathing, circulation, and cell production. It represents the minimum number of calories needed to sustain vital bodily processes while at complete rest.
- **Bran**: The outer protective covering of the seed that is rich in fiber, B vitamins, and trace minerals.
- **Calorie**: A unit of energy that measures how much energy food provides when consumed and metabolized.
- **Carbohydrate**: Macronutrients that serve as the body’s main source of energy, found in foods like grains, fruits, vegetables, and dairy. They include sugars, starches, and fiber, which the body breaks down into glucose for fuel.
- **Chronic Disease Risk Reduction Levels (CDRR)**: Nutrient intake targets set to help reduce the risk of diet-related chronic diseases, such as heart disease or type 2 diabetes. They represent the maximum daily intake level for certain nutrients where reducing consumption is expected to lower disease risk.
- **Coenzymes**: Small, organic molecules that work with enzymes to help speed up chemical reactions in the body.
- **Cofactors**: Non-protein substances, often minerals, that assist enzymes in carrying out chemical reactions. They can be either inorganic ions like zinc or magnesium, or organic molecules called coenzymes.
- **Complementary protein pairing**: The practice of combining two or more plant-based protein sources to provide all nine essential amino acids. For example, eating rice with beans creates a complete protein.
- **Complex carbohydrates**: Long chains of sugar molecules (starches and fibers) found in foods like whole grains, legumes, and vegetables. They provide sustained energy and often contain fiber, which supports digestion and overall health.
- **Complete proteins**: Protein sources that contain all nine essential amino acids in sufficient amounts for the body’s needs. They are typically found in animal products like meat, fish, eggs, and dairy, as well as some plant sources such as quinoa and soy.
- **CRAP:** An acronym that stands for "calorie-rich and processed foods" and/or "carbonated drinks, refined sugars, artificial additives, and processed foods."
- **Dietary Guidelines Advisory Committee (DGAC)**: A group of experts appointed by the U.S. Departments of Agriculture (USDA) and Health and Human Services (HHS) to review nutrition science. Their recommendations help shape the Dietary Guidelines for Americans, updated every five years.
- **Daily Values (DVs)**: reference amounts of nutrients set by the FDA to help consumers understand the nutrient content of foods in the context of a total daily diet. They are used on Nutrition Facts labels as percentages based on a 2,000-calorie diet.
- **Department of Health and Human Services (DHHS)**: A U.S. federal agency responsible for protecting public health and providing essential human services. It oversees agencies such as the FDA, CDC, and NIH.
- **Dietary cholesterol**: Cholesterol found in animal-based foods such as meat, eggs, and dairy products. While it can raise blood cholesterol levels in some people, its effect is generally less significant than that of saturated and trans fats.

- **Dietary fiber**: This refers specifically to the indigestible parts of plant foods—such as fruits, vegetables, grains, and legumes—that help regulate the body's use of sugars, assist in digestion, and contribute to satiety and bowel regularity.
- **Dietary Folate Equivalents (DFE)**: A unit used to account for the differences in bioavailability (how well the body absorbs and uses) between natural folate from food and synthetic folic acid from supplements or fortified foods.
- **Dietary pattern**: The overall combination of foods and beverages a person regularly consumes. It emphasizes how different foods and nutrients work together to affect health over time.
- **Dietary Guidelines for Americans (DGAs)**: Science-based recommendations published every five years by the USDA and HHS. They provide advice on healthy eating patterns to promote health, reduce the risk of chronic disease, and meet nutrient needs.
- **Dietary Reference Intakes (DRIs):** A set of standards that includes recommended intakes of all essential nutrients, recommendations for balancing intakes of macronutrients, and upper safe limits for selected nutrients.
- **Dietary Thermogenesis (Thermic Effect of Food):** The increase in energy expenditure that occurs after eating, as the body digests, absorbs, transports, and stores nutrients. It typically accounts for about 5–10% of total daily energy expenditure.
- **Digestion**: The process by which the body breaks down food into smaller components, such as nutrients, that can be absorbed and used for energy, growth, and repair. It involves both mechanical actions, like chewing, and chemical processes, such as enzyme activity.
- **Disaccharides** are carbohydrates made up of two monosaccharide molecules bonded together; common examples include sucrose (glucose + fructose), lactose (glucose + galactose), and maltose (glucose + glucose).
- **Empty Calories**: calories from foods and beverages that provide little to no nutritional value—meaning they are high in added sugars and/or solid fats but low in essential nutrients like vitamins, minerals, or fiber. Common sources include sugary drinks, candy, pastries, and fried foods.
- **Endosperm**: The Large center of the seed that provides energy, primarily in the form of complex carbohydrates.
- **Energy-dense**: Foods that provide a high amount of calories relative to their weight or volume. They are often high in fat and added sugars but low in nutrients, such as fast food, pastries, and fried snacks.
- **Esophagus**: A muscular tube that transports food from the pharynx to the stomach.
- **Exercise-Associated Hyponatremia**: A condition occurring during or after prolonged physical activity in which blood sodium levels drop below 135 mEq/L, typically due to excessive fluid intake outpacing sodium losses.
- **Fat (triglycerides)**: The most common type of fat in the body and food, consisting of three fatty acids attached to a glycerol backbone. They serve as a major energy source and are stored in adipose tissue for later use.
- **Fatty acids**: The building blocks of fats, made up of chains of carbon and hydrogen atoms with a carboxyl group at one end. They can be classified as saturated, monounsaturated, or polyunsaturated, depending on their chemical structure.
- **Fat-soluble vitamins**: Vitamins (A, D, E, and K) that dissolve in fat and are stored in the body's fatty tissue and liver. Because they can accumulate, excessive intake may lead to toxicity.
- **Food and Drug Administration (FDA)**: A U.S. federal agency responsible for protecting public health by regulating food, drugs, medical devices, and dietary supplements. It ensures the safety, effectiveness, and accurate labeling of these products.
- **Fiber**: A type of carbohydrate that the body cannot digest or absorb. It passes through the digestive system largely intact and plays a vital role in maintaining digestive health.
- **Flavonoids**: A group of naturally occurring plant compounds with antioxidant and anti-inflammatory properties. They are found in foods like fruits, vegetables, tea, and dark chocolate, and may help protect against chronic diseases.
- **Free radicals**: Unstable molecules with unpaired electrons that can damage cells, proteins, and DNA through oxidative stress. They are produced naturally in the body and can also come from external sources like pollution, smoking, and radiation.
- **Gallbladder**: A small, green organ beneath the liver that stores and releases bile into the small intestine.
- **Germ**: A part of the plant seed from which a new plant can sprout that provides fatty acids, vitamin E, B vitamins, and antioxidants.
- **Glucose**: A simple sugar that serves as the body's primary source of energy for cells, tissues, and organs. It is obtained from carbohydrates in food and transported in the blood as blood sugar.
- **Glycemic index (GI)**: A measure of how quickly a carbohydrate-containing food raises blood glucose levels compared to pure glucose. Foods with a high GI cause rapid spikes in blood sugar, while low-GI foods lead to slower, steadier increases.
- **Glycogen**: The stored form of glucose found in the liver and muscles. It serves as a readily available energy reserve that the body can break down quickly during physical activity or between meals.
- **High-density lipoprotein (HDL) cholesterol**: Often called "good" cholesterol because it helps remove excess cholesterol from the bloodstream and transports it to the liver for excretion. Higher HDL levels are linked to a lower risk of heart disease.
- **Holistic approach to healthy eating:** This approach considers not only the nutritional content of food but also how dietary choices impact overall well-being, including physical, mental, social, and environmental health. This approach emphasizes balance, variety, and moderation, while also taking into account factors like cultural preferences, food sourcing, lifestyle habits, and the enjoyment of food as part of a healthy, sustainable lifestyle.
- **Hypervitaminosis:** A condition that occurs when a person has excessive levels of one or more vitamins in the body, typically

as a result of over-supplementation rather than food intake. This buildup can lead to toxic effects and interfere with normal body functions.

- **Hyponatremia:** A medical condition characterized by abnormally low sodium concentration in the blood, typically resulting from excessive fluid intake, excessive sodium loss (such as through prolonged sweating), or a combination of both. In exercise settings, it most often occurs when an individual consumes large amounts of fluid without adequate electrolyte replacement, leading to dilution of blood sodium levels and potential impairment of nerve, muscle, and brain function.
- **Incomplete proteins**: Protein sources that lack one or more of the nine essential amino acids. They are typically found in plant-based foods such as grains, nuts, seeds, and vegetables.
- **Insoluble fiber**: A type of dietary fiber that does not dissolve in water and adds bulk to stool, helping prevent constipation. It is found in foods like whole grains, nuts, seeds, and the skins of fruits and vegetables.
- **Kilocalorie (kcal)**: The amount of energy needed to raise the temperature of 1 kilogram of water by 1°C. In nutrition, it is the standard unit used to measure the energy content of foods, and it is often referred to simply as a "Calorie."
- **Large Intestine (Colon)**: Includes ascending, transverse, descending, and sigmoid sections; responsible for water absorption and forming feces.
- **Legumes**: A group of plants that include beans, lentils, peas, and chickpeas, valued for their high protein, fiber, and nutrient content. They are an important source of plant-based protein and can help support heart and digestive health.
- **Linoleic acid (18:2)**: An essential omega-6 fatty acid that the body cannot produce and must obtain from food. It is found in vegetable oils, nuts, and seeds, and plays a key role in cell structure and normal growth.
- **Lipids**: A group of fats and fat-like substances, including triglycerides, phospholipids, and sterols, that are insoluble in water but essential for energy, cell structure, and hormone production. They provide more than twice the energy per gram compared to carbohydrates or proteins.
- **Lipogenesis**: the metabolic process by which the body converts excess carbohydrates and proteins into fatty acids, which are then stored as fat. This primarily occurs in the liver and adipose tissue.
- **Liver**: A large organ located on the upper right side of the abdomen; it produces bile for fat digestion.
- **Low-Density Lipoprotein Cholesterol (LDL)**: Often called "bad" cholesterol because high levels can lead to plaque buildup in arteries, increasing the risk of heart disease and stroke. It carries cholesterol from the liver to the body's cells.
- **Macronutrients**: Nutrients the body needs in large amounts to provide energy and support basic functions: carbohydrates, proteins, and fats. Water is also considered a macronutrient, though it does not provide calories.
- **Micronutrients**: Vitamins and minerals that the body requires in small amounts for proper growth, development, and overall health. They help regulate processes like metabolism, immunity, and bone health.
- **Metabolism**: The sum of all chemical processes in the body that convert food into energy and support essential functions like breathing, digestion, and cell repair.
- **Metabolic rate**: The rate at which the body uses energy (calories) to carry out these metabolic processes, including at rest and during physical activity.
- **Minerals**: Inorganic nutrients the body needs in small amounts to support vital functions such as building strong bones, transmitting nerve signals, and maintaining fluid balance. Examples include calcium, iron, potassium, and zinc.
- **Mineral toxicity**: Occurs when the body accumulates excessive amounts of a mineral, leading to harmful effects on health. It is usually caused by high-dose supplements or overexposure rather than food sources.
- **Monosaccharides**: They are the simplest form of carbohydrates, consisting of a single sugar molecule such as glucose, fructose, or galactose.
- **Monounsaturated fats**: Healthy fats that have one double bond in their chemical structure and can help reduce bad cholesterol levels. They are found in foods like olive oil, avocados, and many nuts and seeds.
- **Mouth**: The entry point where food is ingested and mechanical digestion (chewing) begins.
- **Nutrients**: Substances in food that are essential for the body's growth, development, and overall functioning. Nutrients include carbohydrates, fats, proteins, vitamins, minerals, and water, which are the compounds required for growth and survival that must be obtained from food.
- **Nutrient-dense**: Foods that provide a high amount of vitamins, minerals, and other beneficial nutrients relative to their calorie content. Examples include fruits, vegetables, whole grains, lean proteins, and legumes.
- **Nutrient-rich**: Foods that supply abundant vitamins, minerals, and other beneficial nutrients with relatively few calories. They support overall health and are often whole, minimally processed foods like vegetables, fruits, and lean proteins.
- **Omega-3**: Essential polyunsaturated fats that support heart, brain, and immune health. They are found in fatty fish, flaxseeds, chia seeds, walnuts, and canola oil.
- **Omega-6**: Essential polyunsaturated fats that help with growth, brain function, and normal development. They are found in vegetable oils, nuts, and seeds, but excessive intake compared to omega-3s may promote inflammation.
- **Osteoporosis**: A disease characterized by weakened bones and reduced bone density, increasing the risk of fractures. It often develops with aging and is influenced by factors like low calcium intake, hormonal changes, and lack of physical activity.
- **Pancreas**: A yellow, elongated organ that secretes digestive enzymes and bicarbonate into the small intestine.
- **Partially hydrogenated oils (PHOs)**: Oils that have been chemically altered to make them more solid and extend shelf life,

creating trans fats in the process. Because trans fats raise LDL (“bad”) cholesterol and lower HDL (“good”) cholesterol, PHOs are no longer generally recognized as safe for use in food.

- **Percent Daily Values (%DV)**:
- **Pharynx**: The passage connecting the mouth to the esophagus; involved in swallowing.
- **Phytochemicals**: Naturally occurring compounds in plants that are not essential nutrients but provide health benefits, such as reducing inflammation and lowering disease risk. They are abundant in fruits, vegetables, whole grains, legumes, and tea.
- **Phytosterols**: Plant-based compounds structurally similar to cholesterol that can help lower LDL (“bad”) cholesterol levels by reducing its absorption in the intestine. They are naturally found in foods like vegetable oils, nuts, seeds, and whole grains.
- **Plant-based protein**: Protein that comes from sources such as beans, lentils, nuts, seeds, soy, and whole grains. While some are incomplete proteins, combining different plant foods can provide all essential amino acids.
- **Polyunsaturated fats**: Healthy fats that contain two or more double bonds in their chemical structure and help reduce LDL (“bad”) cholesterol levels. They are found in foods like fatty fish, walnuts, flaxseeds, and vegetable oils.
- **Polyphenols**: A large group of plant compounds with antioxidant and anti-inflammatory properties that may protect against chronic diseases. They are abundant in foods such as berries, tea, coffee, red wine, and dark chocolate.
- **Potassium**: An essential mineral and electrolyte that helps regulate fluid balance, nerve signals, and muscle contractions. It is found in foods like bananas, potatoes, beans, and leafy greens.
- **Proteins**: Macronutrients made up of amino acids that build and repair tissues, support immune function, and serve as enzymes and hormones. They are found in both animal and plant-based foods.
- **Rectum**: The final section of the large intestine, where feces are stored before elimination.
- **Recommended Dietary Allowance (RDA)**: The average daily nutrient intake level sufficient to meet the needs of nearly all (97–98%) healthy individuals in a specific age and sex group. It is used as a goal for planning and assessing diets.
- **Resting Metabolic Rate (RMR):** The amount of energy the body uses at rest to perform basic functions such as breathing, circulation, and maintaining body temperature. It is slightly higher than the basal metabolic rate (BMR) because it is measured under less strict conditions.
- **Retinol Activity Equivalents (RAE)**: This unit is used to measure vitamin A activity from both preformed vitamin A (like retinol from animal sources) and provitamin A carotenoids (like beta-carotene from plants). Because the body converts plant-based carotenoids less efficiently than animal-based retinol, RAE helps standardize the amount of usable vitamin A regardless of the source.
- **Salivary Glands:** Located near the mouth, these glands secrete saliva to moisten food and begin the breakdown of carbohydrates.
- **Saturated fatty acids**: Fats in which all carbon atoms are fully “saturated” with hydrogen, containing no double bonds. They are found mainly in animal products and some tropical oils, and high intake is linked to increased LDL (“bad”) cholesterol and heart disease risk.
- **Simple Carbohydrates**: sugars made up of one or two sugar molecules that are quickly digested and absorbed by the body. They provide a rapid source of energy and are found naturally in fruits, milk, and some vegetables, as well as in processed foods like candy, soda, and baked goods with added sugars.
- **Small Intestine** – A long, coiled tube where most nutrient absorption occurs; it lies between the stomach and the large intestine.
- **Sodium**: An essential mineral and electrolyte that helps regulate fluid balance, nerve function, and muscle contractions. However, excessive intake is linked to high blood pressure and increased risk of heart disease and stroke.
- **Soluble fiber**: A type of dietary fiber that dissolves in water to form a gel-like substance, helping slow digestion and regulate blood sugar and cholesterol levels. It is found in foods like oats, beans, apples, and citrus fruits.
- **Stomach**: A J-shaped organ where food is mixed with digestive juices and broken down into chyme.
- **Tolerable Upper Intake Levels (ULs)**: The maximum daily amounts of nutrients unlikely to cause harmful effects for most people. Consistently exceeding the UL increases the risk of toxicity and adverse health effects.
- **Triglycerides**: The most common type of fat in the body and food, made of three fatty acids attached to a glycerol backbone. They store energy for later use, but high blood levels can increase the risk of heart disease.
- **Ultra-Processed Foods (UPFs)**: Industrially manufactured foods that contain ingredients rarely found in home kitchens, including additives, preservatives, artificial flavors, and sweeteners.
- **Unsaturated fats**: Healthy fats that contain one or more double bonds in their chemical structure, making them typically liquid at room temperature. They include monounsaturated and polyunsaturated fats, found in foods like olive oil, nuts, seeds, and fatty fish.
- **United States Department of Agriculture (USDA)**: A federal agency responsible for developing and executing policies on farming, food, and nutrition. It oversees programs like MyPlate, school meals, and food safety regulations.
- **Vitamins**: Organic compounds that the body needs in small amounts to regulate metabolism, support growth, and maintain health. They are classified as fat-soluble (A, D, E, K) or water-soluble (B-complex, C).
- **Vitamin D**: A fat-soluble vitamin that helps the body absorb calcium and phosphorus, supporting bone and immune health. It can be made in the skin through sunlight exposure and is also found in foods like fatty fish and fortified milk.

- **Water**: An essential nutrient that supports nearly every body function, including hydration, temperature regulation, nutrient transport, and waste removal. It is the most abundant substance in the human body and must be consumed regularly for survival.
- **Water-soluble vitamins**: Vitamins that dissolve in water and are not stored in large amounts in the body, so they must be consumed regularly. They include the B-complex vitamins and vitamin C.
- **Whole grains**: Grains that retain all three parts of the original kernel, the bran, germ, and endosperm, after processing. Because these parts are left intact, whole grains are rich in fiber, vitamins, minerals, and beneficial plant compounds.

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9: WEIGHT MANAGEMENT FOR HEALTH AND WELLNESS



Figure 9.1: (Feet on scale; Yunmai via Unsplash)

Introduction to Weight Management for Health and Wellness

Weight management is crucial for health, as excess weight increases the risk of diseases, while being underweight can lead to nutritional deficiencies and other health complications. Weight management refers to the process of adopting long-term lifestyle strategies to maintain a healthy body weight. It includes balancing the number of calories consumed through food and drink with the number of calories the body uses for metabolism, physical activity, and basic bodily functions. Effective weight management involves understanding caloric intake and expenditure, maintaining hydration, and managing electrolytes. It includes balancing the number of calories consumed through food and drink with the number of calories the body uses for metabolism, physical activity, and basic bodily functions. Weight management is not just about losing weight; it also includes preventing unwanted weight gain, maintaining weight loss, and in some cases, gaining weight in a healthy way, such as for individuals recovering from illness or athletes building muscle. Setting realistic goals, tracking food intake, and addressing triggers for unhealthy eating are essential steps. Regular physical activity is critical for weight loss, maintenance, and overall health benefits, such as reduced risk of chronic diseases. Eating disorders like anorexia, bulimia, and binge eating pose significant health risks and require comprehensive treatment involving nutrition and psychiatric counseling. Ultimately, long-term weight management requires adopting healthy habits and reinforcing them over time.

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
- Understand the health risks of being underweight
- Recognize the reality of eating disorders and the harm they can cause

9.1: Weight Management Through Diet

9.2: The Importance of Physical Activity in Maintaining a Healthy Weight

9.3: Healthy Weight Loss, Weight Gain, or Maintain

9.4: Health Risks with Eating Disorders
9.5: Comprehension Check
9.6: Glossary
9.7: References

Thumbnail: Feet on a scale. (Feet on scale; Yunmai via Unsplash)
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9.1: Weight Management Through Diet



Figure 9.1.1: (Tape Measure Diet; Elena Leya via Unsplash)

Introduction

Weight management through healthy dieting is a journey that requires both commitment and understanding. Rather than relying on quick fixes or fad diets, successful and sustainable weight loss comes from making informed decisions about your daily food intake and lifestyle. This guide offers practical steps to help you better understand your nutritional habits, set realistic goals, and create a support system for long-term success. Whether you're just beginning your weight loss journey or looking to fine-tune your approach, these strategies can help you build a healthier relationship with food and achieve lasting results.

Weight Management - 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 to perform a 10-day analysis of nutritional intake. 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 it 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 is 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 (Centers for Disease Control and Prevention, n.d.). [6]

Question

- Why is it important to analyze macronutrient intake in addition to total calories when trying to achieve a healthy weight?
- How might an imbalanced macronutrient distribution impact long-term health and weight management?
- Considering the recommendation to limit weight loss to 1–2 pounds per week, what physiological and psychological consequences might arise from attempting more rapid weight loss through extreme calorie restriction?
- In what ways does combining moderate dietary restriction with physical activity offer advantages over dieting alone, both for weight loss success and overall health improvement?

Getting Started with Weight Loss

Successful weight management is not achieved through quick fixes or fad diets, but rather through a thoughtful, long-term commitment to healthy lifestyle changes. By approaching weight loss as a step-by-step process, individuals can build sustainable habits that promote better health, increased energy, and improved quality of life. This chapter outlines five key steps to help individuals get started on their journey, from making an initial commitment and setting realistic goals to identifying supportive resources and monitoring progress over time. Each step is designed to encourage self-awareness, accountability, and gradual change for lasting results.

Step 1: Make a Commitment

Deciding to lose weight, change your lifestyle, and become healthier is a big step to take. Start simply by committing 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 childcare 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 vegetables with dinner.

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.



Figure 9.1.2: (Fruits in a Bowl; Alexandra Andersson via Unsplash)

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 (Centers for Disease Control and Prevention, n.d.). [9]

Planning a Healthy Diet

A healthy diet provides the body with essential nutrients—carbohydrates, proteins, fats, vitamins, and minerals—while promoting overall well-being and reducing the risk of chronic disease. Key components of a healthy diet include balance, variety, moderation, and adequacy. Following a healthy eating pattern can support energy levels, mental clarity, weight maintenance, and disease prevention (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). [55]

How to Calculate Portion Size

Portion sizes influence caloric intake and overall dietary balance. To control portion sizes, it's important to understand the difference between a "portion" (how much you choose to eat) and a "serving" (a standardized amount used in dietary guidelines). Using visual cues, such as comparing a serving of meat to the size of a deck of cards or a serving of pasta to the size of a baseball, can help individuals make smarter food choices (Centers for Disease Control and Prevention, 2021). [12]

Table 9.1.1 *Visual Guide to Serving Sizes*

Food Group	Food Item	Standard Serving Size	Visual Cue
Grains	Cooked rice, pasta, or cereal	1/2 Cup	Size of a cupcake or cupped palm
	Bread	1 Slice	Size of a CD case
Vegetables	Raw leafy greens	1 Cup	Size of a baseball
	Cooked vegetables	1/2 Cup	Size of a light bulb
Fruits	Fresh fruit	1 Medium piece	The size of a tennis ball
	Dried Fruit	1/4 Cup	The size of an egg or a small handful
Dairy	Milk or Yogurt	1 Cup (8 oz)	Size of a small carton
	Cheese	1.5 oz	Size of 3 dice
Protein	Cooked meat, poultry, and fish	3 oz	Size of a deck of cards
	Nut butter	2 Tablespoons	The size of a ping pong ball
	Beans, tofu	1/2 Cup	Size of a standard muffin cup
Fats/Oils	Butter or oil	1 Teaspoon	Size of a dice cube

In Table 9.1.1, different common types of food are represented with a measured standard serving size as well as a common item that can be used to compare size for determining proper portions (U.S. Department of Agriculture, 2020). [53] Using a visual cue to estimate portions is a good way to keep track of the amount being consumed. If it is possible to measure your food as it is prepared, you can have a more accurate representation of your eating habits.

USDA's MyPlate

MyPlate is a modern visual guide created by the United States Department of Agriculture (USDA) to help Americans build healthier eating patterns and make balanced food choices throughout the day. Introduced in 2011 as a replacement for the Food Pyramid, MyPlate presents a simplified and easy-to-understand depiction of what a healthy meal should look like on a plate (U.S. Department of Agriculture, 2020). [54]

Overview of the Plate

The MyPlate model divides a standard dinner plate into four main sections:

- Fruits
- Vegetables
- Grains
- Protein

A separate, smaller circle next to the plate represents Dairy, typically interpreted as a serving of milk, yogurt, or other calcium-rich alternatives.

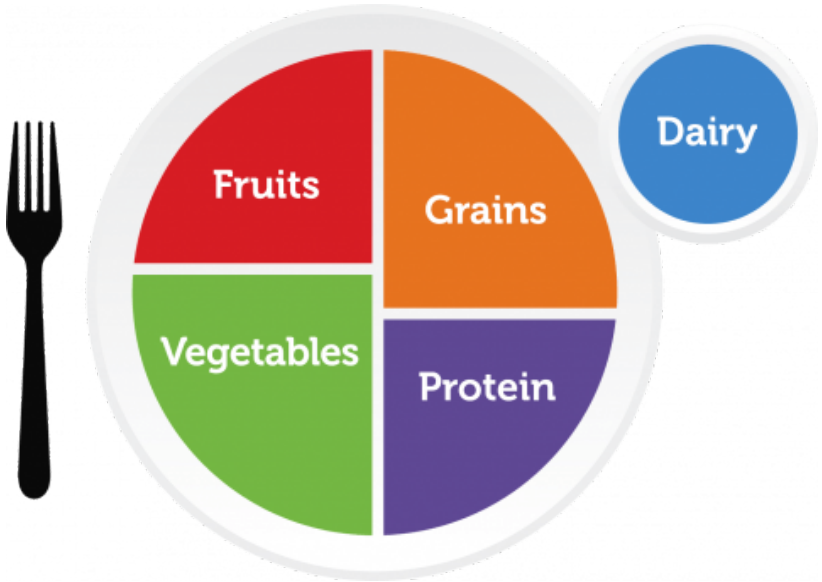


Figure 9.1.3: MyPlate helps an individual understand proportions of different types of foods visually. (Free use adapted from ChooseMyPlate.gov)

The plate is visually split to emphasize:

- Half the plate should consist of fruits and vegetables, with a greater emphasis on a variety of colors and types, especially non-starchy vegetables.
- The other half is divided between grains and protein foods, with an emphasis on whole grains and lean or plant-based proteins.
- The side of dairy encourages consumption of low-fat or fat-free milk or fortified non-dairy alternatives such as soy milk.

Key Principles Behind MyPlate

- Balance and Proportion: Encourages consumers to balance calories by enjoying appropriate portions and choosing nutrient-dense options.
- Variety: Recommends incorporating a wide variety of foods from each food group to ensure adequate intake of essential nutrients.
- Moderation: Advises limiting added sugars, sodium, and saturated fats—commonly found in processed foods, sugary drinks, and fast food.
- Whole Foods First: Promotes the selection of whole fruits over juice, whole grains over refined grains, and fresh or minimally processed items over highly processed ones.

Applying MyPlate in Real Life

- Breakfast: Whole grain toast (grains), scrambled eggs (protein), a side of berries (fruit), and low-fat milk (dairy).
- Lunch: Grilled chicken sandwich on whole grain bread (protein + grain), a leafy green salad with mixed vegetables

(vegetables), and a piece of fruit.
- Dinner: Baked salmon (protein), brown rice (grain), steamed broccoli and carrots (vegetables), and a cup of low-fat yogurt (dairy).

Average American Diet vs MyPlate Recommendations

The average American diet often exceeds the recommended intakes of added sugars, sodium, and saturated fats while falling short in fruits, vegetables, whole grains, and dairy. These discrepancies contribute to high rates of obesity, type 2 diabetes, and heart disease. MyPlate offers a corrective model for aligning eating habits with nutritional guidelines for better health outcomes (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). [55]

MyPlate Tool - USDA

MyPlate also aligns with the Dietary Guidelines for Americans, which emphasize a lifelong approach to healthy eating. It serves as a helpful tool for individuals, families, educators, and health professionals to plan meals and assess dietary patterns.

For personalized recommendations, individuals can use the MyPlate Plan tool available at ChooseMyPlate.gov, which offers daily food group targets based on age, sex, height, weight, and physical activity level

Food Groups

A well-balanced diet includes a variety of nutrient-rich foods from different groups, each offering unique health benefits. Understanding the role of grains, dairy, protein, oils, fruits, and vegetables is essential for meeting the body's nutritional needs. In addition to these foundational food groups, incorporating **superfoods** can further enhance diet quality and support long-term wellness. The following sections highlight the importance of each group, offering guidance on how to make informed choices that align with dietary recommendations and promote overall health.

Grains

Grains are essential sources of carbohydrates, fiber, and B vitamins. They are divided into whole and refined grains. Whole grains, such as brown rice and whole wheat bread, retain the bran, germ, and endosperm, providing more nutrients and fiber. At least half of daily grain intake should be whole grains to support heart health and digestion (U.S. Department of Agriculture, 2020). [54]

Dairy

The dairy group includes milk, yogurt, and cheese, providing calcium, vitamin D, and potassium. Fat-free and low-fat options are recommended to reduce saturated fat intake while maintaining bone health and reducing the risk of osteoporosis (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). [55]



Figure 9.1.4: (Grazing Cows by Daniel Quiceno M on Unsplash)

Protein

Protein sources include both animal (meat, poultry, seafood, eggs) and plant-based foods (beans, peas, nuts, seeds, and soy products). Varying protein choices and incorporating lean or plant-based proteins support muscle maintenance and heart health (U.S. Department of Agriculture, 2020). [54]

Oils

Oils are not a food group but are essential sources of unsaturated fats and vitamin E. Healthy oils come from plants and fish, such as olive oil, canola oil, and fatty fish. The guidelines recommend using oils instead of solid fats, such as butter and lard, to reduce saturated fat intake (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2020). [55]

Fruits and Vegetables

Fruits and vegetables are rich in vitamins, minerals, antioxidants, and fiber. A diverse intake—especially deeply colored varieties like berries, leafy greens, and carrots—supports immune function and reduces the risk of chronic diseases such as cancer and heart disease (Centers for Disease Control and Prevention, 2022). [16] The Dietary Guidelines recommend filling half the plate with fruits and vegetables at each meal (U.S. Department of Agriculture, 2020). [54]

Superfoods

Superfoods are nutrient-dense foods known for their health-promoting properties. Examples include blueberries, salmon, kale, chia seeds, and quinoa. These foods are rich in antioxidants, omega-3 fatty acids, fiber, and phytochemicals. While no single food can ensure health, incorporating superfoods into a balanced diet enhances nutritional quality and disease prevention (Harvard T.H. Chan School of Public Health, n.d.). [27]



Figure 9.1.5: (Superfoods by Maddi Bazzocco on Unsplash)

Food Skills

Maintaining a healthy diet goes beyond selecting nutritious foods; it also involves the practical skills needed to plan, prepare, and manage meals in everyday life. From organizing weekly menus to making smart choices when dining out, food skills are essential for sustaining long-term healthy eating habits. Additionally, understanding food safety practices and leveraging modern technology can further enhance the quality and convenience of daily nutrition. The following sections explore key strategies for effective meal planning, navigating fast food and restaurant options, and ensuring food safety with the help of innovative tools.

Meal Planning and Preparation

Meal planning promotes balanced eating, reduces food waste, and saves money. It involves creating a weekly menu, shopping with a list, and preparing ingredients in advance. Batch cooking and using leftovers creatively can improve consistency in healthy eating habits (Academy of Nutrition and Dietetics, 2023). [2]

Fast Food and Restaurant Choices

Eating out presents challenges to healthy eating due to large portions and high levels of sodium, sugar, and fats. Making healthier choices—such as selecting grilled over fried options, requesting dressings on the side, or splitting entrees—can help maintain diet quality while dining out (Centers for Disease Control and Prevention, 2021). [12]

Food Safety and Technology

Maintaining food safety is a critical aspect of healthy eating, as it helps prevent foodborne illnesses that can result from improper handling, preparation, or storage of food. According to the U.S. Food and Drug Administration (FDA), millions of Americans are affected by foodborne diseases each year, which can lead to symptoms ranging from mild discomfort to severe health complications (U.S. Food and Drug Administration, 2021). [56]

Key Food Safety Practices

To reduce the risk of contamination, the FDA recommends four essential practices:

1. Clean – Wash hands with soap and water for at least 20 seconds before and after handling food. Clean fruits, vegetables, and all food contact surfaces.

2. Separate – Avoid **cross-contamination** by keeping raw meats separate from ready-to-eat foods in your grocery cart, refrigerator, and during food prep.
3. Cook – Cook foods to the appropriate internal temperature to kill harmful bacteria (e.g., 165°F for poultry).
4. Chill – Refrigerate perishable foods within two hours and keep the fridge at or below 40°F to prevent bacterial growth.

The Role of Technology in Food Safety and Nutrition

Modern technology plays an increasing role in helping people adopt and maintain healthy dietary practices.

- Smart kitchen appliances, such as refrigerators with internal temperature sensors and ovens with preset cooking temperatures, help ensure food is stored and prepared safely.
- Mobile apps and wearable devices assist with meal planning, portion tracking, and monitoring nutrient intake, making it easier to follow dietary guidelines.
- Barcode scanners and AI-powered food trackers can offer real-time insights into the nutritional quality and safety of packaged foods.

By combining basic hygiene and food safety knowledge with the advantages of modern technology, individuals can take a proactive approach to both preventing illness and supporting long-term nutritional health.

Dietary Approaches to Weight Loss

Healthy eating is not about strict dietary limitations or depriving yourself of the foods you love. Instead, it's about feeling great, having more energy, improving your health, and stabilizing your mood. The following tips provide practical strategies to help you make more nutritious choices, control portion sizes, stay hydrated, plan, and enjoy your favorite comfort foods in moderation. After reviewing the suggestions, take a few moments for self-reflection to identify which habits you already practice, where improvements can be made, and what small, achievable changes can support a healthier lifestyle moving forward.

Tips for Healthy Eating

- Emphasize fruits, vegetables, whole grains, and fat-free or low-fat milk and milk products
- Include a variety of protein foods such as seafood, lean meats and poultry, eggs, legumes (beans and peas), soy products, nuts, and seeds.
- Reduce saturated fats, trans fats, cholesterol, salt (sodium), and added sugars
- Stay within your daily calorie needs
    - Replace some higher-calorie foods with foods that are lower in calories and fill you up.
    - Choose smaller portion sizes. Research shows that people unintentionally consume more calories when faced with larger portions.
    - If eating out where there are large portion sizes, take half of your meal home.
    - When eating a salad, dip your fork into the dressing instead of pouring lots of dressing on the salad.
    - When eating out, substitute a broth-based soup or a green lettuce salad for French fries or chips as a side dish.
    - Add more vegetables such as cucumbers, lettuce, tomato, and onions to a sandwich instead of extra meat or cheese.
- Rethink your drink and drink more water
    - Carry a water bottle with you and refill it throughout the day.
    - Freeze some freezer-safe water bottles. Take one with you for ice-cold water all day long.
    - Choose water over sugary drinks.
    - Opt for water when eating out. You'll save money and reduce calories.
    - Serve water during meals.
    - Add a wedge of lime or lemon to your water. This can help improve the taste and help you drink more water than you usually do.
- Plan your meals
    - Since high-calorie foods are everywhere, it's important to take the time to plan to make sure you have healthy options available.
    - Check the restaurant menu and plan your meal ahead of time.
    - Write down everything you eat and drink. It keeps you accountable to yourself!
- Have healthy snacks ready
    - "Grab-and-go" fruits: apples, oranges, bananas, canned fruit without added sugars, and raisins

- Washed and chopped fresh vegetables: celery, carrots, and cucumbers
- Low-fat and fat-free milk products: yogurt without added sugars, milk, and low-fat cheeses
- Whole-grain crackers and breads
- Protein choices such as low-fat deli turkey slices or almonds, and other nuts and seeds

When Eating Your Favorite Comfort Foods

- Eat them less often. If you normally eat these foods every day, cut back to once a week or once a month.
- Eat smaller amounts. If your favorite higher-calorie food is a chocolate bar, have a smaller size or only half a bar.
- Try a lower-calorie version. Use lower-calorie ingredients or prepare food differently. For example, if your macaroni and cheese recipe includes whole milk, butter, and full-fat cheese, try remaking it with non-fat milk, less butter, low-fat cheese, fresh spinach, and tomatoes. Just remember not to increase your portion size (National Institute of Diabetes and Digestive and Kidney Disease, 2025). [43]

Self Reflection Opportunity

After reviewing the tips for healthy eating, take a moment to reflect on your current eating habits.

- Which of these tips do you already practice regularly?
- Which tips stood out to you as areas where you could make positive changes?
- Think about your typical meals and snacks. What small, realistic changes could you make this week to improve your eating habits?
- How can you plan to make healthier choices easier and more convenient for yourself?
- How might adjusting your approach to portion sizes, drinks, or comfort foods make a difference in your overall health?

Write your thoughts, goals, and any specific actions you plan to take.



Figure 9.1.6: (Salad Bowl; Ella Olsson via Pexels.com)

Specific Diets

The **Dietary Guidelines** for Americans stresses the importance of developing a healthy eating pattern. For some people, it can be helpful to follow a specific diet. If you are interested in following a diet, it is important to recognize that even if a particular diet may be successful for one person, it may not be effective for another due to individual differences in genes and lifestyle.

Anti-Inflammation Diet

The **anti-inflammatory diet** is a nutritional approach designed to reduce chronic inflammation in the body, which is believed to contribute to a wide range of health issues, including heart disease, diabetes, arthritis, and certain cancers. Rather than a strict set of rules, it emphasizes specific food choices and overall eating patterns that promote lower levels of inflammatory markers.

Core Components

- Fruits and Vegetables: A high intake of colorful fruits and vegetables is encouraged, as they are rich in antioxidants, vitamins, minerals, and phytochemicals that help neutralize harmful free radicals and reduce oxidative stress.
- Whole Grains: Instead of refined grains, the diet focuses on whole grains like oats, quinoa, brown rice, and barley, which provide fiber that supports gut health and regulates blood sugar levels.
- Healthy Fats: Emphasis is placed on consuming sources of omega-3 fatty acids, such as fatty fish (salmon, mackerel, sardines), flaxseeds, chia seeds, and walnuts. Olive oil is often promoted as the primary fat for cooking and dressings because of its anti-inflammatory properties.
- Lean Proteins: Plant-based proteins like legumes (beans, lentils, chickpeas) and moderate amounts of lean animal proteins are recommended. Fish, particularly oily fish high in omega-3s, is preferred over red or processed meats.
- Spices: Certain herbs and spices, such as turmeric, ginger, cinnamon, and garlic, are included for their natural anti-inflammatory effects.
- Beverages: Green tea is often highlighted for its high content of anti-inflammatory polyphenols.
- Avoidance of Pro-Inflammatory Foods: The diet limits or eliminates highly processed foods, refined carbohydrates, added sugars, sugary beverages, excessive alcohol, trans fats, and processed meats, all of which are associated with increased inflammation (Harvard T.H. Chan School of Public Health, n.d.). [24]

Overall Philosophy

The anti-inflammatory diet shares similarities with other healthy eating patterns, such as the Mediterranean diet, emphasizing plant-based foods, healthy fats, and balanced eating over restrictive measures. The goal is not only to manage inflammation but to promote overall health, enhance immune function, and lower the risk of chronic disease over time (Hu, 2008). [28]

Dietary Approaches to Stop Hypertension (DASH) Diet

The **DASH diet**—which stands for Dietary Approaches to Stop Hypertension—is a well-researched eating plan developed to help prevent and manage high blood pressure (hypertension). It is also recognized for promoting overall heart health and offering benefits for weight management and diabetes prevention.

Core Components

- **Fruits and Vegetables**: The DASH diet emphasizes a high intake of fruits and vegetables, aiming for about 4–5 servings of each per day. These foods are rich in potassium, magnesium, and fiber—nutrients known to help regulate blood pressure.
- **Whole Grains**: At least 6–8 servings of whole grains are recommended daily. Grains such as brown rice, whole wheat bread, quinoa, and oatmeal provide essential fiber and energy.
- **Low-Fat Dairy Products**: Two to three servings of low-fat or fat-free dairy products are encouraged to supply calcium and vitamin D without the added saturated fat found in full-fat options.
- **Lean Proteins**: The diet includes moderate amounts of lean proteins such as poultry, fish, and legumes. Red meat is limited, and plant-based proteins like beans, lentils, and nuts are strongly recommended.
- **Nuts, Seeds, and Legumes**: About 4–5 servings per week of these foods are suggested because they provide healthy fats, protein, and important minerals like magnesium.
- **Fats and Oils**: Healthy fats, particularly those from nuts, seeds, and vegetable oils, are emphasized, while saturated and trans fats are minimized.
- **Sweets**: Sweets are limited to a few servings per week, focusing on low-fat or fat-free options.
- **Sodium**: One of the central features of the DASH diet is sodium reduction. The standard DASH plan allows up to 2,300 mg of sodium per day, but a lower-sodium version (1,500 mg per day) is often recommended for greater blood pressure control (National Heart, Lung, and Blood Institute, 2021). [39]

Overall Philosophy

The DASH diet promotes balanced eating with a strong focus on natural, minimally processed foods. It naturally provides nutrients known to help lower blood pressure, such as potassium, calcium, and magnesium, while limiting sodium, saturated fat, and added sugars. Numerous studies have demonstrated that following the DASH diet can significantly lower blood pressure, improve lipid profiles, and reduce the risk of heart disease, stroke, and diabetes (Mayo Clinic, 2024). [34]

Gluten-Free Diet for Weight Loss

A **gluten-free** diet involves the elimination of all foods that contain gluten, a protein found naturally in wheat, barley, rye, and their derivatives. Originally developed as a medical treatment for people with celiac disease or non-celiac gluten sensitivity, the gluten-free diet has also become popular among individuals seeking to lose weight, though its effectiveness for weight management is debated.



Figure 9.1.7: Since "everything is gluten free," this cafe supports a gluten-free diet, which is critical for people with gluten intolerance. (A Sign That is Sitting on a Table; Brad via Unsplash)

Core Components

- **Allowed Foods**: Naturally gluten-free foods include fruits, vegetables, lean meats, poultry, fish, dairy, legumes, nuts, seeds, and grains such as rice, corn, quinoa, millet, and certified gluten-free oats.
- **Avoided Foods**: All forms of wheat (including spelt, durum, and farro), barley, rye, and foods containing ingredients derived from these grains must be avoided unless labeled gluten-free.
- **Processed Foods**: Many processed and packaged foods contain hidden sources of gluten. Careful label reading is essential, and many who follow a gluten-free diet rely on certified gluten-free products (Academy of Nutrition and Dietetics, 2019). [1]

Some individuals report weight loss when adopting a gluten-free diet, but this is not guaranteed. Weight loss usually occurs because:

- The diet often eliminates many high-calorie, processed foods like pastries, breads, pastas, and fast foods.
- Individuals may start eating more whole foods such as fruits, vegetables, and lean proteins.
- Increased mindfulness about food choices and ingredient labels can lead to healthier eating habits overall.

However, gluten-free processed products (e.g., gluten-free cookies, gluten-free pizza) can be high in sugar, fat, and calories, meaning that simply eating gluten-free products will not necessarily result in weight loss unless overall calorie intake and food quality are controlled.

Potential Pitfalls

- Gluten-free diets can be lower in fiber, vitamins (like B vitamins), and minerals (such as iron) if not carefully planned.
- Some people may compensate for eliminating gluten by consuming higher amounts of fats and sugars found in gluten-free processed foods (Harvard T.H. Chan School of Public Health, n.d.). [21]

Overall Philosophy

A gluten-free diet can support weight loss if it focuses on whole, unprocessed foods and proper portion control. However, it is not inherently a weight-loss diet, and success depends more on overall dietary patterns and lifestyle habits.

Intermittent Fasting for Weight Loss

Intermittent fasting is an eating pattern that alternates between periods of eating and periods of fasting. Rather than focusing on what foods are eaten, intermittent fasting primarily focuses on when food is consumed. This approach has gained popularity both for its potential weight loss benefits and its possible improvements in metabolic health.

Core Methods

- Time-Restricted Eating: Involves eating only during a specific window each day (e.g., an 8-hour window like 12 p.m. to 8 p.m., and fasting the remaining 16 hours).
- Alternate-Day Fasting: Involves alternating between days of regular eating and days of fasting or very low-calorie intake (about 500 calories).
- 5:2 Diet: Involves eating normally for five days of the week and significantly restricting calories (about 500–600 calories) on two non-consecutive days.

Intermittent fasting can lead to weight loss because it may help people naturally reduce calorie intake without consciously restricting calories at each meal. During fasting periods, insulin levels drop, encouraging the body to use stored fat for energy. Studies suggest that intermittent fasting can lead to a reduction in body weight, body fat percentage, and improvements in blood sugar regulation (Johns Hopkins Medicine, n.d.). [29]

Additional Potential Benefits

- Improved insulin sensitivity
- Reduced inflammation
- Enhanced heart health markers, such as lower blood pressure and cholesterol
- Possible support for cellular repair processes (such as autophagy)

Important Considerations

- Results vary between individuals. Some people may overeat during eating periods, which could counteract the calorie deficit created by fasting.
- Intermittent fasting may not be suitable for everyone, particularly individuals with a history of eating disorders, pregnant or breastfeeding women, or those with certain medical conditions.
- Long-term studies are still ongoing to fully understand its effects over decades of use.

Overall Philosophy

Intermittent fasting offers a flexible structure that many people find easier to maintain than traditional calorie-restriction diets. However, successful and sustainable results are best achieved when the eating periods still include nutrient-dense, balanced meals rather than high-calorie, low-nutrient foods (Patterson & Sears, 2017). [48]

Ketogenic Diet for Weight Loss

The **ketogenic diet**, often referred to as the keto diet, is a very low-carbohydrate, high-fat, and moderate-protein eating plan designed to induce a metabolic state called ketosis. In ketosis, the body shifts from using glucose (derived from carbohydrates) as its primary energy source to using ketones, which are produced by the liver from fat.

Core Components

- **Carbohydrates**: Typically restricted to about 5–10% of total daily calories (usually 20–50 grams of net carbs per day).
- **Fats**: Make up the majority of daily calories, around 70–80%, with an emphasis on healthy fats like avocados, olive oil, nuts, seeds, and fatty fish.
- **Proteins**: Kept at a moderate intake (about 20–25% of total calories) to prevent gluconeogenesis (conversion of protein into glucose) that could disrupt ketosis.



Figure 9.1.8: Buttered toast is a ketogenic snack. (Bread on White Ceramic Plate by Seriously Low Carb via Unsplash)

Typical Foods Included:

- High-fat foods: avocados, coconut oil, butter, cheese, fatty fish, and meats
- Low-carb vegetables: leafy greens, broccoli, zucchini, cauliflower
- Nuts and seeds
- Minimal berries (low in sugar)
- Eggs

Foods Avoided:

- Grains (bread, pasta, rice)
- Sugary foods (cakes, candies, soda)
- High-carb fruits (bananas, apples, grapes)
- Starchy vegetables (potatoes, corn)

Many individuals adopt the ketogenic diet for weight loss because it can lead to:

- Reduced appetite: Ketones and the high-fat content can suppress hunger hormones.
- Rapid fat loss: The body burns stored fat for energy in the absence of sufficient carbohydrates.
- Improved insulin sensitivity: Lower carb intake can stabilize blood sugar levels.

Other Potential Benefits

- May help manage conditions like epilepsy (especially drug-resistant epilepsy)
- Potential improvements in cholesterol levels (increase in HDL, decrease in triglycerides)
- Possible neuroprotective effects are being studied in Alzheimer's disease and Parkinson's disease (Kossof & Wang, 2013). [30]

Important Considerations

- The diet can be difficult to sustain long-term due to its restrictive nature.
- Potential side effects include the "keto flu" (fatigue, headaches, nausea during adaptation), constipation (due to low fiber intake), and nutrient deficiencies if not carefully planned.
- It is not recommended for individuals with certain health conditions, such as pancreatic disease, liver conditions, or disordered eating histories, without medical supervision (Harvard T.H. Chan School of Public Health, n.d.). [22]

Overall Philosophy

The ketogenic diet can be an effective strategy for rapid weight loss and blood sugar management when properly structured, but it requires careful planning, appropriate monitoring, and a focus on nutrient-dense foods to avoid long-term health risks.

Mediterranean Diet

The **Mediterranean diet** is a way of eating based on the traditional dietary patterns of countries bordering the Mediterranean Sea, such as Greece, Italy, and Spain. It emphasizes whole, minimally processed foods and a balanced approach to nutrition that has been associated with numerous health benefits, including reduced risks of heart disease, stroke, type 2 diabetes, and certain cancers.



Figure 9.1.9: The Mediterranean diet is a popular way to meal plan. (Vegetable Salad with Grilled Salmon; Toa Heftiba via Unsplash)

Core Components

- Fruits and Vegetables: High consumption of a variety of colorful fruits and vegetables forms the foundation of the diet.
- Whole Grains: Foods like whole wheat bread, oats, barley, and brown rice are prioritized over refined grains.
- Healthy Fats: Olive oil is the primary fat source, replacing butter or margarine. Nuts, seeds, and fatty fish also contribute heart-healthy fats, particularly omega-3 fatty acids.
- Lean Proteins: Moderate intake of fish and seafood (at least twice per week) is encouraged, while poultry, eggs, and dairy

(cheese and yogurt) are consumed in moderation. Red meat is limited to occasional consumption.
- Legumes and Nuts: Beans, lentils, chickpeas, almonds, and walnuts provide fiber and plant-based protein.
- Herbs and Spices: Meals are seasoned with herbs and spices instead of salt.
- Wine: Moderate red wine consumption is sometimes included, usually with meals (optional and only for those who already drink alcohol).

The Mediterranean diet is not designed specifically as a weight-loss program, but it often results in healthy weight loss and improved metabolic health. Its emphasis on fiber-rich foods, healthy fats, and reduced intake of processed foods can help regulate appetite, improve insulin sensitivity, and lower inflammation (Harvard T.H. Chan School of Public Health, n.d.). [25]

Additional Benefits

- Reduced risk of cardiovascular diseases
- Improved cognitive function and lower risk of dementia
- Lower rates of certain cancers
- Longer lifespan

Important Considerations

- Focuses more on eating patterns and food quality than calorie counting.
- Encourages mindful eating and enjoying meals socially.
- It is widely considered sustainable and adaptable to different cultural and personal preferences.

Overall Philosophy

The Mediterranean diet promotes overall well-being through a nutrient-dense, flavorful, and flexible approach to eating. It supports heart health, metabolic health, and weight maintenance, making it one of the most scientifically endorsed dietary patterns worldwide (Mayo Clinic, 2024). [35]

Mindful Eating

The **mindful eating** diet is not a traditional “diet” in the sense of prescribing specific foods or restricting calories. Instead, it is an approach to eating that emphasizes awareness, presence, and intentionality around food choices, eating behaviors, and the experience of eating. Mindful eating draws heavily from principles of mindfulness meditation, focusing on being fully attentive to the physical and emotional sensations associated with eating.

Core Components

- **Eating with Full Attention**: Mindful eating encourages individuals to slow down and focus fully on the eating experience—paying attention to flavors, textures, smells, and how food makes them feel physically and emotionally.
- **Recognizing Hunger and Fullness**: It teaches people to differentiate between true physical hunger and emotional or environmental triggers for eating, and to stop eating when comfortably full.
- **Non-Judgmental Awareness**: Mindful eaters observe their thoughts and feelings about food without labeling them as “good” or “bad,” helping to reduce guilt and shame around eating.
- **Appreciating Food**: There is an emphasis on gratitude for the food, recognizing where it comes from and the effort involved in its preparation.
- **Reducing Distracted Eating**: Mindful eating discourages multitasking during meals (such as watching TV or scrolling on a phone) to foster a deeper connection with the act of eating.

While not explicitly designed for weight loss, mindful eating can lead to natural weight management because:

- It can reduce overeating and binge eating behaviors.
- People often become more attuned to true hunger cues and make healthier food choices.
- It fosters a healthier relationship with food, improving emotional regulation around eating (Harvard T.H. Chan School of Public Health, n.d.). [23]

Additional Potential Benefits

- Reduction in emotional and stress-related eating
- Improved digestion and satisfaction with meals
- Lower risk of disordered eating behaviors
- Better blood sugar control and metabolic health

Important Considerations

- Mindful eating requires practice and patience; it is a skill that builds over time.
- It is often used as a complement to other dietary strategies rather than a complete diet replacement.
- Some structured mindful eating programs integrate cognitive-behavioral therapy (CBT) techniques to enhance effectiveness for people struggling with emotional eating or chronic dieting (Kristeller & Wolever, 2011). [31]

Overall Philosophy

Mindful eating re-frames the relationship with food as an experience that nourishes both the body and mind. Fostering attention and self-compassion during eating supports sustainable, long-term improvements in eating habits, emotional health, and, potentially, body weight.

Paleo Diet for Weight Loss

The **Paleo diet**, also known as the Paleolithic diet or "caveman diet," is based on the idea of eating similarly to how prehistoric humans are believed to have eaten during the Paleolithic era. It emphasizes whole, unprocessed foods that could theoretically have been hunted or gathered, while excluding foods that became common after the advent of agriculture.

Core Components

- Foods Emphasized: Lean meats (especially grass-fed or wild-caught), fish, fruits, vegetables, nuts, and seeds.
- Foods Avoided: Grains (such as wheat, rice, and oats), legumes (beans, lentils, peanuts), dairy products, refined sugars, processed foods, and highly processed vegetable oils.
- Cooking Methods: Encourages natural cooking methods like roasting, grilling, and steaming over heavily processed techniques.

The Paleo diet may promote weight loss through several mechanisms:

- Reduced calorie intake: By eliminating highly processed foods and refined carbohydrates, many people naturally consume fewer calories.
- Higher protein intake: Protein is emphasized, which can increase satiety, reduce appetite, and preserve muscle mass during weight loss.
- Lower glycemic load: By avoiding refined sugars and grains, blood sugar levels remain more stable, which may reduce fat storage and hunger spikes.
- Whole foods focus: Encouraging nutrient-dense, fiber-rich vegetables and fruits may help regulate digestion and appetite.

Several studies suggest that individuals following a Paleo diet may lose more weight in the short term compared to traditional low-fat diets, although more research is needed on its long-term sustainability and health effects (Manheimer et al, 2015). [33]

Additional Potential Benefits

- Improved blood pressure and lipid profiles
- Enhanced glucose control
- Reduced inflammation markers

Important Considerations

- The diet can be restrictive and may lead to nutrient deficiencies (such as calcium and vitamin D) if dairy and legumes are not adequately replaced.
- Long-term adherence can be challenging due to food restrictions and social limitations.
- Critics note that the assumptions about Paleolithic diets vary, and there was no single “Paleo” diet historically.

Overall Philosophy

The Paleo diet encourages a return to simple, whole foods while removing processed and modern agricultural products. For many, this shift leads to healthier eating patterns, weight loss, and improved metabolic health, especially when the focus is on quality sources of meat, abundant vegetables, and healthy fats (Harvard T.H. Chan School of Public Health, n.d.). [26]

Question

- Compare two diets (e.g., ketogenic vs. Mediterranean or intermittent fasting vs. mindful eating).
  - What are the key differences in philosophy, structure, and potential health outcomes?
- Some diets, like the gluten-free or ketogenic diet, can result in nutrient deficiencies if not carefully planned.
  - How could someone ensure they’re meeting their nutritional needs while following a restrictive diet?
- If you were advising a friend interested in trying a new diet for health or weight loss, what factors would you encourage them to consider before choosing one?

Bariatric Surgery

Weight-loss surgery, also known as **bariatric surgery**, is an operation that makes changes to the digestive system. In the United States, surgeons most often perform three types of operations: the gastric sleeve, gastric bypass, and adjustable gastric band. Bariatric surgery may be an option if you have extreme obesity (over 40 BMI) or are at lower levels of obesity (over 30 BMI), but you have serious health problems, such as type 2 diabetes or sleep apnea, related to obesity. Bariatric surgery can improve many of the medical conditions linked to obesity, especially type 2 diabetes. Side effects of the surgery may include bleeding, infection, leakage from the surgery site, diarrhea, and blood clots.



Figure 9.1.10: (Surgery; National Cancer Institute via Unsplash)

A longitudinal study of bariatric surgery (gastric bypass and gastric band) was conducted to understand immediate and long-term effects (National Institute of Diabetes and Digestive and Kidney Diseases, 2021). [40] The study included people who had bariatric surgery between 2005 and 2009. Researchers met with the participants before surgery, 30 days after, and then

annually until 2015.

Thirty days after bariatric surgery, researchers found

- Death rates were low. Only 2.1 percent of participants who had open gastric bypass and 0.2 percent of participants who had laparoscopic gastric bypass died. No participants who had gastric band surgery died.
- Only 4.1 percent of participants had at least one major bad outcome, such as death, development of blood clots, repeat surgeries, or failure to be released from the hospital.
- No significant differences in complication risk were found based on the type of gastric bypass procedure.
- Participants with the highest BMI values had the greatest risk of complications.
- Participants with a history of deep vein blood clots or sleep apnea had a higher risk of complications (Smith et al, 2011). [51]

At the 7-year follow-up, researchers found

- Participants lost an average of 28.4 percent of their body weight after gastric bypass surgery and 14.9 percent of their body weight after laparoscopic gastric band surgery.
- Most participants maintained their weight loss. Three to 7 years after surgery, participants who had gastric bypass surgery regained an average of 3.9 percent of their body weight, and participants who had gastric band surgery regained an average of 1.4 percent of their body weight.
- High cholesterol was less common after gastric bypass and gastric band surgery.
- Diabetes and high blood pressure were less common after gastric bypass surgery. Over time, diabetes reoccurred in some patients, but the number of new cases was low.
- Alcohol use disorders increased after gastric bypass surgery but not after gastric band surgery.
- Pain and physical function improved after bariatric surgery (Courcoulas et al, 2018). [20]

Key Points

- Focus on long-term habits. Lasting weight loss comes from sustainable changes to diet and lifestyle, not quick fixes or fad diets.
- Aim for safe, gradual progress. Losing 1–2 pounds per week through a mix of calorie reduction and exercise is the healthiest and most effective.
- Set realistic, trackable goals. Create specific, achievable goals and monitor progress regularly to stay motivated and make adjustments as needed.
- Build a support network. Family, friends, and professionals can provide encouragement, accountability, and helpful resources along the way.
- A healthy diet includes balanced portions of essential nutrients, guided by tools like MyPlate and visual cues to support moderation and variety.
- MyPlate emphasizes filling half the plate with fruits and vegetables, choosing whole grains and lean proteins, and limiting added sugars and saturated fats.
- Eating a wide variety of foods from all food groups, especially nutrient-dense superfoods, enhances overall health and disease prevention.
- Practical food skills, safe preparation, and mindful dining choices are key to maintaining long-term healthy eating habits.

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9.2: The Importance of Physical Activity in Maintaining a Healthy Weight



Figure 9.2.1: Engaging in physical activity regularly is important to long-term functioning. (Woman Running Down a Road; Jeremy Stewart via Unsplash)

Introduction

Physical activity plays a vital role in achieving and maintaining a healthy weight, but its benefits extend far beyond weight management. For individuals embarking on a weight loss journey or striving to maintain their progress, incorporating regular physical activity into daily routines is crucial for achieving long-term success and overall well-being. Physical activity supports cardiovascular health, reduces the risk of chronic diseases, enhances mood, and boosts energy levels, making it a powerful tool for both physical and mental health. This section explores the significance of physical activity, the recommended amounts, and the types of exercises that can help individuals achieve their health objectives.

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) who fall into the overweight classification based on BMI is 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 (National Institute of Diabetes and Digestive and Kidney Diseases, n.d.). [41]



Figure 9.2.2: Obesity is a large societal problem. (CC BY 3.0 via Wikimedia Commons)

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 (Centers for Disease Control and Prevention, n.d.). [5] 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 that 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 their 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 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.

Food for Thought...

Think about someone you know or yourself:

- How could using multiple body composition measurements change the way you view health and fitness goals compared to just using BMI?
- What insights might you gain that you would have missed otherwise?

Negative Health Implications of Obesity

People who have obesity, 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
- Many types of cancer
- Low quality of life
- Mental illness, such as clinical depression, anxiety, and other mental disorders
- Body pain and difficulty with physical functioning

Understanding Diabetes

Diabetes is a disease that affects how the body turns food into energy. There are three main types of diabetes: type 1, type 2, and gestational diabetes, which occurs during pregnancy. More than 122 million Americans are currently living with diabetes (37.3 million, or 11.3% of the U.S. population) or prediabetes (96 million, or 38.0% of the adult population) (Centers for Disease Control and Prevention, 2022). [14]

Insulin plays a central role in managing blood sugar levels. Most of the food people eat is broken down into sugar (glucose) and released into the bloodstream. When blood sugar levels rise, the pancreas is signaled to release insulin. Insulin acts like a key, allowing blood sugar to enter the body's cells to be used for energy. Without insulin, glucose cannot enter the cells and instead builds up in the bloodstream, leading to high blood sugar. Elevated blood sugar levels can damage the body and are responsible for many of the symptoms and complications of diabetes.



Figure 9.2.3: Technology continues to evolve surrounding diabetes and the process of testing and administering. (Diabetic Tools; Mikhail Nilov via Pexels)

In type 1 diabetes, the pancreas either produces no insulin or very little. This form of diabetes accounts for about 5–10% of all cases and is typically diagnosed in children, teens, and young adults. It is believed to be caused by an autoimmune reaction in which the body mistakenly attacks the insulin-producing cells in the pancreas.

Type 2 diabetes, which accounts for 90–95% of all diabetes cases, occurs when the body's cells do not respond normally to insulin. This type develops gradually over time and is usually diagnosed in adults, although increasing numbers of children, teens, and young adults are also affected. Type 2 diabetes can often be prevented or delayed through healthy lifestyle changes such as weight loss, nutritious eating, and regular physical activity.

Individuals may be at risk for developing type 2 diabetes if they:

- Have prediabetes
- Are overweight
- Are 45 years or older
- Have a parent, brother, or sister with type 2 diabetes
- Are physically active less than 3 times a week
- Have ever had gestational diabetes (diabetes during pregnancy) or given birth to a baby who weighed more than 9 pounds
- Are African American, Hispanic/Latino American, American Indian, or Alaska Native (some Pacific Islanders and Asian Americans are also at higher risk)

Unhealthy Lifestyle Factors

We make healthy and unhealthy choices every day, and many of these decisions—whether intentional or habitual—significantly influence our risk of becoming overweight or obese. These choices encompass a wide range of behaviors, including what we eat, how much physical activity we engage in, how well we manage stress, and even how much sleep we get each night. For example, choosing to eat highly processed, calorie-dense foods and sugary drinks on a regular basis can lead to consuming more calories than the body needs, resulting in weight gain over time. Likewise, a sedentary lifestyle—spending hours sitting at a desk or in front of screens—reduces energy expenditure and contributes to fat accumulation.

Other lifestyle habits, like getting too little sleep or experiencing chronic stress, can alter hormone levels that regulate hunger and fullness, increasing cravings and leading to overeating. Additionally, skipping meals or eating erratically may disrupt metabolism and contribute to poor dietary patterns. While each of these behaviors may seem minor on its own, they can compound over time, making weight management more difficult. The good news is that by becoming more aware of these choices and making small, consistent changes—like incorporating more physical activity, eating more whole foods, and getting adequate sleep—individuals can reduce their risk of obesity and improve their overall health.

Personal Factors

Multiple lifestyle and environmental factors contribute to weight gain and the rising prevalence of obesity. Among the most influential are physical inactivity, poor diet, inadequate sleep, and chronic stress—all of which disrupt the body's ability to maintain a healthy weight. Additionally, where we live, how we get around, the food available in our communities, and the demands of modern work environments can all play a role in shaping our health behaviors. Understanding these influences is essential for developing effective strategies to support healthy weight management.

Lack of physical activity

Lack of physical activity increases your risk of obesity and type 2 diabetes. Strong scientific evidence shows that physical activity helps people maintain a stable weight over time and can reduce the risk of excessive weight gain and the incidence of obesity. Healthy lifestyle changes, such as being physically active and reducing screen time, can help you aim for a healthy weight.

Unhealthy Behaviors and Patterns

Several lifestyle factors can contribute to unhealthy weight gain and increased risk of chronic disease. Key influences include poor eating habits, inadequate sleep, and high levels of stress, all of which can disrupt the body's ability to regulate weight and overall health.

Unhealthy eating behaviors

Unhealthy eating behaviors often contribute to weight gain and increased risk of chronic diseases. Consuming more calories than the body uses can lead to excess fat storage, especially when those calories come from unhealthy sources. Diets high in saturated

and trans fats can raise bad cholesterol levels and increase the risk of heart disease. Similarly, eating foods high in added sugars can lead to spikes in blood sugar, weight gain, and insulin resistance. Additionally, not getting enough dietary fiber can negatively affect digestion, blood sugar control, and cholesterol levels. Making healthier food choices is essential for maintaining long-term health and well-being.

Not enough sleep

Many studies have seen a high BMI in people who do not get enough sleep. Some studies have seen a relationship between sleep and the way our bodies use nutrients for energy, and how lack of sleep can affect hormones that control hunger urges.

High amounts of stress

Acute stress and chronic stress affect the brain and trigger the production of hormones, such as cortisol, that control our energy balances and hunger urges. Acute stress can trigger hormone changes that make you not want to eat. If the stress becomes chronic, hormone changes can make you eat more and store more fat.



Figure 9.2.4: A person's environment can contribute to stress and peace. (Women Walking; Carmen Laezza via Unsplash)

Environmental Factors

Geography, food availability, transportation, and work environments are environmental factors that can increase your risk for being overweight and obese (Lee et al, 2019). [32]

Geography

Where you live may impact your risk of obesity. In the U.S., the South and the Midwest have the highest level of obesity among adults. There is also an increase in BMI in rural areas, which is said to be contributing to approximately 55% of the global increase in BMI. The increase of BMI in rural areas may be due to having farther distances between residences and supermarkets, clinical settings, and recreational opportunities.

Food Availability

The food that is available in your community may impact your risk of obesity. Historical data have shown a relationship between the amount of fast food available in a community and the rate of obesity. The lack of affordable, healthy food is termed a “food desert.” Communities that have been designated as “food deserts” have higher rates of obesity. The ease and availability of high sugar drinks, large portion sizes, and highly processed snack foods all relate to increased risk of obesity.

Transportation

How your community is designed may impact your risk of obesity. A neighborhood purposefully developed to allow for people to be able to walk instead of drive reduces your risk of obesity; high neighborhood walkability is associated with decreased prevalence of overweight and obesity. Neighborhoods that provide recreational facilities, access to sidewalks and paths that remove pedestrians from traffic hazards, and access to parks have all been reported to be facilitators of physical activity.

Work Environment and Advances with Technology

Have you considered how jobs have changed with the advances in technology? From 1960 to 2010, jobs in the U.S. private industry shifted from 50% requiring at least moderate to vigorous physical activity to less than 20% requiring this level of activity intensity (Church et al, 2011). [19] National Health and Nutrition Examination Survey data have documented an association between decreases in work-related energy expenditure and weight gain over the same period. The changes in energy expenditure may be due to advances in technology, for example, the use of email to quickly transmit documents rather than walking them to a colleague.

Individual Factors

Although environmental factors have been shown to impact obesity rates, people can have the same environmental factors and still have variances in obesity, fat distribution, and health issues. Thus, it is important to understand how individual characteristics, such as genetics, impact the risk of obesity.

Race or Ethnicity

Some racial and ethnic minority groups are more likely to have obesity. Rates of obesity in American adults are highest in blacks, followed by Hispanics, then whites. This is true for men or women. While Asian men and women have the lowest rates of unhealthy BMI, they may have high amounts of unhealthy fat in the abdomen, which increases the risk for cardiovascular disease and diabetes. Samoans may be at risk for overweight and obesity because they may carry a DNA variant that is associated with increased BMI.

Sex

In the United States, obesity is more common in black or Hispanic women than in black or Hispanic men.

A person's sex may also affect the way the body stores fat. For example, men store more unhealthy fat around the abdomen than women.

Overweight and obesity are also common in women with polycystic ovary syndrome (PCOS). This is an endocrine condition that causes large ovaries and prevents proper ovulation, which can reduce fertility.

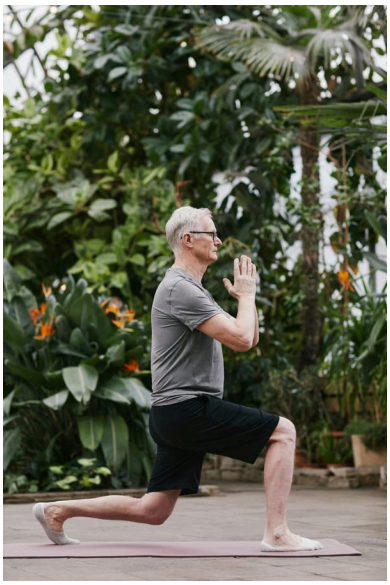


Figure 9.2.5: Yoga is an excellent low-impact activity. (Man Practicing Yoga; Marcus Aurelius via Pexels))

Age

Many people gain weight as they age. The risk of unhealthy weight gain increases as you age. Adults who have a healthy BMI often start to gain weight in young adulthood and continue to gain weight until 60 to 65 years old, when they tend to start losing weight. Childhood obesity remains a serious problem in the United States, and children who are obese are more likely to be obese as adults.

Genetic Influences

The relationship of genetics to obesity has been studied for over 100 years. Although over 50 genes have been shown to have an association with obesity, in most obese people, no single genetic cause can be identified. A study comparing identical and fraternal twins who either grew up together or apart showed that their genetics was more substantially related to their BMI than the environment in which they grew up (Stunkard et al, 1990). [52] Most obesity seems to be multifactorial, that is, the result of complex interactions among many genes and environmental factors.

Medical Conditions

Several genetic syndromes are linked to overweight and obesity due to their impact on metabolism, appetite regulation, and physical activity. For example, **Prader-Willi syndrome** causes chronic hunger and low muscle tone, leading to excessive weight gain from an early age. **Bardet-Biedl syndrome**, **Alström syndrome**, and **Cohen syndrome** are also associated with obesity, often accompanied by developmental delays and metabolic abnormalities.

In addition to genetic factors, endocrine disorders can contribute to weight gain. **Hypothyroidism** slows metabolism due to low thyroid hormone levels, while **Cushing's syndrome** results from excessive cortisol, which promotes fat accumulation, particularly in the abdomen. Furthermore, medical conditions such as arthritis can limit physical activity due to pain or mobility issues, making it harder to maintain a healthy weight. These biological and medical factors highlight the complex causes of obesity beyond lifestyle alone.

Medicines

Some medications can lead to weight gain; these include antipsychotics, antidepressants, antiepileptics, and antihyperglycemics.

Rethinking the Causes of Obesity

After learning about the variety of factors that influence obesity — including genetics, race/ethnicity, sex, age, medical conditions, and medications:

- How does this change your perspective on the common belief that weight management is solely about diet and exercise?
- How might this understanding influence how you approach your own or others' health and wellness goals?

Overweight and Obesity in the United States

According to data from the National Health and Nutrition Examination Survey (NHANES):

- About 1 in 3 adults was considered to be overweight.
- More than 2 in 3 adults were considered to be overweight or obese.
- More than 1 in 3 adults was considered to have obesity.
- About 1 in 13 adults was considered to have extreme obesity.
- About 1 in 6 children and adolescents ages 2 to 19 were considered to have obesity.

Causes and Health Consequences of Being Overweight or Obese

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.



Figure 9.2.6: (Fruits and Juice; Brooke Lark via Unsplash)

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.

More to Explore

For more information on the causes and health consequences of overweight and obesity, please visit NIDDK's web pages on Understanding Adult Overweight and Obesity.

Table 9.2.1 Percentages by Gender of Overweight People

Categories	All (Men and Women)	Men	Women
Overweight and Obesity	70.2%	73.7%	66.9%
Overweight	32.50%	38.7%	26.5%
Obesity (including extreme obesity)	37.7%	35%	40.4%
Extreme Obesity	7.7%	5.5%	9.9%

As shown in the Table 9.2.1:

- More than 2 in 3 adults (70.2 percent) were considered to be overweight or have obesity
- About 1 in 3 adults (32.5 percent) were considered to be overweight
- More than 1 in 3 adults (37.7 percent) were considered to have obesity
- About 1 in 13 adults (7.7 percent) were considered to have extreme obesity
- More than 1 in 3 (38.7 percent) of men, and about 1 in 4 (26.5 percent) of women, were considered to be overweight
- Obesity was higher in women (about 40 percent) than in men (35 percent)
- Extreme obesity was higher in women (9.9 percent) than in men (5.5 percent)
- Almost 3 in 4 men (73.7 percent) were considered to be overweight or have obesity, and about 2 in 3 women (66.9 percent) were considered to be overweight or have obesity.

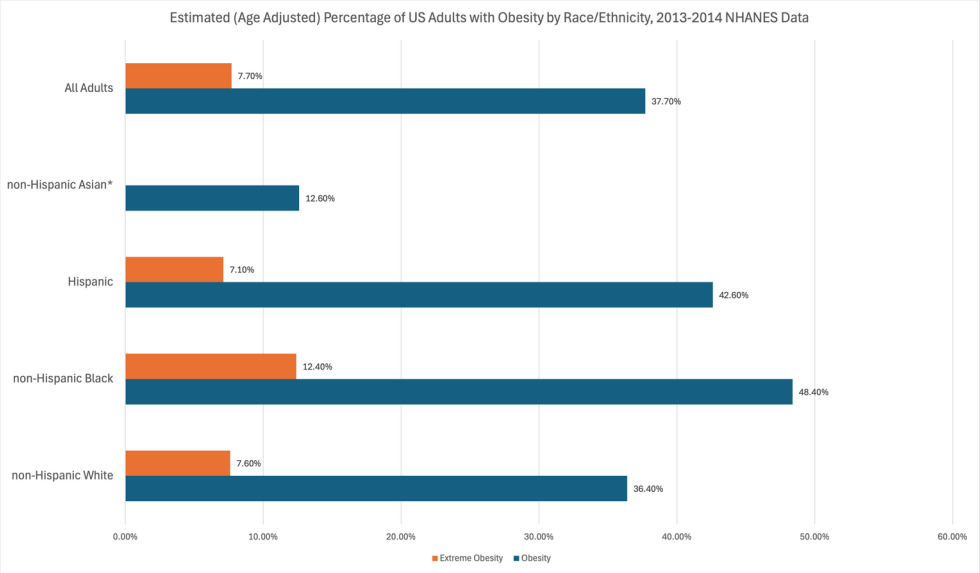


Figure 9.2.7: Obesity rates by race. Data recreated from NHANES; Rusty Johnson, and is in the Public Domain

As shown in the bar graph in Figure 9.2.7:

- Among non-Hispanic white adults, more than 1 in 3 (36.4 percent) were considered to have obesity, and about 1 in 13 (7.6 percent) were considered to have extreme obesity.
- Among non-Hispanic black adults, almost half (48.4 percent) were considered to have obesity, and about 1 in 8 (12.4 percent) were considered to have extreme obesity.
- Among Hispanic adults, about 1 in 2 (42.6 percent) were considered to have obesity, and about 1 in 14 (7.1 percent) were considered to have extreme obesity.
- Among non-Hispanic Asian adults, about 1 in 8 (12.6 percent) were considered to have obesity.
- Data for extreme obesity in Asians were not reported since the numbers are close to zero.

Why is Physical Activity Important?

Regular **physical activity** is important for overall health and is especially critical for individuals aiming to lose or maintain a healthy weight. When it comes to weight loss, increased physical activity helps the body burn more calories, contributing to a

calorie deficit—an essential condition in which the body uses more energy than it consumes. This deficit encourages the body to utilize stored fat for fuel. Although initial weight loss is often primarily due to reduced caloric intake, research indicates that long-term weight maintenance depends heavily on consistent physical activity. Without regular movement, individuals are more likely to regain lost weight. In addition to its role in weight management, physical activity independently provides substantial health benefits. It reduces the risk of chronic diseases such as cardiovascular disease and type 2 diabetes, even in the absence of significant weight loss. Thus, regular exercise not only supports weight control but also promotes heart health, improves blood sugar regulation, and enhances overall well-being.

When it comes to losing weight, increasing physical activity plays a crucial role by helping the body burn more **calories** for energy. This process, combined with a reduction in caloric intake, creates what is known as a "calorie deficit"—a condition where the body uses more energy than it receives from food. This deficit is essential for weight loss, as it forces the body to tap into stored fat for fuel. While most initial weight loss is typically the result of eating fewer calories, research shows that maintaining that weight loss over time requires a consistent commitment to regular physical activity. Without ongoing movement, it is much easier to regain lost weight. Beyond its role in managing weight, physical activity offers significant health benefits on its own. It reduces the risk of serious chronic conditions such as cardiovascular disease and type 2 diabetes, even if no significant weight loss occurs. This means that staying active not only helps with weight control but also strengthens the heart, improves blood sugar regulation, and supports overall long-term health.

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 (Centers for Disease Control and Prevention, 2022) [17]

More to Explore

On its website, the CDC explains the importance of including physical activity as part of any weight loss program (Centers for Disease Control and Prevention, n.d.). [7]

Visit the CDC website for more information on how the inclusion of physical activity will help you reach your goals:

Centers for Disease Control - Importance of Physical Activity

How Much Physical Activity Do I Need?

When it comes to weight management, individuals vary significantly in how much physical activity they require, as needs are influenced by factors such as age, gender, genetics, metabolic rate, body composition, and overall lifestyle. While general recommendations provide a useful starting point, it's important to recognize that some people may need more or less activity to achieve or maintain a healthy weight. For example, those with sedentary jobs or slower metabolisms may require more exercise to prevent weight gain, while individuals with naturally higher metabolic rates may find it easier to maintain their weight with less activity. The key is to personalize physical activity levels based on one's goals and to adjust them over time. Understanding and applying these individualized needs—while aiming to meet or exceed the standard physical activity guidelines—can significantly improve long-term weight management and overall health.

To Maintain Your Weight

Individuals are encouraged to gradually increase their physical activity to meet the recommended guidelines of at least 150 minutes of moderate-intensity aerobic exercise, 75 minutes of vigorous-intensity aerobic exercise, or a combination of both each week. Moderate-intensity activities may include brisk walking, dancing, or light cycling, while vigorous-intensity exercises can involve running, swimming laps, or high-intensity interval training (HIIT).

Extensive research supports the role of regular physical activity in maintaining a healthy body weight over time. However, the

specific amount of activity needed to prevent weight gain or sustain weight loss can vary considerably among individuals due to factors such as genetics, metabolism, dietary habits, and overall lifestyle.

Some people may require more than 150 minutes of moderate activity per week to maintain their current weight, particularly if they are not also modifying their diet. For individuals who have already lost weight, higher levels of physical activity—often ranging from 200 to 300 minutes per week—may be necessary to avoid weight regain.

Consistency remains essential, and it is beneficial for individuals to engage in forms of physical activity they enjoy and can maintain long-term. Beyond structured exercise sessions, increasing daily movement through activities such as walking more, using stairs, or standing during work can further support weight management and enhance overall health.

What do you like to do?

Think about the various ways to be physically active through recreation, home gardening, exercise, and competition.

- What do you enjoy doing?
- What is challenging for you?
- Can you combine the two things and do things you enjoy that are challenging to stay active?

To Lose Weight and Keep it Off

Achieving and maintaining a healthy weight requires a balanced approach that includes both regular physical activity and a nutritious, calorie-conscious eating plan. If you are aiming to lose weight but do not make changes to your diet, you will need to engage in a high volume of moderate to vigorous physical activity just to create a calorie deficit. Similarly, focusing solely on dietary changes without incorporating regular movement can limit your results and make it more difficult to sustain weight loss over time.

In reality, combining exercise and healthy eating is the most effective and sustainable strategy. Physical activity helps you burn calories, preserve lean muscle mass, and boost your metabolism, while a well-balanced diet ensures that your body receives the nutrients it needs without excess calories.

Trying to rely on just one of these elements often leads to frustration, stalled progress, and a higher likelihood of regaining weight. For long-term success, it's important to adopt a holistic lifestyle approach that includes both increased physical movement and mindful eating habits. This balanced method not only supports healthy weight management but also contributes to better energy levels, mental health, and overall well-being.

Moderate-Intensity Activities

While performing the 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

- 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 (Centers for Disease Control and Prevention, 2023) [18]

Table 9.2.2 provides a list of common moderate intensity physical activities and the average calories expended during those activities.

Table 9.2.2 Calorie Expenditure by Moderate Intensity Activity

Moderate Intensity Physical Activity	Approximate Calories / 30 Minutes for a 154 lb. Person	Approxi
Hiking	185	
Light Gardening/Yard Work	165	
Dancing	165	
Golf (Carrying Clubs)	165	
Bicycling (<10 mph)	145	
Walking (3.5 mph)	140	
Weightlifting (General Light Workout)	110	
Stretching	90	

Calories burned per hour will be higher for persons who weigh more than 154 lbs (70 kg) and lower for persons who weigh less. This data was adapted from the CDC guidance (Centers for Disease Control and Prevention, 2022). [15]

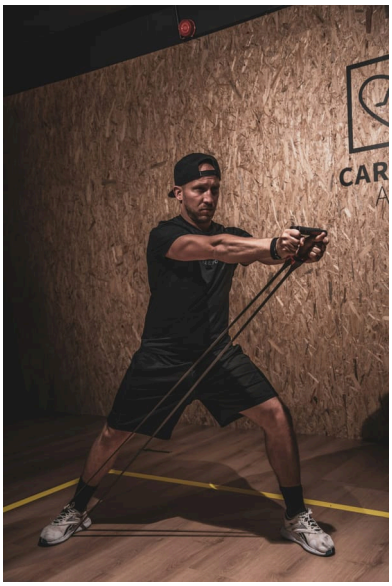


Figure 9.2.8: (Man Exercising; Sven Mieke via Unsplash)

Vigorous-Intensity Activities

If your heart rate is increased substantially, and you are breathing too hard and fast to have a conversation, it is probably vigorous and intense.

Examples of vigorous exercise include:

- Jogging/running
- Swimming laps
- Rollerblading/inline skating at a brisk pace
- Cross-country skiing
- Most competitive sports (football, basketball, or soccer)
- Jumping rope (Centers for Disease Control and Prevention, 2023) [18]

Table \(\PageIndex{2}\) provides a list of common vigorous physical activities and the average calories expended during those activities.

Table 9.2.3 Calorie Expenditure by Vigorous Intensity Activity

Vigorous Intensity Physical Activity	Approximate Calories / 30 Minutes for 154 lb. Person	Approx
Running/Jogging (5 mph)	295	
Bicycling (>10 mph)	295	
Swimming (Slow Freestyle Laps)	255	
Aerobics	240	
Walking (4.5 mph)	230	
Heavy Yard Work (Chopping Wood)	220	
Weightlifting (Vigorous Effort)	220	
Basketball (Vigorous)	220	

Calories burned per hour will be higher for persons who weigh more than 154 lbs (70 kg) and lower for persons who weigh less. This data was adapted from the CDC guidance. (Centers for Disease Control and Prevention, 2022). [15]

Question

- What does moderate and vigorous intensity mean?
  - Think about 2 moderate and 2 vigorous activities that you could see yourself doing regularly.

Importance of Resistance Training

Resistance training, also referred to as strength or weight training, involves exercises designed to improve muscular strength and endurance by making muscles work against a force. This force may come from free weights, resistance bands, machines, or body weight. Resistance training is a foundational component of physical fitness and plays a vital role in body composition, metabolic function, bone health, and overall well-being. Its benefits extend beyond athletic performance and are crucial for individuals pursuing weight loss, weight maintenance, or healthy weight gain.



Figure 9.2.9: Strength training is just as important as cardio and flexibility work. (Deadlift; Alora Griffiths via Unsplash)

Weight Loss

Resistance training is an essential component of a comprehensive weight loss strategy. Unlike aerobic exercise, which primarily burns calories during the activity, resistance training contributes to an increased resting metabolic rate through the development of lean muscle mass. Muscle tissue is metabolically active, meaning it burns more calories at rest than fat tissue (Westcott, 2012). [57] Therefore, building muscle helps individuals burn more energy throughout the day, even when not exercising.

In addition, resistance training helps preserve lean mass during caloric restriction. This is important because losing muscle mass during weight loss can lead to a slower metabolism and an increased risk of weight regain. By preserving or even increasing muscle mass, resistance training promotes more effective and sustainable fat loss (Willis et al, 2012). [58]

Maintenance

Maintaining weight loss can be more challenging than achieving it. Resistance training is a powerful tool for weight maintenance because it supports continued metabolic health, strength, and functional fitness. Consistent strength training sessions—typically two to three per week—help maintain muscle tissue, which is key to preserving energy expenditure over time.

Moreover, regular resistance exercise improves insulin sensitivity, reduces visceral fat, and helps regulate hormones involved in appetite and metabolism (Westcott, 2012). [57] These benefits are particularly important for aging adults, as resistance training also counters age-related muscle loss (**sarcopenia**), which can compromise balance, mobility, and independence.

Healthy Weight Gain

For individuals who need to gain weight—whether due to underweight status, athletic goals, or recovery from illness—resistance training provides a healthy and structured approach. Rather than accumulating excess fat, resistance training stimulates hypertrophy, or muscle growth, especially when combined with a calorie-surplus diet rich in high-quality protein (Phillips & Winett, 2010). [49] This approach leads to improved strength, body composition, and physical function.

Progressive overload—gradually increasing the resistance or volume of training—is a core principle of resistance training and essential for muscle development. Through this method, individuals can achieve weight gain in the form of lean mass, which supports long-term health and fitness.

Key Points

- **Physical activity and health**: Regular physical activity is essential for maintaining a healthy weight, improving cardiovascular health, and lowering the risk of chronic disease. It also enhances mood, boosts energy, and supports overall quality of life.
- **Rising obesity rates**: Since 1962, rates of overweight and obesity in the U.S. have risen sharply, with overweight rates more than doubling and obesity nearly tripling. Today, over 70% of adults are classified as overweight or obese.
- **Childhood and adolescent obesity**: Obesity among children and adolescents continues to grow, with 17.4% of children (ages 6–11) and 20.6% of adolescents (ages 12–19) affected. These trends increase the risks of insulin resistance and early-onset type 2 diabetes.
- **Comprehensive health assessment**: Relying on BMI alone can be misleading, so combining it with waist circumference and body fat percentage provides a clearer picture of health risks. This approach improves accuracy in evaluating obesity-related outcomes.
- **Health risks of obesity**: Excess weight significantly raises the likelihood of developing serious health conditions such as cardiovascular disease, diabetes, hypertension, stroke, osteoarthritis, sleep apnea, certain cancers, and mental health disorders.
- **Diabetes and lifestyl**e: Type 2 diabetes accounts for 90–95% of all diabetes cases and is closely linked to obesity and lifestyle factors. It can often be prevented or managed through a healthy diet, regular physical activity, and weight control.
- **Contributing factors to obesity**: Obesity is influenced by a combination of lifestyle, environmental, and personal factors. Poor diet, inactivity, stress, inadequate sleep, medications, and limited access to healthy foods all play important roles.
- **Beyond willpower**: Weight management is not solely about self-control, as genetics, medical conditions, socioeconomic environment, and cultural influences also contribute. Recognizing these factors highlights the complexity of obesity.
- **Weight control and health**: Physical activity supports weight loss, helps prevent weight regain, and reduces chronic disease risk. It plays a central role in sustaining long-term health and well-being.
- **Activity recommendations**: Adults should aim for at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity activity per week. For weight-loss maintenance, 200–300 minutes may be required.
- **Resistance training**: Strength training builds lean muscle, increases resting metabolism, and supports bone health. It also prevents age-related muscle loss, improving mobility, balance, and overall function.
- **Balanced lifestyle approach**: The most sustainable strategy for weight management combines regular physical activity with a healthy, nutrient-rich diet. This approach promotes lasting weight control, higher energy, and improved overall wellness.

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9.3: Healthy Weight Loss, Weight Gain, or Maintain



Figure 9.3.1: (Man Eating Noodles; Khanh Nguyen via Unsplash)

Introduction

Maintaining weight loss requires more than just reaching a number on the scale—it involves reshaping the behaviors, routines, and emotional patterns that influence how and why we eat. The Centers for Disease Control and Prevention (CDC) encourages a long-term, habit-based approach to weight management through the simple yet powerful strategy of Reflect, Replace, Reinforce. This chapter explores how to identify personal eating habits and triggers, replace unhealthy behaviors with positive alternatives, and reinforce these new habits to build a healthier, more mindful relationship with food. By taking small, intentional steps, individuals can create lasting change that supports both weight maintenance and overall well-being.

Keeping the Weight Off

The CDC emphasizes that permanent weight loss is not about quick fixes, crash diets, or temporary programs, but rather about making sustainable changes to your eating habits that integrate seamlessly into your everyday life. This concept is rooted in the understanding that our habits—especially those surrounding food and nutrition—are deeply tied to our routines, emotions, and environment. Therefore, long-term weight management requires a gradual shift in mindset, behavior, and choices.

Rather than focusing on restrictive diets that eliminate entire food groups or drastically cut calories, a more effective and healthy approach involves adopting balanced, mindful eating practices that you can maintain over time. This includes learning to recognize hunger and fullness cues, practicing portion control, incorporating more whole foods like fruits, vegetables, whole grains, and lean proteins, and reducing the intake of processed and high-sugar items—not because they're "off-limits," but because you begin to prefer healthier options that make you feel better.

The key to lasting success lies in consistency, not perfection. Occasional indulgences or off days don't derail progress when healthy habits are firmly established as part of your lifestyle. Over time, as these habits become second nature, they lead to a natural, sustained improvement in weight and overall health.

In essence, the CDC's guidance reflects the reality that true transformation happens through small, intentional changes that are realistic, enjoyable, and compatible with your life, not through drastic overhauls that are impossible to maintain. [9]

Reflect, Replace, Reinforce: A Process for Improving Your Eating Habits

The concept of reflection, replacement, and reinforcement of your positive tendencies is a powerful framework for creating lasting change in eating habits and supporting weight loss. It begins with reflecting on your current eating behaviors—identifying when, where, and why you eat, especially in response to emotions, stress, or routines. Once you recognize these patterns, the next step is to replace unhealthy habits with healthier alternatives, such as swapping out sugary snacks for fruits or choosing water over soda. Finally, it's important to reinforce these positive changes by celebrating small successes and reminding yourself of the benefits, like increased energy or improved mood. By consistently applying this cycle, individuals can build sustainable habits that support long-term weight management and a healthier lifestyle.

Reflect, Replace, Reinforce: Personal Application

- 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 (See the list of common habits below).
- 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 (See the list of common triggers below).
- 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.

Common eating habits that can lead to weight gain

- Eating too fast
- Always clean 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)

Common triggers for eating when not hungry

- 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 [8]



Figure 9.3.2: Candy can be a common poor eating habit. (Variety of Candy Bars; Behnam Norouzi via Unsplash)

Reflection and Replacement: Going Further

- Can I do anything to avoid the cue or situation that causes unhealthy eating habits?
  - 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 to sit so you are not next to the vending machine?
- For things I cannot avoid, can I do something differently that would be healthier?
  - 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 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, commit to sharing 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 that 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. [8]

Healthy Weight Loss

Achieving and maintaining a healthy weight is essential for physical and mental well-being. It reduces the risk of chronic diseases

such as heart disease, diabetes, and certain cancers while improving energy levels, mood, and mobility. Whether the goal is weight loss or healthy weight gain, understanding energy balance, nutritional strategies, and sustainable habits is key to long-term success.

Healthy weight loss focuses on reducing body fat while preserving lean muscle mass, supporting overall health, and avoiding harmful dieting practices. The most effective approach involves a combination of balanced nutrition, increased physical activity, and consistent behavior changes. [55]

Energy Balance

Weight changes are fundamentally influenced by energy balance, which refers to the relationship between the number of calories consumed and the number of calories the body burns.

Neutral

A **neutral energy balance** occurs when caloric intake equals caloric expenditure. In this state, weight is maintained because the body is receiving just enough energy to support its functions and activity levels. [46]

Positive

A **positive energy balance** happens when calorie intake exceeds calorie expenditure, leading to weight gain. If excess energy is not used for physical activity or metabolic demands, it is stored as body fat. [13]

Negative

A **negative energy balance** is required for weight loss. This occurs when the body burns more calories than it consumes, forcing it to draw energy from stored fat. [57] A safe and sustainable rate of weight loss is generally 1–2 pounds per week, which typically requires a daily deficit of 500–1,000 calories. [13]

Cutting Calories

Reducing overall caloric intake is a core method for creating a negative energy balance. However, not all calories are created equal. Emphasis should be placed on nutrient-dense foods that provide vitamins, minerals, and fiber while limiting added sugars, saturated fats, and empty-calorie foods. [54]

For example:

- Replace sugar-sweetened beverages with water or unsweetened tea.
- Choose smaller portions and eat mindfully to avoid overeating.
- Incorporate more fruits, vegetables, lean proteins, and whole grains.

Cutting Carbohydrates

Some individuals choose to reduce carbohydrate intake as a weight loss strategy. While low-carb diets can lead to initial weight loss—often due to water loss and reduced calorie intake—the key is choosing healthy carbohydrates over refined ones. Complex carbs such as whole grains, legumes, fruits, and vegetables offer fiber and nutrients essential to a balanced diet. [2] Total elimination of carbohydrates is not recommended, especially for active individuals.

Healthy Weight Gain

Healthy weight gain is just as important as weight loss for underweight individuals, recovering from illness, or building muscle mass. The focus should be on gaining lean body mass, not excess fat, through a combination of calorie surplus and resistance training.

Strategies

Gaining weight healthily and sustainably requires more than simply eating more food—it involves a strategic approach that prioritizes quality nutrition and physical activity. The goal of healthy weight gain is to increase lean body mass rather than excess fat, which can be achieved through a combination of increased caloric intake, nutrient-dense food choices, and consistent resistance training. Individuals looking to gain weight—whether due to underweight status, athletic goals, or recovery from illness—can benefit from adopting specific habits that support muscle growth and overall health. The following strategies provide a framework for gaining weight safely and effectively.

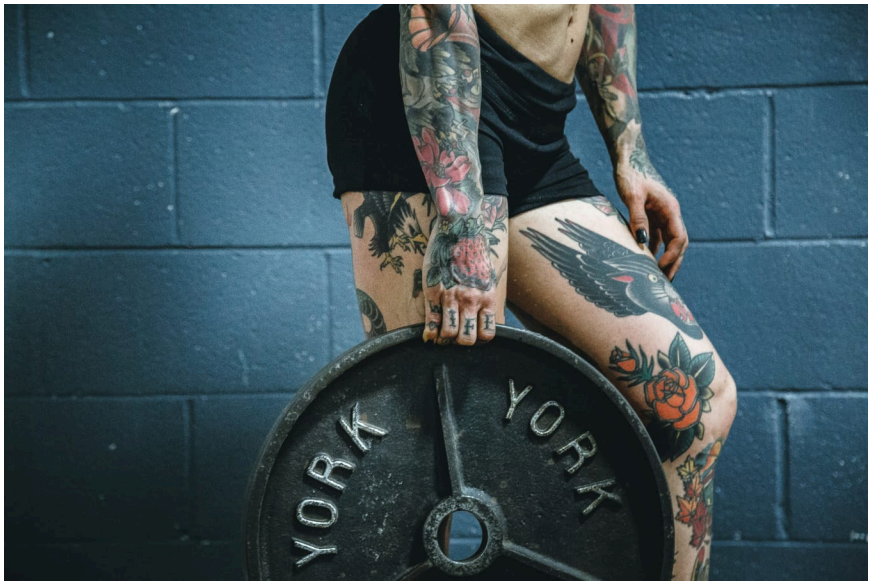


Figure 9.3.3: Working out, combined with increased caloric intake, will aid in healthy weight gain. (Black Weight Plate; Alora Griffiths via Unsplash)

Increase Caloric Intake Gradually

Add 300–500 calories per day above maintenance needs to gain weight steadily and healthfully. Emphasize calorie-dense but nutritious foods like nuts, nut butters, dried fruit, whole grains, and avocados. [49]

Eat More Frequently

Consuming five to six smaller meals throughout the day can be easier than three large meals. Include snacks with protein and healthy fats to support muscle growth.

Choose Nutrient-Dense Foods

Instead of loading up on empty calories, focus on high-protein foods (e.g., chicken, eggs, Greek yogurt), healthy fats (e.g., olive oil, seeds), and complex carbohydrates (e.g., oats, brown rice) to promote healthy gains.

Engage in Resistance Training

Strength training stimulates muscle hypertrophy when paired with adequate protein and caloric intake. This helps ensure that the weight gained is primarily lean mass rather than fat. [57]

Track Progress

Monitor body weight, energy levels, and strength to ensure that the approach is effective and healthy. Adjust intake and exercise accordingly.



Figure 9.3.4: Managing caloric intake with a healthy diet is important to reaching nutrition and weight management goals. (ChatGPT Generated Picture via OpenAI)

Introduction to Weight Loss Strategies and Programs

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. 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.

Most individuals have likely encountered weight loss advertisements in newspapers, magazines, or social media platforms. With approximately 50% of the U.S. population reporting an attempt to lose weight within the past year, it is unsurprising that the weight loss industry has grown into a $3 billion market. [11]

Achieving and maintaining a healthy weight involves more than just willpower — it requires a thoughtful approach that includes understanding personal motivation, setting realistic goals, and making lasting behavior changes. Safe and effective weight management takes into account not only diet and exercise but also lifestyle factors, medical conditions, and individual needs. From self-guided strategies to professional programs and medical interventions like bariatric surgery, there are a variety of tools available to support individuals on their weight loss journey. The key is to find a sustainable and evidence-based approach that promotes long-term health and well-being.



Figure 9.3.5: Busy people sometimes need to eat on the go, throwing nutritional goals aside. (Waistline Measurement by Kaboompics.com via Pexels.com)

Commit to a Weight Loss Plan

Committing to a weight management plan requires more than good intentions; it demands thoughtful preparation and consistent action. The process begins with making a firm commitment to change, supported by a clear understanding of the reasons for improving health. From there, individuals should evaluate their current habits, health status, and lifestyle. Setting S.M.A.R.T. (Specific, Measurable, Achievable, Relevant, and Time-bound) goals provides a focused and realistic path forward. Equipping oneself with the proper resources, tools, and support systems further strengthens the journey. Finally, regularly recording progress and celebrating milestones reinforces the effort invested and helps build the motivation necessary to sustain long-term success.

Setting goals is important for behavior change

1. Commit to losing weight. Individuals should clearly define their reasons for wanting to lose weight.
2. Take stock of the current situation. Take time to assess their current health and lifestyle. Keeping a food and exercise diary for one week and reviewing it can help identify changes that may support weight loss.
3. Set S.M.A.R.T. goals.
4. Utilize resources and support. Individuals should seek out resources, tools, information, or support systems that can assist in successfully reaching their goals.
5. Record progress and celebrate achievements. Tracking progress and acknowledging or rewarding effort reinforces motivation and commitment.

More to Explore

The Body Weight Planner is a helpful tool for assisting you in making a personalized calorie and physical activity plan to reach your goal weight within a specific period and to maintain it afterwards.

Individuals who feel they would benefit from additional help and support may consider enrolling in a structured weight loss program. With the wide variety of programs available today, ranging from commercial plans to medically supervised clinics, it can often be overwhelming to determine which option is best suited to their needs. A good starting point is to have an open conversation with a healthcare provider. By expressing concerns about weight, individuals may receive recommendations for reputable weight loss programs or referrals to specialists such as registered dietitians or weight management counselors. When evaluating different programs, it is important to focus on those that promote lasting lifestyle changes rather than quick fixes or rigid diets that emphasize only specific foods or supplements. The most effective programs take a holistic approach, addressing nutrition, physical activity, behavioral habits, emotional well-being, and long-term maintenance strategies to support overall health and sustainable weight loss.

Picking a Program

According to the National Institute of Diabetes and Digestive and Kidney Diseases, a safe and successful weight-loss program should include:

- **Behavioral treatment**, also called lifestyle counseling, can teach you how to develop and stick with healthier eating and physical activity habits—for example, keeping food and activity records or journals.
- Information about getting enough sleep, managing stress, and the benefits and drawbacks of weight-loss medicines.
- Ongoing feedback, monitoring, and support throughout the program, either in person, by phone, online, or through a combination of these approaches.
- Slow and steady weight-loss goals—usually 1 to 2 pounds per week (though weight loss may be faster at the start of a program).
- A plan for keeping the weight off, including goal setting, self-checks such as keeping a food journal, and counseling support.

If you would prefer an online program, it should include:

- Organized weekly lessons, offered online or by podcast, and tailored to your personal goals.
- Support from a qualified staff person to meet your goals.
- A plan to track your progress on changing your lifestyle habits, such as healthy eating and physical activity, using tools such as cellphones, activity counters, and online journals.
- Regular feedback on your goals, progress, and results is provided by a counselor through email, phone, or text messages.
- The option of social support from a group through bulletin boards, chat rooms, or online meetings.

Avoid weight-loss programs that make any of the following promises:

- Lose weight without diet or exercise!
- Lose weight while eating as much as you want of all your favorite foods!
- Lose 30 pounds in 30 days!
- Lose weight in specific problem areas of your body!
- Other warning signs to look out for include
  - Very small print, asterisks, and footnotes which may make it easy to miss important information.
  - Before-and-after photos that seem too good to be true.
  - Personal endorsements that may be fabricated. [42]



Figure 9.3.6: (Healthy Diet; Mikhail Nilov via Pexels.com)

Key Points

- Long-term weight loss comes from sustainable habits, not short-term diets. True success means making healthy eating a lasting part of your lifestyle.
- Reflect, Replace, Reinforce is a simple, effective behavior change strategy. Identify unhealthy habits, replace them with better choices, and reinforce your progress.
- Triggers like stress and routine can lead to mindless eating. Recognizing and managing these cues helps prevent eating when not truly hungry.
- Self-awareness and patience are key to building healthy habits. Track your behavior, plan, and stay kind to yourself as you make changes.
- Healthy weight loss involves creating a negative energy balance through reduced calorie intake and increased physical activity while preserving lean muscle mass.
- A sustainable calorie deficit should focus on nutrient-dense foods and may include moderate carbohydrate reduction without eliminating essential nutrients.
- Healthy weight gain requires a calorie surplus combined with resistance training to support lean muscle growth rather than fat accumulation.
- Strategies for gaining weight include eating more frequently, choosing calorie- and nutrient-dense foods, and regularly tracking progress to ensure effectiveness.
- Start with a plan: Successful weight loss begins with commitment, clear goals, and tracking habits and progress.
- Choose sustainable programs: Safe plans promote gradual weight loss and focus on lifestyle changes, not quick fixes.
- Use support systems: Effective programs offer structure, feedback, and social or professional support.
- Avoid false promises: Be wary of programs that promise fast results, unrestricted eating, or target fat loss in specific areas.

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9.4: Health Risks with Eating Disorders

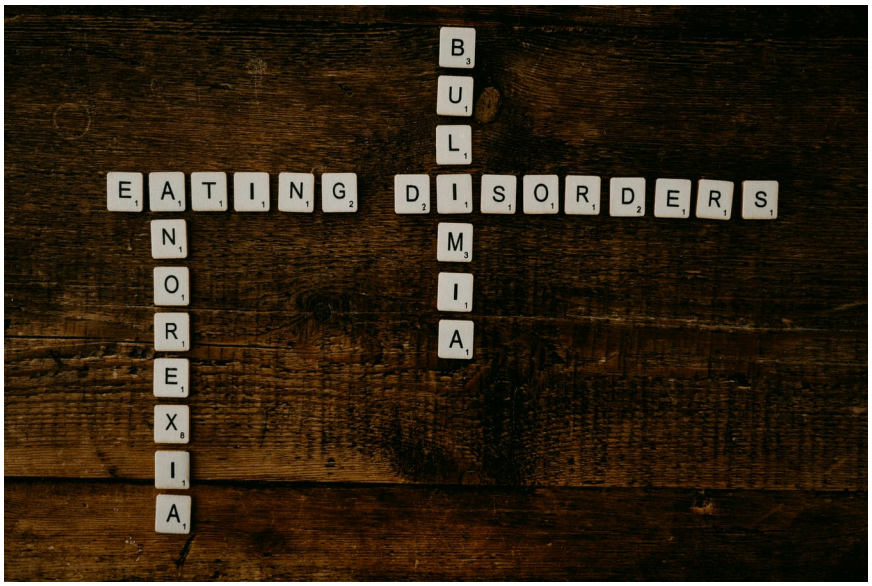


Figure 9.4.1: Eating disorders include anorexia and bulimia. (Eating Disorders; Annie Spratt via Unsplash)

Introduction

Maintaining a healthy body weight is essential for overall well-being, yet millions of individuals struggle with weight-related issues that can lead to serious physical and mental health consequences. Underweight conditions, often caused by inadequate nutrition or chronic illness, can result in a range of complications from nutrient deficiencies to increased vulnerability to disease. Eating disorders such as anorexia nervosa, bulimia, and binge-eating disorder further illustrate the complex relationship between diet, mental health, and body image. These disorders not only disrupt physical health but also have deep psychological roots that require comprehensive treatment. Understanding the causes, symptoms, and treatments of these conditions is crucial for promoting healthier lifestyles and supporting those affected.

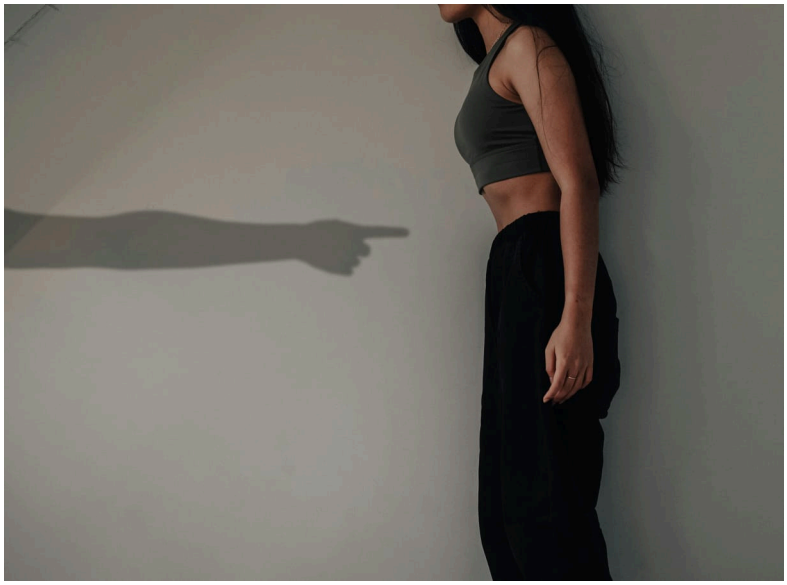


Figure 9.4.1: General discomfort and anxiety can be a contributing factor to some disorders. (Woman in Black Tank Top and Black Pants; Hannah Xu via Unsplash)

Eating Disorders

While there is no single cause of **eating disorders**, research indicates that body dissatisfaction is the best-known contributor to the development of eating disorders and body dysmorphic disorder. **Body dysmorphic disorder** (BDD) is a distressing preoccupation or a markedly excessive concern with one or more perceived or slight defects in physical appearance, associated with significant distress and functional impairment.

Eating disorders are serious and often fatal illnesses that are associated with severe disturbances in people's eating behaviors and related thoughts and emotions. They are associated with a wide range of adverse psychological, physical, and social consequences. A person with an eating disorder may start just eating smaller or larger amounts of food, but at some point, their urge to eat less or more spirals out of control. Severe distress or concern about body weight or shape, or extreme efforts to manage weight or food intake, also may characterize an eating disorder.

Eating disorders are real, treatable medical illnesses. They frequently coexist with other illnesses such as depression, substance abuse, or anxiety disorders. Other symptoms can become life-threatening if a person does not receive treatment, which is reflected by anorexia being associated with the highest mortality rate of any psychiatric disorder.

Anorexia Nervosa

Anorexia nervosa, more often referred to as "anorexia," is a psychiatric illness in which a person obsesses about their weight and about the food that they eat. Anorexia results in extreme nutrient inadequacy and eventually leads 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. Still, 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 engages in purposeful starving, it 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.



Figure 9.4.2: What we see, and they see, can be two different things. (Free License via ChatGPT)

Many people with anorexia nervosa see themselves as overweight, even when they are underweight. Eating, food, and weight control become obsessions. People with anorexia nervosa typically weigh themselves repeatedly, portion food carefully, and eat very small quantities of only certain foods. Some people with anorexia nervosa also may engage in binge eating followed by extreme dieting, excessive exercise, self-induced vomiting, or misuse of laxatives, diuretics, or enemas.

The goals of treatment for anorexia are to restore a healthy body weight and significantly reduce the behaviors associated with 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 body weight for the rest of their lives (National Institute of Mental Health, 2022). [44]

Symptoms of anorexia nervosa include:

- Extremely low body weight
- Severe food restriction
- Relentless pursuit of thinness and unwillingness to maintain a normal or healthy weight
- Intense fear of gaining weight
- Distorted body image and self-esteem that is heavily influenced by perceptions of body weight and shape, or a denial of the seriousness of low body weight
- Lack of menstruation among girls and women.
- Some who have anorexia nervosa recover with treatment after only one episode.
- Others get well but have relapses. Still others have a more chronic, or long-lasting, form of anorexia nervosa, in which their health declines as they battle the illness.
- Thinning of the bones (osteopenia or osteoporosis)
- Brittle hair and nails
- Dry and yellowish skin
- Growth of fine hair all over the body (lanugo)
- Mild anemia, muscle wasting, and weakness
- Severe constipation
- Low blood pressure, or slowed breathing and pulse
- Damage to the structure and function of the heart
- Brain damage
- Multi-organ failure
- Drop in internal body temperature, causing a person to feel cold all the time
- Lethargy, sluggishness, or feeling tired all the time
- Infertility (Mayo Clinic Staff, 2023) [38]

Bulimia Nervosa

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 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 like 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.

Unlike anorexia nervosa, people with bulimia nervosa usually maintain what is considered a healthy or normal weight, while some are slightly overweight. But like people with anorexia nervosa, they often fear gaining weight, desperately want to lose weight, and are intensely unhappy with their body size and shape. Usually, bulimic behavior is done secretly because feelings of disgust or shame often accompany it. The binge eating and purging cycle can happen anywhere from several times a week to many times a day.

Other symptoms include:

- A chronically inflamed and sore throat
- Swollen salivary glands in the neck and jaw area
- Worn tooth enamel and increasingly sensitive and decaying teeth as a result of exposure to stomach acid

- Acid reflux disorder and other gastrointestinal problems
- Intestinal distress and irritation from laxative abuse
- Severe dehydration from purging of fluids
- Electrolyte imbalance—too low or too high levels of sodium, calcium, potassium, and other minerals that can lead to a heart attack or stroke (Mayo Clinic Staff, 2023). [37]

Binge-Eating Disorder

Like 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. Binge-eating disorder is commonly associated with depression and anxiety disorders. 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 (National Institute of Mental Health, 2024). [45] People with binge-eating disorder who are obese are at a higher risk of developing cardiovascular disease and high blood pressure. They also experience guilt, shame, and distress about their binge eating, which can lead to more binge eating (Mayo Clinic Staff, 2023). [38]



Figure 9.4.2: Many high sugar and high salt foods can contribute to binge eating. (Processed Foods; Tim Samuel via Pexels)

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 of 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 composition** is often associated with individuals struggling with eating disorders, the majority of whom are females (Centers for Disease Control and Prevention, n.d.). [4]



Figure 9.4.3: Lower body composition can be dangerous if the person is not consuming the correct nutrients. (Shadowed Girl; cottonbro studio via Pexels)

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 obtained from foods, bone deficiencies will result. 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
- **Osteoporosis**
- Skin, hair, and teeth problems
- Low energy (fatigued all the time)
- Slow or impaired growth due to a lack of nutrients
- Mental health issues such as Depression
- Increased mortality from external causes like accidents, injuries, and suicide (Roh et al, 2014). [50]

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 ensure 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 (Callahan et al, 2020). [3]

Reflection

Answer the following questions briefly, either in writing or during a group discussion:

1. How does body image influence how people feel about themselves?
2. Why is body dissatisfaction considered a major contributor to eating disorders?
3. What are some warning signs of an unhealthy relationship with food or body image?
4. What are one or two healthy strategies you or others could use to build a more positive body image?
5. What is one important thing you are taking away from this topic?

Underweight

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 (Centers for Disease Control and Prevention, n.d.). [4]



Figure 9.4.3: (Woman Eating at Table; Annie Spratt via Unsplash)

How can I help someone?

1. Recognize signs early and educate yourself.
2. Guide them to professional assessment—medical, nutritional, and mental health.
3. Establish a multifaceted care plan: therapy, nutrition, medical oversight, and peer support.
4. Use federal programs.
    - **SAMHSA** - Substance Abuse and Mental Health Services Administration
        - The Substance Abuse and Mental Health Services Administration (SAMHSA) is the agency within the U.S. Department of Health and Human Services (HHS) that leads public health efforts to advance the behavioral health of the nation and to improve the lives of individuals living with mental and substance use disorders, and their families.
    - **NIMH** - National Institute of Mental Health
        - The National Institute of Mental Health (NIMH) is the lead federal agency for research on mental disorders. NIMH is one of the 27 Institutes and Centers that make up the National Institutes of Health (NIH), the largest biomedical research agency in the world. NIH is part of the U.S. Department of Health and Human Services (HHS).
5. Tap nonprofits for emotional, financial, and familial support.
    - **NEDA** - National Eating Disorders Association
        - The National Eating Disorders Association (NEDA) works to advance research, build community, and raise awareness to support the nearly 30 million Americans who will experience an eating disorder in their lifetimes.
    - **ANAD** - The National Association of Anorexia Nervosa and Associated Disorders
        - ANAD believes people heal better when they know they're not alone. As the leading nonprofit in the U.S., ANAD is a free peer support community that is here to help anyone struggling with an eating disorder.
    - **OA** - Overeaters Anonymous

        - OA is a community of people who, through shared experience, strength, and hope, are recovering from unhealthy relationships with food and body image.
    - **Project Heal** - The Project Heal
        - Project Heal advances the national movement for affirming, accessible, and affordable mental healthcare for people with eating disorders
    - **F.E.A.S.T.** - Families Empowered and Supporting Treatment for Eating Disorders
        - F.E.A.S.T. walks alongside families as they navigate the challenges of their loved one's eating disorder. They provide parents and caregivers with transformative peer support, education, empowerment, and community through a multitude of top-notch free programs and services.
6. Maintain continuity: support meals, therapy adherence, and be ready for crisis intervention.

Key Points

- Being underweight can lead to serious health issues such as nutrient deficiencies, weakened immunity, and increased risk of chronic diseases.
- Anorexia nervosa is a life-threatening mental illness marked by extreme calorie restriction, distorted body image, and severe nutrient deficiencies.
- Bulimia involves cycles of binge eating and purging, often maintaining a normal weight but causing internal damage like electrolyte imbalances and tooth erosion.
- Binge-eating disorder leads to overeating without purging, contributing to obesity and related health risks, and is often linked to depression and anxiety.
- Learn to recognize the signs of mental illness so you can support a friend, family member, or anyone in need in getting the help they deserve.
- Body image influences how people think, feel, and behave about their bodies and is shaped by internal and external factors.
- Body dissatisfaction is a leading cause of eating disorders and body dysmorphic disorder.
- Eating disorders are serious, potentially life-threatening conditions with both physical and mental health consequences.
- Both excessive and low body fat can harm health, affecting body systems and overall well-being.
- Promoting positive body image, early intervention, and healthy habits can help prevent and manage body image and eating disorders.

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9.5: Comprehension Check

Summary

This chapter explores how to approach weight management with a healthy mindset, focusing on diet, physical activity, and sustainable lifestyle changes. Managing weight effectively starts with understanding daily calorie intake and expenditure, staying hydrated, and maintaining proper nutrient balance. Healthy weight loss should be gradual—about 1–2 pounds per week—and combine a nutritious diet with regular physical activity to avoid muscle loss and health risks.

The CDC outlines a five-step process for starting a weight loss plan: making a commitment, evaluating current habits, setting realistic goals, finding support, and monitoring progress. Physical activity plays a crucial role in both losing and maintaining weight, offering additional health benefits like reduced risk of chronic diseases and improved mental well-being.

The chapter also discusses the importance of identifying and changing unhealthy eating habits through the CDC's "Reflect, Replace, Reinforce" method. Additionally, it highlights the health risks of being underweight and provides overviews of common eating disorders—anorexia nervosa, bulimia nervosa, and binge eating disorder—emphasizing the psychological and physical consequences of each and the need for comprehensive treatment.

Test Your Understanding

1. What is the recommended rate of healthy weight loss per week, and why is this rate advised over faster methods?
2. Explain the relationship between physical activity, caloric intake, and weight loss. How does creating a "calorie deficit" contribute to weight loss?
3. What are some common cues or triggers that can lead to unhealthy eating habits, and what strategies can be used to address them?
4. How do anorexia nervosa, bulimia nervosa, and binge-eating disorder differ in terms of behavior, physical effects, and treatment approaches?
5. Why is it important to combine dietary changes with physical activity when trying to maintain long-term weight loss?

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Chapter 9 Glossary

- **Alström syndrome**: A rare inherited disorder causing vision and hearing loss, obesity, diabetes, heart disease, and organ damage. There is no cure, but symptoms can be managed.
- **Anorexia Nervosa**: An eating disorder marked by extreme food restriction, fear of gaining weight, and a distorted body image, resulting in dangerously low body weight.
- **Anti-Inflammation Diet**: A way of eating that focuses on consuming foods that reduce inflammation in the body. It emphasizes fruits, vegetables, whole grains, healthy fats (like olive oil and nuts), and lean proteins while limiting processed foods, added sugars, and unhealthy fats.
- **Bardet-Biedl syndrome**: A rare genetic disorder causing vision loss, obesity, extra fingers/toes, kidney issues, and developmental delays. It has no cure, but symptoms can be managed.
- **Bariatric Surgery**: A weight-loss procedure that reduces stomach size or alters digestion to help limit food intake and promote weight loss.
- **Behavioral Treatment**: A therapy that helps individuals change unhealthy behaviors by using strategies like goal setting, self-monitoring, and positive reinforcement to improve health and well-being.
- **Binge Eating Disorder**: An eating disorder characterized by regularly consuming large amounts of food in a short period while feeling a loss of control, often followed by guilt or distress, but without compensatory behaviors like purging.
- **Body Dysmorphic Disorder**: A mental health condition where a person becomes excessively preoccupied with perceived flaws or defects in their physical appearance, which are often minor or unnoticeable to others, leading to significant distress and impaired daily functioning.
- **Body Image**: A person's thoughts, feelings, and perceptions about their physical appearance and how they believe others view them.
- **Body Positivity**: The belief that all people deserve to have a positive body image, regardless of their size, shape, or appearance, promoting self-acceptance and challenging unrealistic beauty standards
- **Bulimia Nervosa**: An eating disorder characterized by cycles of binge eating followed by compensatory behaviors such as vomiting, excessive exercise, or fasting to prevent weight gain, often driven by a fear of gaining weight and a distorted body image.
- **Calories**: Units of energy that measure the amount of energy food provides when consumed and the body uses when performing physical activities. They are essential for fueling the body's functions, including breathing, digestion, and movement.
- **Cohen syndrome**: A rare genetic disorder causing developmental delays, vision problems, low muscle tone, distinct facial features, childhood obesity, and low white blood cell count. Symptoms are managed with supportive care.
- **Cross-Contamination**: The transfer of harmful bacteria from one surface or food to another, often occurring when raw and ready-to-eat foods come into contact without proper cleaning, leading to potential foodborne illness.
- **Cushing's syndrome**: Caused by excess cortisol, often from steroid use or a tumor. Symptoms include weight gain, a round face, thin skin, muscle weakness, and high blood pressure. Treatment targets the underlying cause.
- **Diabetes**: A chronic condition where the body cannot properly regulate blood sugar (glucose) levels due to problems with insulin production or function, leading to high blood sugar and potential long-term health complications.
- **Diet**: The types and amounts of food and beverages a person habitually consumes to meet their nutritional needs and maintain overall health.
- **Dietary Approaches to Stop Hypertension (DASH) Diet**: An eating plan designed to lower high blood pressure by emphasizing fruits, vegetables, whole grains, lean proteins, and low-fat dairy while reducing sodium, saturated fats, and added sugars.
- **Dietary Guidelines**: Science-based recommendations that provide advice on healthy eating patterns to promote health, reduce the risk of chronic diseases, and meet nutritional needs.
- **Eating Disorders**: Mental health conditions characterized by unhealthy and harmful eating behaviors, such as extreme food restriction, binge eating, or purging, often driven by concerns about body image, weight, or control.
- **Female Athlete Triad**: A medical condition involving three interrelated components: low energy availability (with or without disordered eating), menstrual dysfunction, and low bone mineral density. It is commonly seen in physically active females and can lead to serious long-term health issues if not properly addressed.
- **Gluten Free**: A diet or food product that does not contain gluten, a protein found in wheat, barley, and rye, commonly followed by individuals with celiac disease or gluten sensitivity.
- **Hypothyroidism**: A condition where the thyroid makes too much hormone, causing weight loss, fast heartbeat, nervousness, and heat intolerance. It's treated with medication, radioactive iodine, or surgery.
- **Intermittent Fasting**: An eating pattern that cycles between periods of eating and fasting, focusing on when you eat rather

than what you eat, and is often used for weight management and potential health benefits.
- **Ketogenic Diet**: A high-fat, very low-carbohydrate diet that shifts the body into a state of ketosis, where it burns fat for energy instead of carbohydrates, commonly used for weight loss and managing certain medical conditions.
- **Low Body Composition**: Having a low percentage of body fat and a higher proportion of lean mass (muscle, bone, and other fat-free tissues), which is generally associated with better physical fitness and health when maintained within healthy ranges.
- **Mediterranean Diet**: A dietary pattern based on the traditional eating habits of countries bordering the Mediterranean Sea, emphasizing fruits, vegetables, whole grains, legumes, nuts, olive oil, fish, and moderate wine consumption, while limiting red meat and processed foods.
- **Mindful Eating**: The practice of paying full attention to the experience of eating, including the taste, texture, and smell of food, as well as recognizing hunger and fullness cues, to promote healthier eating habits and improve the relationship with food.
- **Negative Energy Balance**: When the body burns more calories than it consumes, leading to weight loss as the body uses stored fat for energy.
- **Neutral Energy Balance**: When the number of calories consumed equals the number of calories the body burns, resulting in weight maintenance.
- **Obesity**: A medical condition characterized by excessive accumulation of body fat that increases the risk of health problems such as heart disease, diabetes, and certain cancers. It is commonly defined by a body mass index (BMI) of 30 or higher.
- **Osteoporosis**: A condition where bones become weak and brittle due to a loss of bone mass and density, increasing the risk of fractures, especially in the hips, spine, and wrists.
- **Overweight**: A condition where a person has more body weight than is considered healthy for their height, typically defined by a body mass index (BMI) between 25 and 29.9.
- **Paleo Diet**: A dietary pattern based on eating foods presumed to have been available to early humans, focusing on meat, fish, fruits, vegetables, nuts, and seeds, while avoiding processed foods, grains, dairy, and legumes.
- **Physical Activity**: Any movement of the body that requires energy expenditure. It includes all forms of movement, such as walking, running, lifting, dancing, gardening, or structured exercise, and contributes to overall health and fitness.
- **Portion Size**: The amount of food or drink a person chooses to consume at one time, which may be more or less than a standard serving size.
- **Positive Energy Balance**: When a person consumes more calories than their body uses, leading to weight gain as the excess energy is stored as fat.
- **Prader-Willi Syndrome**: A genetic disorder causing poor muscle tone, insatiable appetite, obesity, developmental delays, and behavioral issues. It has no cure, but symptoms can be managed.
- **Progressive Overload**: The gradual increase of stress placed on the body during exercise to improve strength, endurance, or muscle growth. This is achieved by increasing variables such as weight, intensity, duration, or frequency over time, allowing the body to adapt and become stronger.
- **Resistance Training**: A form of physical activity that involves working muscles against an external force—such as weights, resistance bands, or body weight—to improve muscular strength, endurance, and size.
- **Sarcopenia**: An age-related loss of muscle mass, strength, and function, typically beginning around the age of 30 and accelerating with advancing age. It can lead to reduced mobility, increased risk of falls, and decreased quality of life if not addressed through regular physical activity and proper nutrition.
- **Superfood**: A term used to describe nutrient-dense foods that are especially rich in vitamins, minerals, antioxidants, and other compounds believed to promote health and reduce the risk of disease. Examples include foods like blueberries, salmon, kale, and chia seeds.
- **Underweight**: A body weight that is considered too low to be healthy, typically defined as having a Body Mass Index (BMI) below 18.5.
- **Weight Management**: The process of adopting long-term lifestyle habits—such as healthy eating, regular physical activity, and behavior changes—to achieve and maintain a healthy body weight. It includes strategies for losing, gaining, or maintaining weight in a way that supports overall health and well-being.

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10: STRESS, SLEEP, AND MENTAL HEALTH



Figure 10.1: (Man in thinking pose; Ben White via Unsplash)

Introduction to Stress, Sleep, and Mental Health

Stress, sleep, and mental health are deeply interconnected factors that influence nearly every aspect of human well-being. For students and young adults, these areas often present unique challenges as academic demands, social pressures, and lifestyle habits intersect. From a biological perspective, stress triggers physical and emotional responses through the nervous and endocrine systems, affecting mood, cognition, and overall health. While stress can be a motivating force, chronic stress places strain on the body and mind, contributing to illness and impaired functioning.

This chapter explores the nature of stress, including its definitions, sources, and the physiological and psychological responses it produces. It will also examine how stress influences wellness, as well as strategies to manage stress effectively. Sleep, another critical component of health, will be discussed through both its physiological processes and its importance in maintaining energy, concentration, and resilience. The role of adequate sleep in preventing chronic disease and supporting daily performance will be emphasized. Finally, the chapter will highlight the importance of mental health for overall wellness, addressing how stress and sleep interact with emotional well-being and providing strategies to build balance and support long-term mental health.

Learning Objectives

- Identify the nature of stress.
- Discover the physiology of stress and relaxation.
- Recognize the effects of stress on health and performance.
- Differentiate between chronic stress and acute stress.
- Identify comprehensive stress management techniques.
- Recognize how emotional health is an important part of mental health.
- Identify early warning signs of mental health disorders.
- Recognize the important health benefits of adequate sleep.

10.1: Stress and the Stress Response

10.2: Stress - Contributing Factors

10.3: Stress and Wellness
10.4: Sources of Stress
10.5: Managing Stress
10.6: Stress - Or Something More Serious?
10.7: The Importance of Sleep
10.8: Mental Health and Wellness
10.9: Comprehension Check
10.10: Glossary
10.11: References

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10.1: Stress and the Stress Response



Figure 10.1.1: Negative stress can lead to feelings of being overwhelmed and fatigue. (Man in shirt and black pants; Yosi Prihantoro via Unsplash)

Introduction

Stress is a natural response that occurs when the demands placed on a person exceed their perceived ability to cope. Despite its reputation, stress is not always negative as short-term stress can sharpen focus, boost energy, and help individuals rise to challenges. However, when stress becomes intense or prolonged, it can strain both the body and mind. Understanding what stress is, how it works, and why it occurs provides the foundation for learning how to manage it effectively.

What is Stress?

Stress is a universal human experience that affects everyone, though the type and impact can vary widely. Positive stress, known as **eustress**, can motivate people to rise to challenges, enhance focus, and build resilience, such as preparing for a competition or meeting a deadline. Negative stress, or **distress**, occurs when demands exceed a person's coping abilities, leading to feelings of overwhelm, fatigue, or anxiety. Whether helpful or harmful, stress influences both physical and mental health across all stages of life. Thus, stress is the physiological and psychological response of the body to any demand, challenge, or change that disrupts balance or requires adaptation. It involves activation of the nervous and endocrine systems, releasing hormones such as cortisol and adrenaline that prepare the body to respond. Whether it is eustress or distress, the body has specific physiological responses, while at the same time, there are also specific emotional responses to stress.

Stressors are the events, situations, or conditions that trigger the body's stress response. Basically, it's any physical, psychological, or emotional event or condition that produces usually negative reactions. They can be external, such as academic deadlines, financial pressures, work responsibilities, or relationship conflicts, or internal, like negative self-talk and unrealistic expectations. Stressors may be acute, such as a sudden exam or presentation, or chronic, like ongoing caregiving responsibilities or job strain. While some stressors can promote growth and motivation, others may overwhelm coping resources and contribute to distress and health challenges.

The **stress response** is the body's automatic reaction to any demand or challenge, whether real or perceived, that threatens physical or psychological well-being. It involves a complex series of physiological and psychological changes designed to help an individual cope with the stressor.

A simple way to differentiate these terms is the following equation:

Stressor + Stress Response = Stress

Common Stressors

Stress can take many forms, recurring, short-term, or long-term, and may arise from both ordinary situations and major life events. For example, commuting to school or work every day may create ongoing stress, while moving to a new home represents a more significant, transitional stressor. Recognizing the different types of stressors helps us better understand how they affect health and well-being.

Short-term stressors are typically immediate pressures that demand quick adaptation. Examples include trying to complete multiple tasks in a limited time, facing daily inconveniences like traffic delays or running late, preparing for a class presentation, or having an argument (Dhabhar, 2018). [17]

Long-term stressors are ongoing challenges that persist over weeks, months, or even years. These may include chronic workplace difficulties, ongoing family conflict, financial strain, long-term illness, or the burden of caring for someone with serious health needs. Major life events such as the death of a loved one can also create long-lasting stress.

Stressors can be grouped into three broad categories:

- **Environmental stressors** include external conditions such as noise, crowding, traffic, or unsafe living environments.
- **Psychological stressors** stem from internal pressures, such as perfectionism, negative thinking, or fear of failure.
- **Social stressors** arise from interactions and relationships, including conflicts with friends or family, discrimination, or the demands of caregiving.

Change is another leading cause of stress, and it can be either positive or negative, real or perceived. Mild changes, such as watching a scary movie, riding a rollercoaster, or winning a competition, may cause brief stress that quickly passes. More significant changes, such as marriage, divorce, serious illness, or a car accident, create greater emotional and physical strain. In extreme cases, exposure to violence or traumatic events can trigger severe stress reactions that may last long after the event itself.

When the body encounters stress, it triggers a series of physical, psychological, and emotional reactions designed to help cope with the challenge. These responses are part of the body's natural stress response system, which prepares individuals to act quickly in demanding situations. In a general sense, physically, the heart rate may increase and muscles tense; psychologically, attention and focus sharpen; and emotionally, feelings such as anxiety, excitement, or irritability can arise. Understanding these responses sets the stage for exploring the mechanisms behind the stress response (Yaribeygi, 2017). [69]

The Physical Stress Response

The physical response to stress involves a series of automatic changes in the body that prepare it to respond to perceived threats or challenges. Often called the **"fight-or-flight" response**, which activates the nervous, endocrine, and cardiovascular systems to prepare the body for immediate action. For example, heart rate and blood pressure increase, breathing becomes faster, and energy is mobilized to essential muscles. These physiological reactions are designed to enhance survival by increasing alertness, strength, and energy. While these changes can be helpful in short-term situations, chronic activation of the stress response can have negative effects on the body. This section explores the key systems involved, how the body reacts, and the implications for long-term health (Yaribeygi, 2017). [69]

Individual responses to stress can vary widely depending on factors such as genetics, personality, past experiences, and coping strategies. For example, one person might feel energized and motivated when faced with a challenging deadline, while another may experience anxiety, muscle tension, or headaches in the same situation. Similarly, public speaking might excite some individuals and trigger a sense of accomplishment, yet provoke intense nervousness in others. Despite these differences, the body's stress response ultimately aims to maintain balance. This leads to the concept of **homeostasis**, which refers to the body's ability to regulate its internal environment and maintain stable conditions, such as body temperature, blood pressure, breathing rate, and hormone levels, even when faced with external or internal stressors. Homeostasis allows the body to function efficiently, supporting survival and overall health, and the stress response is one mechanism that helps the body restore this equilibrium when it is challenged.

The physical stress response, or "fight-or-flight", prepares the body to react to threats, whether they are real or imagined, and

whether or not they are immediate dangers, minor challenges, or even purely psychological stressors. When the body senses a stressor, the nervous system and endocrine system trigger a cascade of physiological changes. Heart rate and blood pressure increase to deliver more oxygen and nutrients to muscles, breathing quickens to supply extra oxygen, and energy stores such as glucose are released to fuel rapid action. Pupils dilate, senses sharpen, and nonessential functions, like digestion, temporarily slow down. This response occurs regardless of whether the threat is real, imagined, large, or small, equipping the body to respond effectively and protect itself from potential harm. Over time, frequent activation of this system without sufficient recovery can cause wear and tear on the body, underscoring the importance of managing stress.

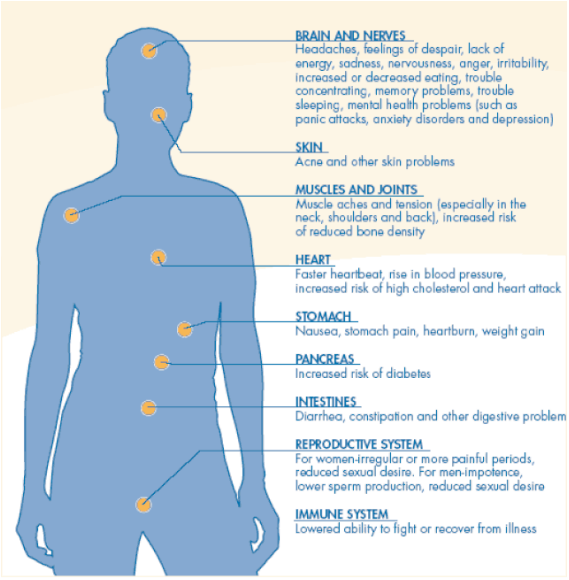


Figure 10.1.2: The different areas of the body that are affected by stress. These are denoted by a yellow circle in the area, from the top of the image; the brain and nerves, the skin, the muscles and joints, the heart, the stomach, the pancreas, the intestines, the reproductive system, and the immune system. (CC BY-SA 3.0; Gdudycha via Wikemedia Commons)

Figure 10.1.2 image is a blue silhouette of a human body, with lines pointing to yellow circles that label different body systems and organs that can be affected by stress. Each label describes potential physical, emotional, or mental health effects:

- **Brain and Nerves**: Stress may cause headaches, feelings of despair, lack of energy, sadness, nervousness, anger, irritability, changes in appetite, trouble concentrating, memory problems, sleep disturbances, and mental health problems such as panic attacks, anxiety disorders, and depression.
- **Skin**: Acne and other skin problems can appear or worsen.
- **Muscles and Joints**: Muscle aches and tension, particularly in the neck, shoulders, and back, as well as an increased risk of reduced bone density.
- **Heart:** Faster heartbeat, higher blood pressure, and increased risk of high cholesterol and heart attack.
- **Stomach**: Nausea, stomach pain, heartburn, and weight gain.
- **Pancreas**: Increased risk of developing diabetes.
- **Intestines**: Diarrhea, constipation, and other digestive problems.
- **Reproductive System**: For women, irregular or more painful menstrual periods and reduced sexual desire. For men, impotence, lower sperm production, and reduced sexual desire.
- **Immune System**: Reduced ability to fight off or recover from illness.

The overall visual emphasizes how stress affects the entire body, linking the nervous, cardiovascular, digestive, reproductive, musculoskeletal, skin, and immune systems.

The Nervous System

The nervous system is the body's primary communication network, responsible for receiving, processing, and responding to internal and external stimuli. It is divided into two main parts: the **central nervous system (CNS)**, which includes the brain and spinal cord, and the **peripheral nervous system (PNS)**, which connects the CNS to the rest of the body. Within the PNS, the autonomic nervous system (ANS) plays a critical role in regulating involuntary bodily functions, such as heart rate, respiration, and digestion. The ANS itself has two main branches: the sympathetic nervous system, which prepares the body for action, and the

parasympathetic nervous system, which promotes rest and recovery.

During a physical stress response, the nervous system coordinates the body's rapid reaction to a perceived threat. When the brain identifies a stressor, it signals the sympathetic nervous system to activate the "fight-or-flight" response. This triggers a series of physiological changes: the heart beats faster, breathing becomes more rapid, muscles receive increased blood flow, and energy stores like glucose are released to fuel immediate action. The nervous system ensures that these responses occur almost instantaneously, allowing the body to respond effectively to danger, whether real or imagined. This coordinated activation highlights the essential role of the nervous system in maintaining survival and preparing the body to cope with stress.

The **autonomic nervous system (ANS)** is a branch of the peripheral nervous system responsible for regulating involuntary bodily functions, including heart rate, digestion, respiratory rate, and blood pressure. It acts largely outside of conscious control, helping maintain the body's internal balance, or homeostasis, during both restful and active states. The ANS has two primary branches: the **sympathetic nervous system** and the **parasympathetic nervous system**. These branches work in opposition to ensure the body responds appropriately to changing internal and external conditions.

The sympathetic nervous system is a specialized branch of the ANS that becomes particularly active during a stress response. Often described as controlling the "fight-or-flight" reaction, it prepares the body for immediate action when a threat is perceived, whether real or imagined. Activation of the sympathetic nervous system triggers rapid physiological changes: the heart rate increases, breathing quickens, blood flow is redirected to major muscle groups, and energy stores are released to provide quick fuel. In contrast, the parasympathetic nervous system dominates during non-stressful periods, promoting rest, digestion, and recovery. Together, these branches of the ANS allow the body to maintain balance while responding efficiently to both everyday challenges and acute stressors.

When a stressor or surge of emotions activates the sympathetic nervous system, the body initiates the "fight-or-flight" response. This system prepares the body to respond quickly to a perceived threat, whether real or imagined. The adrenal glands release stress hormones such as **adrenaline** (epinephrine) and **noradrenaline**, which increase heart rate, elevate blood pressure, and speed up breathing. At the same time, blood flow is directed away from nonessential processes, like digestion, and redirected toward the muscles and brain to support rapid action and heightened alertness.

Alongside these immediate effects, the adrenal glands also release **cortisol**, often called the "stress hormone." Cortisol helps sustain the body's response by increasing blood sugar, enhancing the availability of energy, and suppressing noncritical functions like immunity and reproduction during the stress period. This ensures the body has the resources needed to deal with the challenge. While this response is vital in the short term, prolonged or frequent activation and elevated cortisol can lead to negative health outcomes such as weight gain, weakened immune function, and chronic disease risk.

These changes happen almost instantly, allowing a person to react more effectively to danger or challenge. Pupils may dilate to improve vision, muscles tense to prepare for movement, and glucose is released into the bloodstream to provide quick energy. While these responses are helpful in short-term situations, constant activation of the sympathetic nervous system can place strain on the body, contributing to chronic health problems such as high blood pressure, digestive issues, or a weakened immune system. This balance highlights the importance of both understanding the stress response and developing healthy coping strategies.

Even after the immediate fight-or-flight response has subsided, the body may remain in a state of heightened alert if stress continues, even at a low level. This prolonged response is largely regulated by the **hypothalamic-pituitary-adrenal (HPA) axis,** a key system that links the brain and endocrine glands. When the brain perceives ongoing stress, the hypothalamus releases corticotropin-releasing hormone (CRH), which signals the pituitary gland to secrete adrenocorticotropic hormone (ACTH). ACTH then stimulates the adrenal glands to release cortisol. Cortisol helps maintain energy by regulating metabolism, blood sugar, and inflammation, but if the HPA axis stays overactive, the body experiences **chronically high cortisol levels.** This ongoing activation can disrupt sleep, weaken the immune system, increase the risk of anxiety and depression, and contribute to long-term health problems such as cardiovascular disease and metabolic disorders. The level of cortisol does not return to normal until the threat passes. Once the stress crisis passes, the body can return to the state of homeostasis thanks to the parasympathetic nervous system. If feelings of anxiety, tension, and unease continue, there are relaxation techniques that can help the body return to homeostasis. Section 10.5 will delve into these strategies in detail.

Question

- Think about a time when you were feeling really stressed out.

1. What physical responses did you experience?
2. Were you able to use a strategy that helped you calm down?
3. Does your stress response seem to last a long time?

The Emotional Stress Response

People respond to stress in different ways. Some may experience physical symptoms like digestive issues or headaches, while others may have emotional or cognitive reactions, such as sleeplessness, depressed mood, anger, or irritability. Understanding the distinction between emotional and behavioral responses can help identify how stress is affecting both your internal state and outward actions. The emotional stress response is just as significant as the physical response, shaping how individuals think, feel, and behave in challenging situations. While the body prepares to face a perceived threat through physical changes, the mind reacts with emotions such as anxiety, fear, frustration, or sadness. Not all emotional responses are negative; however, stress can also bring about feelings of motivation, focus, or excitement in the case of positive stress (eustress). These emotional reactions influence decision-making, coping strategies, and overall mental well-being. Having an understanding of the emotional side of stress is essential, as it provides insight into how stress impacts daily life and highlights the importance of managing emotions effectively for long-term wellness.

Anger

Anger is a natural emotional response to stress and perceived threats, arising when individuals feel wronged, threatened, or frustrated. From an evolutionary perspective, anger serves as a protective mechanism, preparing the body to respond to danger by triggering the "fight" component of the fight-or-flight response. Physiologically, it can increase alertness, focus, and energy, enabling a person to defend themselves, assert boundaries, or confront challenges effectively. In this way, anger can be adaptive, motivating constructive problem-solving, promoting self-advocacy, and signaling to others that a boundary has been crossed.



Figure 10.1.3: Although anger is a natural emotional response, intense anger can be harmful. (Man in white and blue crew neck; Ryan Snaadt via Unsplash)

However, anger can become inappropriate or harmful when it is excessive, uncontrolled, or misdirected. Chronic or intense anger can lead to aggressive behavior, impaired judgment, and damage to personal and professional relationships. It may also exacerbate stress-related health issues such as hypertension, cardiovascular strain, and weakened immune function. When expressed in ways that violate social norms or ethical boundaries, anger can hinder conflict resolution, escalate disputes, and have lasting emotional consequences for both the individual and those around them.

Anger often emerges in response to perceived threats such as betrayal, injustice, or jealousy. These situations challenge an individual's sense of fairness, trust, or self-worth, naturally provoking emotional arousal. For example, discovering a friend's betrayal may trigger feelings of indignation, while witnessing unfair treatment at work can evoke righteous anger. Recognizing

anger as a natural, situational response allows individuals to process it consciously, channel it into constructive actions, and avoid letting it become destructive.

Anger can become a problematic response when it is triggered in situations where it is not appropriate or when the body is already under strain. For example, being overly tired, hungry, or stressed can lower emotional regulation, making a person more likely to react with anger to minor frustrations. Similarly, anger may arise even in situations where there is no real threat, such as feeling slighted or disrespected in a safe environment. In these cases, the emotional response is disproportionate to the situation, potentially leading to conflict, impaired decision-making, and regret. Repeatedly responding with anger in inappropriate contexts can strain relationships, increase stress, and reinforce negative patterns of thinking and behavior, making it harder to respond calmly in the future. Developing awareness and coping strategies for anger is therefore essential for maintaining emotional balance and managing stress effectively.

Here's a list of harmful manifestations of anger:

- **Verbal aggression:** Yelling, name-calling, or harsh criticism
- **Physical aggression:** Hitting, throwing objects, or other violent behaviors
- **Passive-aggressive behavior:** Sarcasm, silent treatment, or subtle sabotage
- **Impulsive decision-making:** Acting without thinking due to heightened emotional arousal
- **Social withdrawal:** Isolating oneself from others to avoid conflict
- **Chronic irritability:** Persistent frustration that affects mood and relationships
- **Health consequences:** Increased blood pressure, heart rate, and stress-related illnesses
- **Relationship strain:** Damaging friendships, family bonds, or professional relationships
- **Self-harm tendencies:** Engaging in destructive behaviors toward oneself
- **Rumination:** Obsessively replaying anger-inducing events, which intensifies stress

Although releasing anger or venting seems like a productive way to deal with anger, it is rarely a good approach. Rather than addressing the situation or helping restore emotional composure, an uncontrolled release of anger only reinforces and escalates the emotion. Chronic or intense anger can have serious health consequences. It increases the risk of cardiovascular problems, such as high blood pressure, heart disease, and stroke, by placing repeated strain on the heart and blood vessels. Anger can also weaken the immune system, disrupt sleep, and contribute to stress-related conditions like headaches, digestive issues, and anxiety.

Suppressed anger can have significant negative effects on both mental and physical health, even when it is not outwardly expressed. When anger is consistently held in, it often manifests as **passive-aggressive behavior**, such as sarcasm, silent treatment, procrastination, or subtle obstruction. Individuals may also develop hostile or cynical attitudes, which can create ongoing tension in relationships and undermine trust and communication. Over time, these patterns not only strain social connections but can also contribute to chronic stress, increasing the risk of high blood pressure, heart disease, digestive problems, and weakened immune function. Learning to recognize and express anger in healthy, constructive ways is therefore essential for maintaining both emotional well-being and strong interpersonal relationships.

Anger is a normal and natural emotion that everyone experiences, signaling when boundaries are crossed or when something feels unfair or threatening. Because it is inevitable, it is important to learn how to manage anger in healthy and constructive ways. Positive strategies for managing anger include practicing deep breathing or relaxation techniques, engaging in physical activity to release tension, and using calm, assertive communication to express feelings without aggression.

Question

Have you ever felt your anger rising and weren't sure how to respond? Ask yourself these three questions when you feel your anger rising:

1. Is this situation significant enough to warrant anger?
2. Do I have a valid reason to feel angry?
3. Will expressing my anger lead to a constructive outcome?

Constructively stating your feelings is possible. Being assertive without being aggressive or demanding can help express anger constructively and respectfully. If that is not possible, using techniques to help calm the feelings of anger may be the best strategy.

Fear and Anxiety

Fear and anxiety are common emotional responses to stress that prepare the body and mind to respond to potential threats. **Fear** is a reaction to an immediate or clearly identifiable danger, triggering a heightened state of alertness and readiness to act, while **anxiety** is a more persistent state of worry, often with prolonged feelings of apprehension or worry about potential future threats. Both fear and anxiety can be categorized as rational when they are proportional to the actual threat, or irrational when they occur in situations where the perceived danger is exaggerated, unlikely, or nonexistent. Fear and anxiety can be either rational or irrational, depending on whether they are proportional to the actual threat or concern.

Fear and anxiety are often used interchangeably; however, recognizing the difference between rational and irrational fear and anxiety is important for understanding their impact on behavior and overall well-being. Rational fear and anxiety arise in situations where a genuine challenge or risk is present, such as feeling nervous before a big exam, worrying about meeting a deadline, or being cautious when walking alone late at night. These feelings can motivate students to study, plan, or take safety precautions. Irrational fear and anxiety, on the other hand, occur when the level of worry is out of proportion to the situation, such as panicking at the thought of asking a question in class, fearing complete failure after one poor grade, or avoiding social events due to the unlikely belief that everyone will judge harshly. While some anxiety is normal and even helpful, irrational fears and anxieties can interfere with academic performance, relationships, and overall well-being if left unaddressed. Irrational fear and anxiety often take the form of phobias, which are intense, persistent, and disproportionate fears of specific objects, situations, or activities. A **phobia** is defined as an excessive fear response that goes beyond normal caution and leads to avoidance behaviors, even when the feared object or situation poses little or no real danger. For example, a student with social phobia may feel overwhelming anxiety about speaking in class or meeting new people, despite being in a safe and supportive environment. Similarly, someone with a test-taking phobia might experience panic at the idea of exams, even if they are well-prepared (St. Pe et al, 2025). [57] These irrational fears can interfere with daily life, limit opportunities for growth, and increase stress, making it important to recognize and address phobias when they begin to disrupt normal functioning (Himle et al, 1989). [26]

These examples show how fear and anxiety can either be protective and helpful or excessive and disruptive, depending on whether they match the actual level of threat:

- **Rational fear**: Feeling afraid when walking alone at night in an unfamiliar, poorly lit area; the fear is proportional to the real risk of danger.
- **Irrational fear** (phobia): Experiencing intense fear at the sight of a harmless spider, even though it poses no real threat.
- **Rational anxiety**: Feeling nervous before giving an important presentation or taking a major exam, which can motivate preparation and focus.
- **Irrational anxiety**: Worrying excessively about unlikely events, such as believing the house will catch fire while sleeping, despite having functioning smoke detectors.

Fear is a normal and adaptive emotion that helps protect people from danger. In everyday life, fear prompts caution and prepares the body to respond to threats through the “fight-or-flight” response. **Disordered fear**, however, occurs when the intensity, duration, or frequency of the fear response is disproportionate to the actual threat, or when it interferes with daily functioning. In these cases, fear shifts from being protective to becoming disruptive. Examples include phobias or **generalized anxiety disorder (GAD)**, where constant worry occurs even without a specific threat. GAD is characterized by excessive, persistent worry about a wide range of everyday situations, even when little or no real threat exists. GAD manifests in ways like worrying excessively about worst-case scenarios. For example, a college student with GAD may constantly worry about failing classes, losing friendships, or running out of money, despite having good grades, supportive relationships, and stable finances. Another example of disordered fear is altered in people who have **post-traumatic stress disorder or PTSD**. PTSD is a mental health condition in which the body’s natural fear response becomes overactive, causing a person to feel threatened even when they are safe. Instead of subsiding after danger has passed, the fear reaction persists and is often triggered by reminders of the traumatic event. More information on PTSD and GAD can be found in Chapter 1. Unlike normal fear, disordered fear does not easily subside and often leads to avoidance behaviors, impaired relationships, or difficulties in work and school.

Constant, excessive anxiety can take a significant toll on both physical and mental health. Prolonged activation of the stress response can lead to elevated blood pressure, increased risk of heart disease, gastrointestinal problems, and a weakened immune system. It can also contribute to sleep disturbances, chronic fatigue, headaches, and exacerbate mental health issues such as depression or panic disorders. This can make maintaining a normal lifestyle very difficult and can also lead to the inability to relax at all.

Question

- Think about when you might have learned about a University or other school shooting.
  - Do you or those close to you have rational fears, irrational fears, or anxiety about these events?

Emotional, Psychological, and Cognitive Manifestations of Stress

Emotional, psychological, and cognitive responses reflect how stress impacts thoughts and feelings. Here are some common responses:

- Feeling heroic, euphoric, or invulnerable
- Denial or disbelief
- Anxiety, fear, or worry about safety
- Irritability or anger
- Restlessness
- Sadness, moodiness, grief, or depression
- Distressing or vivid dreams
- Guilt or “survivor guilt”
- Feeling overwhelmed, helpless, or hopeless
- Isolation, loneliness, or feeling abandoned
- Apathy or disengagement
- Over-identification with others’ experiences
- Feeling misunderstood or unappreciated
- Memory problems or forgetfulness
- Disorientation or confusion
- Slowed thinking or difficulty analyzing
- Trouble setting priorities or making decisions
- Difficulty concentrating or limited attention span
- Loss of objectivity
- Persistent intrusive thoughts about stressful events (Falcone, 2022) [19]

Behavioral and Social Manifestations of Stress

Behavioral and social responses show how stress affects actions and interactions with others. Here are some common responses:

- Changes in activity levels
- Decreased efficiency or effectiveness
- Difficulty communicating ideas
- Increased sense of humor/gallows humor
- Irritability, outbursts, or frequent arguments
- Inability to rest, relax, or “let down”
- Changes in eating habits
- Changes in sleep patterns
- Altered job or task performance
- Periods of crying
- Increased use of tobacco, alcohol, drugs, sugar, or caffeine
- Hyper-vigilance about safety or the environment
- Avoidance of places or activities that trigger stressful memories
- Clumsiness or being accident-prone
- Withdrawing or isolating from others
- Difficulty listening or engaging in discussions
- Difficulty sharing ideas or collaborating
- Blaming or criticizing others
- Intolerance of group processes
- Difficulty giving or accepting support

- Impatience or disrespect toward others (Falcone, 2022) [19]

Key Points

- Stress affects people differently, with some experiencing physical symptoms and others responding with emotional or cognitive reactions such as anger, anxiety, or depression.
- Stressors can be varied and include daily life challenges such as academic pressures, work demands, social difficulties, major life changes, or traumatic events.
- Emotional responses are as important as physical responses because emotions like fear, frustration, or sadness influence how people think, behave, and cope under stress.
- Anger is a natural response that can be adaptive by motivating problem-solving, self-advocacy, and boundary-setting, but excessive or misdirected anger can harm health and relationships.
- Anger can manifest in harmful ways, including verbal or physical aggression, passive-aggressive behaviors, impulsive actions, social withdrawal, and rumination.
- Suppressed anger is also harmful, as holding it in often leads to passive-aggressive behaviors, cynicism, chronic stress, and increased risk of cardiovascular or digestive problems.
- Fear and anxiety prepare the body for threats, with fear being an immediate response to danger and anxiety being a prolonged, often future-oriented state of apprehension.
- Fear and anxiety can be rational or irrational, with rational fear and anxiety matching the real level of threat, such as being nervous before an exam, while irrational fear and anxiety are disproportionate, such as phobias or excessive worry in safe situations.
- Chronic, excessive fear and anxiety have serious health impacts, including high blood pressure, heart disease, digestive problems, sleep disturbances, chronic fatigue, and exacerbation of mental health issues like depression or PTSD.
- Understanding stress responses is essential because recognizing how emotions and behaviors are affected by stress helps individuals manage stress effectively and maintain overall well-being.

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10.2: Stress - Contributing Factors



Figure 10.2.1: Understanding how contributing factors affect overall stress can have positive effects on a person's mental health. (A woman with curly hair wearing a colorful top; Look Studio via Unsplash)

Introduction

Stress is a natural part of life and can arise from a wide range of internal and external factors. While some stress can be beneficial by motivating individuals to take action or perform at their best, excessive or chronic stress can negatively affect physical and mental health. Factors that contribute to how people experience stress include personality traits, which influence how individuals perceive and respond to challenges, as well as gender and biological sex, which can shape both physiological and emotional reactions to stress. Additionally, patterns of thinking and cognitive strategies play a critical role, as how individuals interpret events, solve problems, and manage their thoughts can either exacerbate or reduce stress levels. Understanding these contributing factors is essential for developing effective approaches to stress management and promoting overall well-being.

Contributing Factors

Stress is influenced by a variety of factors, including personality traits, biological sex, gender, life experiences, and cognitive patterns. Each individual perceives and responds to stress differently, making stress a highly personal and subjective experience. For example, two people might face the same challenging situation, such as giving a public presentation, yet one may feel intensely anxious while the other remains relatively calm and composed. Factors such as coping skills, past experiences, social support, and even genetic predispositions can shape how a person interprets and reacts to stressors. Because of this variability, strategies for managing stress must often be individualized, as what effectively reduces stress for one person may not work as well for another. Understanding that stress is not a uniform experience highlights the importance of self-awareness and personalized approaches to maintaining emotional and physical well-being.

Personality

Personality refers to the unique and relatively stable patterns of thoughts, feelings, and behaviors that characterize an individual. **Personality traits** influence how people perceive, interpret, and respond to the events in their lives. Because these traits shape how people cope, they play a key role in stress responses. Understanding personality can therefore help explain why some individuals experience and react to stress differently from others, and it can offer valuable insight into effective coping strategies. This connection between personality and stress highlights the importance of exploring different personality types and traits.

Personality types are sometimes described in broader categories, such as Type A and Type B. **Type A individuals** are often

competitive, ambitious, and time-conscious, and they may be more prone to stress-related health problems due to their high levels of urgency and self-imposed pressure (James & Sidin, 2017). [30] **Type B individuals**, in contrast, are generally more relaxed, patient, and less driven by competition, which can provide a protective effect against stress (Korotkov, 2011). [35]

In addition to the well-known Type A and Type B personality classifications, researchers have identified additional personality types that can influence how individuals respond to stress. A **Type C personality** is often characterized by a tendency to suppress emotions, particularly negative feelings, and a strong desire to please others. Individuals with Type C traits may avoid conflict, internalize stress, and have difficulty expressing anger or frustration. This pattern of emotional suppression and passivity has been associated with increased susceptibility to certain health problems, including immune system dysregulation and a higher risk for some cancers (Rymarczyk, 2020). [49]

Type D personality, sometimes called the "distressed" personality, is defined by high levels of negative emotions, such as anxiety, irritation, and worry, combined with social inhibition. People with Type D traits may experience persistent negative emotions but are reluctant to share their feelings or seek support from others. Research indicates that Type D individuals are more vulnerable to stress-related health problems, particularly cardiovascular disease, and may have poorer psychological well-being compared to those without these traits (Denollet, 2000). [16]

One widely used framework for describing personality is the **Five-Factor Model**, often referred to as the "Big Five" personality traits. These traits include openness to experience, which reflects curiosity, creativity, and willingness to try new things; **conscientiousness**, which involves organization, self-discipline, and goal-directed behavior; **extraversion**, characterized by sociability, assertiveness, and high energy; **agreeableness**, which includes compassion, cooperation, and a tendency to prioritize social harmony; and **neuroticism**, which refers to emotional sensitivity, moodiness, and a tendency to experience negative emotions such as anxiety or irritability (Strizzi, 2024). [57] Awareness of one's personality traits and type can help identify natural strengths and vulnerabilities when managing stress, allowing for tailored strategies that enhance resilience and overall well-being.

Although personality traits are relatively stable, individuals can modify certain patterns of thinking and behaviors that may contribute to challenges or stress in their lives. Personality is shaped by a combination of heredity, social influences, psychological factors, and behavioral experiences, yet individuals can gain insight into the reasons behind their thoughts, feelings, and actions. Individuals can modify their responses to stressors by adopting healthier coping strategies and adjusting unhelpful patterns of thinking and behavior.

Question

- How might reflecting on your own personality traits help you better understand why you react to stress or challenges in certain ways, and how could this awareness improve your daily decisions and relationships?
- When you consider the personality traits of people close to you, what insights can you gain about their behavior, communication style, and stress responses, and how could this understanding help you interact more effectively and empathetically with them?

Gender and Biological Sex

Gender and biological sex play significant roles in how individuals experience and manage stress. Research suggests that men and women may perceive, respond to, and cope with stress differently due to a combination of biological, hormonal, and neurological factors as well as social and cultural influences. For example, biological differences such as hormone levels, including cortisol and estrogen, can affect stress reactivity and recovery, while brain structure and function may influence emotional processing and coping strategies. Additionally, cultural expectations and gender norms often shape how people express stress, seek support, and engage in problem-solving or emotional regulation. Understanding these differences is important for recognizing that stress management strategies are not one-size-fits-all and may need to be tailored according to both biological and sociocultural factors. This section explores how gender and biological sex influence stress experiences and coping behaviors.

The human stress response is primarily mediated by the hypothalamic-pituitary-adrenal (HPA) axis, which regulates the release of stress hormones such as cortisol and adrenaline. While both men and women activate this system under stress, subtle differences exist due to hormonal and evolutionary factors. Men typically exhibit a "fight-or-flight" response, characterized by higher acute cortisol and adrenaline spikes that prepare the body for physical confrontation or rapid escape. In contrast, women often show a

"tend-and-befriend" pattern, which involves nurturing behaviors and seeking social support, influenced in part by the hormone oxytocin. **Oxytocin**, which is elevated in women, especially under stress, can reduce cortisol responses and promote affiliative behaviors, potentially mitigating some negative effects of stress (James, 2023). [29]

From an evolutionary perspective, these differences may have developed to increase reproductive success and survival in gender-specific roles. Men's heightened acute stress responses could have aided in hunting or defending territory, whereas women's tendency to maintain social bonds and protect offspring during stressful situations would have improved the survival of both themselves and their children. These evolutionary pressures, combined with hormonal differences such as variations in estrogen, progesterone, and testosterone, help explain why men and women often respond to stress in subtly different ways, both physiologically and behaviorally.

An increasingly prevalent area of gender-related stress is **gender dysphoria**, characterized by a profound sense of unease when an individual's gender identity does not align with their assigned sex at birth. This condition can lead to significant psychological distress, including depression, anxiety, and social isolation. Recent studies indicate a notable rise in the number of adolescents experiencing gender dysphoria. For instance, a 2024 study from the University of York reported that children are now 50 times more likely to experience "gender distress" compared to a decade ago, with the incidence among girls increasing more rapidly than boys (Jarvis et al, 2025). [31] This surge is attributed to various factors, including heightened awareness, increased social acceptance, and the influence of social media, which may provide platforms for individuals to explore and express their gender identities. However, these platforms can also expose individuals to negative experiences such as cyber-bullying and misinformation, potentially exacerbating feelings of distress. Addressing gender dysphoria requires a multifaceted approach, encompassing mental health support, access to gender-affirming care, and societal acceptance to mitigate the associated stress and improve the well-being of affected individuals.

Generational Differences

Generational experiences shape how people perceive and respond to stress. Think about your generational experience and consider whether your stress response aligns.

- **The Silent Generation** (born 1928–1945) and **Baby Boomers** (born 1946–1964) often faced stressors related to post-war recovery, economic growth, and societal change, fostering resilience and strong work ethics.
- **Generation X** (born 1965–1980) grew up during economic uncertainty and changing family dynamics, encouraging pragmatism and self-reliance in coping.
- **Millennials** (born 1981–1996) navigate pressures such as student debt, career development, and constant digital connectivity, influencing their mental health and work-life balance.
- **Generation Z** (born 1997–2010) experiences stress from social media, global issues, and information overload, while simultaneously feeling pressure to succeed academically and professionally in an increasingly competitive world.
- **Generation Alpha** (born 2010 onward) will face new challenges in an increasingly digital, fast-paced, and interconnected world. Understanding these generational differences can inform strategies to support resilience, mental well-being, and effective stress management across all age groups

Cognitive Strategies

Cognitive factors play a critical role in shaping how individuals respond to stressors. While stress often begins as a physiological reaction, the way a person interprets and evaluates a situation largely determines whether it is experienced as overwhelming, manageable, or even motivating. For example, two people might face the same challenge, but one perceives it as a threat while the other views it as an opportunity for growth. Past experiences influence these differences, coping skills, thought patterns, and personal beliefs. As stress is not only about the event itself but also about how it is perceived, cognitive factors help explain why individuals respond so differently to similar stressors and why modifying thought processes can be an effective strategy for stress management.



Figure 10.2.2: Having a positive outlook when faced with a challenge is important when strategizing a solution. (A person with the head in the hand; Quỳnh Lê Mạnh via Unsplash)

Theories About Stress Responses

In the simplest observation, it may seem like people handle stress very differently. However, a closer examination reveals that individuals often rely on similar cognitive steps, described in the **transactional model of stress**. This model illustrates how people appraise stressful events and select coping strategies, thereby helping to explain both the diversity and commonality of stress responses (Lazarus & Folkman, 1984). [36]

Here are the steps of the transactional model of stress:

1. **Primary Appraisal**: The individual evaluates whether an event is irrelevant, benign-positive, or stressful. A common question might be, "Will this stressor cause me harm?" For example, a student sees that an exam is scheduled for next week. They decide whether this exam is threatening (“I might fail”), a challenge (“This could push me to learn”), or not significant (“I already know this material”).
2. **Secondary Appraisal**: The individual assesses their resources and ability to cope with the situation. In other words, "How much control do I have over this threat?" For example, the same student asks, “Do I have enough time to study? Do I understand the material? Can I get help if I need it?”
3. **Coping Efforts**: Based on the appraisal, the person selects strategies to deal with the stressor. Coping can be problem-focused (taking action to change the situation) or emotion-focused (managing emotional reactions). One might ask, "What is the situation? Who is involved? What is the cost-benefit of my different actions?" For example, problem-focused: The student creates a study schedule. Emotion-focused: The student practices deep breathing to calm test anxiety.
4. **Reappraisal**: After coping efforts, the individual evaluates whether the strategy worked and may adjust their response. The question might be, "Have I handled the situation ot does the threat still exist?" For example, after a few study sessions, the student feels more confident and reappraises the exam as less threatening, or if grades don’t improve, they may seek tutoring for additional support.

Another process that people use in response to stress focuses on how successful or unsuccessful they are after a stressful event. The **Attribution Theory** explains how people interpret the causes of events and behaviors, including stressful experiences. When faced with a stressor, individuals naturally try to answer the question, “Why did this happen?” The explanation, or attribution, influences how much stress they feel and how they choose to cope. (Webb et al, 2023). [64]

Attributions are usually described along three dimensions:

- **Internal vs. External** - The question: "Is the cause due to something about me, or something outside of my control?"
- **Stable vs. Unstable** - The question: "Is the cause likely to persist, or is it temporary?"
- **Controllable vs. Uncontrollable** - The question: "Do I have the power to change the outcome, or not?"

The way people attribute causes to stressful events shapes their emotional and behavioral reactions. For instance, if someone views a setback as internal, stable, and uncontrollable (e.g., "I failed because I'm not smart, and I can't change that"), they are more likely to feel helpless and stressed. On the other hand, if they view it as external, unstable, and controllable (e.g., "The test was hard, but I can study differently next time"), they are more likely to feel motivated and resilient (Stillman & Velamuri, 2025). [56]

Some examples of the attribution theory are:

- **Academic stress**: A student who fails a test may think, "I'm just bad at math" (internal, stable, uncontrollable) and feel discouraged, or "I didn't study enough this time" (internal, unstable, controllable), which motivates them to prepare better.
- **Workplace stress**: Missing a deadline could be attributed to "I'm always disorganized" (internal, stable), leading to ongoing stress, or "The project was rushed, but next time I'll plan" (internal, unstable, controllable), leading to adaptive coping.
- **Relationship stress**: After an argument with a friend, attributing it to "I'm a bad friend" (internal, stable) may cause guilt and anxiety, while attributing it to "We were both tired and stressed" (external, unstable) may reduce blame and ease tension.

A key outcome of attribution patterns is the development of **learned helplessness**, which occurs when people consistently interpret stressful events as caused by internal, stable, and uncontrollable factors. Over time, this belief that nothing can be done to change the situation leads to withdrawal, passivity, and a loss of motivation. For example, a student who repeatedly attributes poor grades to "I'm just not smart enough, and I'll never improve" may eventually stop trying altogether, even if resources like tutoring or new study strategies could help. This maladaptive attribution style not only intensifies stress but also increases the risk of anxiety and depression. By contrast, attributing stress to controllable or temporary factors supports resilience and encourages proactive coping strategies (Stillman & Velamuri, 2025). [56]

Attribution theory also suggests that the way people evaluate their coping success influences where they place responsibility. When individuals cope effectively with stress, they are more likely to attribute the outcome to their own efforts, taking personal responsibility for their actions and reinforcing a sense of control. Conversely, when coping attempts are unsuccessful, people are more likely to attribute the stress to external forces such as bad luck, unfair circumstances, or other people. This shift in attribution can either support resilience by encouraging accountability or, if consistently externalized, undermine growth by limiting one's sense of control over future challenges (Webb et al, 2023). [64]

Question

- If our thoughts can shape how we experience and respond to stress, to what extent do you think the belief 'you are what you think' empowers us to control our stress—or, conversely, traps us in patterns of anxiety?

Key Points

- Stress arises from both internal and external sources, and factors such as personality, gender, biological sex, life experiences, and cognitive patterns influence how individuals perceive and respond to stress.
- Different personality types, including Type A, B, C, and D, as well as traits from the Big Five such as openness, conscientiousness, extraversion, agreeableness, and neuroticism, affect how people interpret and cope with stress, with some types being more vulnerable to stress-related health problems.
- Men and women may respond differently to stress due to hormonal, neurological, and evolutionary factors, as well as cultural expectations, with men often exhibiting a fight-or-flight response and women showing a tend-and-befriend pattern.
- Generational experiences shape how people perceive and respond to stress, with older generations facing post-war and economic pressures while younger generations deal with challenges such as social media and global issues.
- The Transactional Model of Stress explains that individuals evaluate events for potential threats, assess their coping resources, implement strategies to manage stress either through problem-solving or emotional regulation, and then reappraise the situation to determine if the strategies were effective.
- Attribution theory demonstrates that how people interpret the causes of stress, whether they see them as internal or external, stable or temporary, and controllable or uncontrollable, affects their emotional reactions, coping behaviors, and the likelihood of experiencing learned helplessness, while effective coping promotes personal responsibility and resilience.

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10.3: Stress and Wellness



Figure 10.3.1: (woman sitting on hill; Matteo Di Iorio via Unsplash)

Introduction

Stress is a natural part of life that affects both physical and mental well-being, influencing how people perform, think, and feel. In moderate amounts, stress can enhance focus, motivation, and productivity by promoting optimal arousal, helping individuals reach their peak performance in academic, work, or personal tasks. However, the impact of stress on wellness depends on its duration and intensity. Short-term, acute stress can be adaptive and even beneficial, preparing the body to respond to immediate challenges. In contrast, chronic stress, which persists over long periods, can have harmful effects on overall health, contributing to conditions such as high blood pressure, cardiovascular disease, digestive problems, weakened immunity, sleep disturbances, and mental health issues like anxiety and depression. Exploring the complex relationship between stress, arousal, performance, and health is essential for managing stress effectively and maintaining overall wellness.

Stress and Performance

Although stress is often associated with negative health outcomes, it can also have positive effects. Certain levels of stress can enhance performance and help individuals reach their full potential. In sports, good stress can act as a motivator, sharpening focus and enhancing performance during competition. For example, an athlete may feel heightened arousal before a big game, which helps increase alertness, reaction time, and energy levels. As the famous sports psychologist Yogi Berra emphasized, “Winning is 10 percent physical and 90 percent mental,” highlighting how mental preparation and the ability to channel stress positively often determine success.

However, contrary to common belief, performance isn't just about sports. Performing under stress occurs when individuals are able to maintain focus and accomplish tasks despite pressure or challenging circumstances. For example, a college student might complete a major research paper on a tight deadline, using the heightened focus and motivation that stress provides to organize ideas and meet the requirements efficiently. This relationship between stress and optimal performance is described by the **Yerkes–Dodson law**, developed in 1908. Despite being called a law, it is actually a conceptual model that explains how performance varies with arousal. Moderate levels of stress (or arousal) promote peak performance, while too little or too much stress can impair it. When stress is too low, individuals may feel bored and seek additional stimulation, whereas excessive stress can trigger behaviors aimed at reducing arousal to cope with overwhelming demands (Nieuwenhuis, 2024). [42]

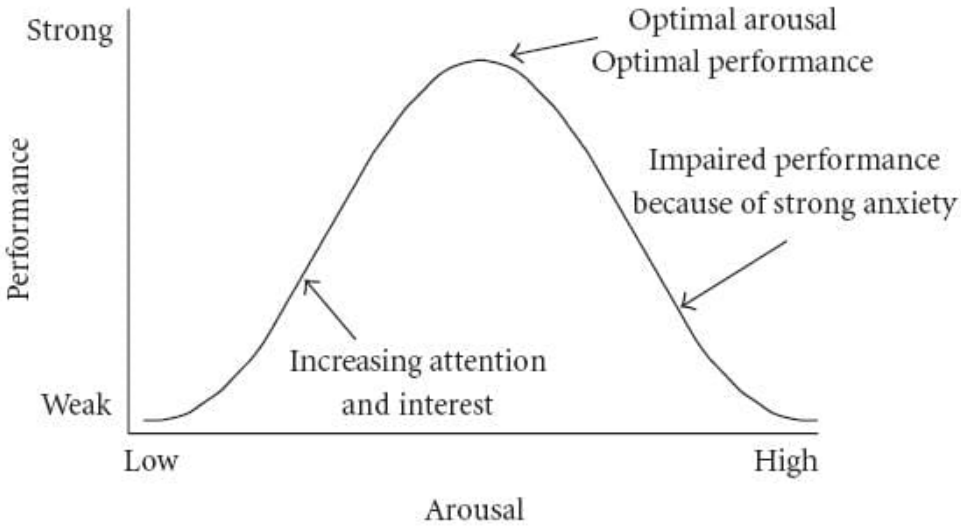


Figure 10.3.2: The optimal arousal for optimal performance curve as depicted by the Yerkes-Dodson Law. (CC0 1.0; Yerkes and Dodson, Hebbian via Wikipedia Commons)

Figure 10.3.2 depicts a line graph illustrating the relationship between arousal and performance, demonstrating the Yerkes–Dodson law. The horizontal (x) axis is labeled "Arousal," ranging from low to high, and the vertical (y) axis is labeled "Performance," ranging from weak to strong.

The curve forms an inverted U-shape:

- On the left side, where arousal is low, performance is weak. An arrow points upward on this rising slope labeled "Increasing attention and interest," indicating that as arousal increases, performance improves.
- At the top of the curve, performance reaches its peak, labeled "Optimal arousal" and "Optimal performance." This represents the ideal balance of stress or stimulation where individuals perform best.
- On the right side, as arousal becomes too high, performance begins to decline. A label here reads "Impaired performance because of strong anxiety," indicating that excessive arousal or stress hinders performance.

Overall, the image shows that moderate levels of arousal lead to the best performance, while too little or too much arousal decreases effectiveness.

Sometimes it is impossible to avoid high-stress situations, such as delivering a crucial presentation or handling an unexpected work crisis. According to the Yerkes–Dodson law, through a process called **"overlearning"** or practicing and mastering a skill beyond basic competence, individuals can perform near their full potential even under extreme stress, because the task has become automatic and less vulnerable to the disruptive effects of high arousal (Nieuwenhuis, 2024). [42]

Many students experience this need to maintain optimal levels of arousal throughout their academic careers. For example, toward the end of the spring semester, students often feel overwhelmed with coursework and long for the rest of summer break, reflecting excessively high arousal. After the semester ends, however, stress levels drop, and students may quickly feel bored and under-stimulated, which can lower productivity and performance. By the time the fall semester begins, many students are ready to return to school and resume productive work. This cycle illustrates how the Yerkes–Dodson law operates in real-life academic settings, showing the dynamic relationship between stress, arousal, and performance.

Acute and Chronic Stress

Although stress is a natural response to challenges or demands, not all stress affects the body and mind in the same way. **Acute stress** is short-term and usually occurs in response to an immediate challenge or threat, such as giving a presentation, taking a timed exam, or narrowly avoiding a car accident. It can be motivating, increase focus, and even improve performance, as the body activates the fight-or-flight response to meet the demand. In contrast, **chronic stress** persists over a long period, often resulting from ongoing pressures such as heavy workload, financial difficulties, or prolonged caregiving responsibilities. Unlike acute stress, chronic stress keeps the body in a constant state of alert, which can lead to physical and mental health problems,

including high blood pressure, weakened immunity, anxiety, and depression. Understanding the differences between acute and chronic stress is essential for managing stress effectively and protecting overall wellness.



Figure 10.3.3: Stress, acute and chronic, can affect people differently. (Man in black crew neck t-shirt; Usman Yousaf via Unsplash)

In the 1930s, endocrinologist Hans Selye became fascinated with the connection between stress and disease. Over the next 50 years, he systematically studied how stress affects the body. In particular, he addressed how chronic stress affects overall health. One of his major contributions was the development of the **General Adaptation Syndrome (GAS)**, which describes a typical pattern the body follows when responding to stress. This response occurs in three stages: alarm, resistance, and exhaustion (Selye, 1950). [51]

The first stage, alarm, occurs when a person encounters a stressor, and the body reacts with the "fight-or-flight" response. In the second stage, resistance, the body attempts to adapt and return to homeostasis, a state of physiological balance and calm. If the stressor continues over time, the body eventually enters the exhaustion stage, where its ability to cope is depleted. Prolonged stress at this stage can suppress the immune system and increase the risk of health problems such as heart disease, digestive issues, depression, and diabetes. Acute stress typically involves only the alarm and resistance stages, allowing the body to recover once the stressor is removed. Chronic stress, however, keeps the body in a prolonged state of resistance, eventually pushing it toward exhaustion and increasing the likelihood of illness.

For example, imagine a student who discovers they must pass a certification test in two months to keep their job and has not yet started studying. Their initial reaction, shock, anxiety, or frustration, represents the alarm stage. Knowing the importance of the test, they develop a study plan and use coping strategies like deep breathing, which reflects the resistance stage. As the test approaches, stress may intensify, causing persistent anxiety, sleep difficulties, or feelings of hopelessness. If these stressors remain unrelieved, the student may enter the exhaustion stage, making them more susceptible to illness as their body's resources are depleted. This example illustrates how acute stress can motivate action and focus, while chronic, unrelieved stress can harm both physical and mental health.

Hans Selye's model of stress also recognized that not all stress is harmful, distinguishing between positive stress and negative stress. He called positive stress eustress, which occurs when a stressor motivates a person to perform, grow, or achieve a goal, such as studying for an important exam or preparing for a job interview. Eustress can enhance focus, energy, and performance without causing long-term harm. In contrast, distress refers to negative stress, which arises when a stressor exceeds an individual's ability to cope, lasts too long, or is perceived as overwhelming. Distress can lead to fatigue, anxiety, impaired functioning, and increased risk of illness. By differentiating between eustress and distress, Selye emphasized that stress is not inherently bad; rather, its impact depends on intensity, duration, and an individual's ability to manage it (Selye, 1950). [51]

Stress and Overall Health

Stress plays a significant role in overall health, influencing both physical and mental well-being in complex ways. **Allostatic**

load is another way to consider the consequences of stress. Allostatic load refers to the cumulative wear and tear on the body that results from chronic exposure to stress and repeated activation of the stress response. While short-term stress can be adaptive, helping the body cope with immediate challenges, prolonged or repeated stress forces physiological systems, such as the cardiovascular, immune, and endocrine systems, to remain activated for extended periods. Over time, this continuous strain can impair normal functioning, increasing the risk of health problems such as hypertension, heart disease, diabetes, weakened immunity, and mental health disorders like anxiety and depression. Allostatic load highlights the importance of managing stress effectively because the body's adaptive mechanisms, when overused, can themselves become sources of harm.

Building on the concept of allostatic load, researchers have also explored how stress affects the immune system. Unlike models such as the Yerkes-Dodson Law or the General Adaptation Syndrome, **Psychoneuroimmunology (PNI)** is a field of study rather than a specific framework. PNI examines the interactions between the nervous system, the endocrine system, and the immune system to better understand how the mind and body influence each other (Goodkin & Visser, 2000). [25] For example, in the 1980s, a married couple, one a psychologist and the other an immunologist, combined their expertise to study stress and immunity in humans. They observed medical students before, during, and after a highly stressful three-day exam and found that stress led to a reduction in **Natural Killer (NK) cells**, which are critical immune cells responsible for fighting infections and disease (Kiecolt-Glaser et al, 1984). [34]

According to a study by E.P. Balakin in 2025, stress can directly impact immune functioning (2025). [8] Chronic stress, in particular, acts as an **immunosuppressant**, reducing the body's ability to mount an effective immune response. Prolonged stress can impair immune system function in both younger and older adults, increasing susceptibility to illness and slowing recovery from disease (Dai et al, 2023). [15] The strong connection between psychological well-being, chronic stress, and overall physical health highlights why effective stress management is essential for maintaining wellness.

Table 10.3.1: Stress-Related Health Problems

Condition	Potential Effects of Acute vs. Chronic Stress
Cardiovascular Disease	• Acute stress: a temporary increase in heart rate and blood pressure, which can be adaptive for short-term challenges. • Chronic stress: prolonged elevation of blood pressure and heart rate, increased risk of hypertension, heart disease, and stroke.
Infections & Immune Function	• Acute stress: short-term activation may enhance immune surveillance. • Chronic stress: suppression of the immune system, reduced Natural Killer (NK) cell activity, higher susceptibility to infections, and slower recovery.
Diabetes	• Acute stress: a temporary increase in blood glucose levels due to stress hormones. • Chronic stress: prolonged elevation of cortisol can lead to insulin resistance and increased risk of developing type 2 diabetes.

Condition	Potential Effects of Acute vs. Chronic Stress
Body Composition & Fat Distribution	• Acute stress: minor, temporary effects on metabolism and energy usage. • Chronic stress: increased abdominal fat, changes in metabolism, higher risk of obesity, and altered body composition due to rises in glucose and insulin in the blood, and long-term exposure to cortisol
Mental Health Disorders	• Acute stress: brief anxiety or irritability, which often resolves quickly. • Chronic stress contributes to anxiety disorders, depression, mood swings, and difficulty coping with daily challenges.
Headaches	• Acute stress: tension headaches or migraines may occur temporarily. • Chronic stress: recurring or chronic headaches, migraines, and exacerbation of pain disorders.
Digestive Problems	• Acute stress: temporary changes in digestion, nausea, or mild stomach upset. • Chronic stress: ulcers, irritable bowel syndrome (IBS), worsening heartburn, acid reflux, and other long-term gastrointestinal issues
Skin Changes	• Acute stress: minor flushing, sweating, or temporary rashes. • Chronic stress: eczema flare-ups, psoriasis worsening, acne, and slower wound healing.
Sleep	• Acute stress: difficulty falling asleep or brief insomnia that usually resolves quickly • Chronic stress: persistent insomnia, poor sleep quality, disrupted circadian rhythms, and fatigue

Key Points

- Moderate stress can be beneficial, enhancing focus, motivation, and productivity by promoting optimal arousal and peak performance.
- Acute stress is short-term and adaptive, preparing the body to respond to immediate challenges, while chronic stress persists over time and can harm health.
- Chronic stress can contribute to serious health problems, including high blood pressure, cardiovascular disease, digestive issues, diabetes, weakened immunity, sleep disturbances, and mental health disorders such as anxiety and depression.
- Hans Selye's General Adaptation Syndrome describes the three stages of the stress response—alarm, resistance, and exhaustion—and shows how prolonged stress can deplete the body's resources.
- Not all stress is negative; Selye distinguished between eustress, which motivates and enhances performance, and distress,

which overwhelms coping abilities and harms health.
- The concept of allostatic load highlights how repeated or prolonged stress causes cumulative wear and tear on the body, impairing normal physiological function.
- Stress also affects the immune system, with chronic stress acting as an immunosuppressant by reducing Natural Killer (NK) cell activity and increasing vulnerability to illness.

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10.4: Sources of Stress



Figure 10.4.1: (CC BY 4.0; Luis Prado via Wikimedia Commons)

Introduction

Stress can arise from a wide variety of sources, ranging from major life events to everyday hassles. Life experiences, whether positive or negative, can challenge an individual's ability to cope and adapt, while daily stressors such as commuting, managing schedules, or minor inconveniences can gradually accumulate and affect well-being. Relationships with friends, family, and colleagues can also contribute to stress, as interpersonal conflicts, social expectations, or lack of support create emotional strain. College students often face academic pressures, tight deadlines, and social adjustments, while working adults may encounter job demands, financial pressures, and career uncertainty. Additionally, social and environmental factors, including patterns of thought, habitual behaviors, and exposure to challenging surroundings, influence how stress is experienced and managed. Being aware of the diverse sources of stress is essential for developing effective coping strategies and maintaining both mental and physical health.

One of the underlying causes of stress is the anticipation of upcoming changes and the uncertainty they bring. Fear of the unknown can heighten anxiety and tension, as individuals worry about how these changes will affect their lives and whether they will be able to cope successfully. Change is the operative word when thinking about stressors because it is the disruption or adjustment to one's routine, environment, or expectations that triggers a stress response, not whether the outcome is positive or negative. Even events that lead to desirable results can be stressful because they require adaptation. For example, starting college is an exciting milestone, but it can produce significant stress as students navigate new routines, responsibilities, and social environments. Similarly, graduating may be a highly anticipated achievement, yet it often generates even greater stress due to uncertainties about careers, finances, and adult responsibilities. This demonstrates that it is not the outcome itself that defines a stressor, but rather the type and magnitude of change that the individual anticipates and must adjust to.

Life Experiences

Life experiences, both large and small, are significant sources of stress because they require individuals to adjust, adapt, and respond to change. While some stressors are obvious and easily identifiable, others occur subtly and accumulate over time. Understanding how different types of life experiences contribute to stress is essential for recognizing triggers and developing effective coping strategies.

Major life changes, such as moving to a new city, starting college, or changing jobs, are often clearly recognized as stressful because they involve significant adjustments and uncertainty. However, **daily hassles**, small, routine challenges such as

traffic jams, misplacing items, disagreements with coworkers, or unexpected errands, can be equally impactful. These minor, often uncontrollable stressors may seem insignificant individually, but their cumulative effect can activate the stress response throughout the day, leading to mental and physical strain over time. These minor, often uncontrollable stressors may seem insignificant individually, but their cumulative effect can activate the stress response throughout the day, leading to mental and physical strain over time. As individuals become more successful, they often face an increasing number of responsibilities, tasks, and expectations, which multiply these daily hassles. What may appear to be “little things” can accumulate and create substantial stress, making it essential to recognize and manage even seemingly minor challenges to maintain overall well-being. A 2025 study by Toma and colleagues showed that daily hassles have a significant impact on both current and future well-being, with negative emotions playing a key role in this process. This finding highlights how even minor, everyday stressors can accumulate over time and affect overall health, underscoring the importance of recognizing and managing these routine challenges (Toma et al, 2025). [60] A 2024 study by Furman and colleagues indicates that both daily hassles and small positive experiences, or uplifts, can influence the risk of developing psychiatric disorders and recurrent episodes of major depression. These findings further underscore the importance of paying attention to everyday stressors and their cumulative impact on mental health (Furman et al, 2024). [24] This highlights the cumulative effect of minor daily stressors on overall well-being, emphasizing the importance of managing these everyday challenges. By acknowledging both large and small sources of stress, individuals can better understand the range of factors that affect their well-being.

Impact of Recent Experiences

Recent experiences, whether positive or negative, can serve as significant sources of stress because they often require rapid adjustment and adaptation. Even events that are generally considered desirable, such as starting a new job, moving to a new city, or beginning college, can provoke stress as individuals navigate unfamiliar routines, expectations, and social environments. Conversely, negative experiences such as illness, conflict, or unexpected setbacks can trigger intense stress reactions due to their immediate demands and potential consequences. Research by Thomas Holmes, MD, at the University of Washington demonstrated that both major life changes and accumulations of smaller stressors are strongly linked to health outcomes. Holmes found that high levels of life change events increase the likelihood of physical illness and psychological strain, highlighting that stress from recent experiences can have measurable effects on overall health (Holmes & Rahe, 1967). [28] The common factor is not the nature of the experience itself, but the degree of change and uncertainty it introduces. By recognizing the role of recent experiences in generating stress, individuals can better prepare for transitions, anticipate potential challenges, and implement strategies to reduce their impact on mental and physical well-being.

Job/Financial Pressures

Work and money are among the most common and persistent sources of stress. Chronic work stress can arise from long hours, heavy workloads, lack of job security, or difficult workplace dynamics, and these pressures can lead to fatigue, burnout, and health problems over time. Financial concerns, such as paying bills, managing student loans, or affording housing, can compound these stressors and create ongoing anxiety. For college students in particular, research shows that those who work more than 20 hours a week often experience poorer health outcomes. For example, G.L. Drăghici et al found that students who combine work with heavy academic demands are more likely to report burnout, test anxiety, and academic difficulties (2022). [18] Similarly, T. Verulava reported that students working part-time jobs during their studies often face declines in both physical health and academic performance, especially when work hours exceed a manageable level (2022). [62] These findings suggest that while working may provide financial relief, it can also add another layer of stress that impacts overall well-being.



Figure 10.4.2: Chronic work stress can lead to burnout and health problems. (CC BY 2.0; CIPHR Connect via Wikiedia Commons)

Beyond students, job and financial stress have broad implications for health across the lifespan. Prolonged stress related to work or money has been linked to increased risk for cardiovascular disease, sleep disturbances, weakened immune function, and mental health conditions such as anxiety and depression (Werner et al, 2022). [65] Individuals under chronic financial strain may experience persistent worry, irritability, and difficulty concentrating, which can further affect job performance and strain personal relationships. Over time, these stressors not only reduce quality of life but also contribute to long-term health disparities, especially among populations with limited financial resources or unstable employment (Roberson et al, 2025). [48] Recognizing the cumulative effects of job and financial stress is essential for developing healthier coping strategies and seeking support when needed.

College Stressors

College life is often described as an exciting period of growth and opportunity, yet it is also one of the most stressful times in many students' lives. The transition to higher education brings new responsibilities, challenges, and uncertainties that can affect both academic performance and personal well-being. Stressors come in many forms, ranging from coursework and finances to relationships and future planning. Understanding the specific types of stress common among college students can help students prepare for and manage these challenges more effectively.

Academic Stress

Academic stress refers to the pressure students feel to meet high expectations in their studies. It often stems from heavy workloads, frequent exams, competition for grades, and the need to maintain scholarships or program requirements. Stress may be amplified by perfectionism or by struggling in challenging courses. While some stress can motivate students to study harder, excessive academic pressure can lead to burnout, anxiety, and decreased performance. A biology major may feel overwhelmed when trying to balance a research project, two midterms, and a lab report all in the same week.

Interpersonal Stress

Interpersonal stress arises from the relationships students build on campus, including friendships, roommates, romantic partners, and group work dynamics. Conflicts, misunderstandings, or feelings of isolation can contribute to stress. In some cases, the pressure to fit in socially or to maintain relationships may interfere with academic focus and emotional well-being. A student may feel stressed when their roommate plays loud music late at night, affecting their ability to study or sleep.

Time Management

Time management is one of the biggest challenges for college students, who must balance classes, homework, jobs, extracurricular activities, and social lives. Poor time management can lead to procrastination, missed deadlines, or the constant feeling of “never having enough time.” This ongoing stress can build into chronic fatigue or academic struggles. A student juggling classes and a part-time job may feel overwhelmed trying to study for exams while also meeting work shifts and attending club meetings.

Financial Stress

Financial stress is a significant issue for many college students. Tuition, textbooks, housing, and food costs add up quickly, often leaving students worried about debt or needing to work while in school. Students who take on multiple jobs to support themselves may sacrifice time for studying or self-care, increasing both academic and emotional strain. A student who takes out large loans may worry constantly about their ability to repay them after graduation.

Stress About the Future

Stress about the future refers to the uncertainty students feel regarding their careers, financial security, and life direction after graduation. Concerns about finding a job, getting into graduate school, or living independently can cause ongoing anxiety. This stress may begin early in college but often intensifies during the final years of study. A senior may feel anxious about whether their major will lead to a stable career after graduation.

Non-Traditional Students

College stress is not limited to younger students. A growing number of college students are over the age of 25, often called non-traditional students. These students may be returning to school after time in the workforce, serving in the military, or raising a family. At many two-year colleges in particular, older students make up a significant portion of the population. Despite their unique life circumstances, non-traditional students are often treated the same as younger peers in terms of course expectations, grading, and workload. This can create added stress as they balance academics with jobs, childcare, and other responsibilities. A 30-year-old student who works full-time and cares for two children may struggle to meet the same project deadlines as an 18-year-old classmate with fewer outside responsibilities.

Relationships and Families

Human connections are essential for emotional health, but they can also be powerful sources of stress. Relationships with friends, romantic partners, and family members provide support, belonging, and stability, yet they may also bring conflict, pressure, or unmet expectations. For college students in particular, navigating friendships, managing long-distance family ties, or adjusting to greater independence can add layers of stress to daily life. Family responsibilities, such as financial dependence, cultural expectations, or caregiving roles, can further complicate the picture. Understanding how relationships and family dynamics influence stress is important because these social factors can either buffer against life’s challenges or intensify them.

Friendships

Friendships are often a primary source of support during the college years, but they can also lead to stress when conflicts arise or when students feel excluded. Forming friendships allows people to share their own experiences and perspectives while also discovering and learning from others. Unlike romantic relationships, friendships tend to carry fewer demands and expectations, which often makes them more stable and long-lasting. Because of this, many individuals turn to friends first for comfort and support, especially during stressful times, sometimes even before turning to family. However, stress within friendships—such as differences in values, busy schedules, or feelings of neglect—can still create tension. Social media may intensify this by amplifying comparisons and feelings of being left out. A student may feel stressed when their roommate spends more time with a new group of friends, leaving them worried about losing the friendship or struggling with feelings of isolation.



Figure 10.4.3: Two hands holding a black, paper heart cut-out. (Two person holding a paper heart 4; Kelly Sikkema via Unsplash)

Romantic Relationships

Romantic relationships are among the most meaningful and profound human experiences, often bringing joy, personal growth, and emotional connection. Love, commitment, and intimacy can enrich life and serve as powerful buffers against stress. However, these relationships also carry unique challenges. Expectations surrounding time, trust, and plans can lead to conflict or strain, particularly when academic, financial, or social pressures interfere. Miscommunication, jealousy, or breakups may cause significant emotional distress that affects mental health and daily functioning. Still, healthy romantic relationships can provide support, companionship, and motivation, which may enhance resilience in the face of stress. For example, a student may feel supported when their partner encourages them before a difficult exam, but stressed when arguments arise about how much time is spent studying versus being together.

Family Pressures

Family can be a strong source of security, guidance, and unconditional support, but it can also be a major source of stress. Pressures may come from parental expectations, financial dependence, sibling rivalries, or cultural values surrounding family obligations. Students often rely on family for encouragement, stability, and advice, yet conflicts can arise when independence grows during the transition to adulthood. The stress of balancing family responsibilities with academic and personal demands can feel overwhelming. At the same time, strong family bonds can serve as protective factors, fostering resilience and helping students navigate challenges more effectively. A student may feel comforted when their parents provide reassurance about career choices, but stressed if those same parents pressure them into pursuing a field they do not enjoy.

Social and Environmental Stressors

In addition to internal and physiological stressors, the social and physical environments in which students live and study can create significant stress. Social stressors include the demands and challenges of interacting with others, while environmental stressors arise from the surrounding physical or institutional setting. Both types can influence mental and emotional well-being, often interacting with other sources of stress to create cumulative effects.

Social Stressors

Social stressors involve navigating interactions and relationships with peers, faculty, and the broader community. Meeting new people, forming friendships, and participating in group activities can be exciting but may also trigger anxiety, especially for students who are shy or feel socially isolated. Experiences of discrimination or bias based on race, gender, sexual orientation, or other personal characteristics can lead to persistent stress and feelings of exclusion. Students for whom English is not a first language may feel added pressure to communicate effectively in academic and social settings. Competitive academic

environments can further amplify social stress, as students compare themselves to peers or feel the need to perform at high levels. A student from another country may feel stressed when presenting in English for the first time in a class discussion, worrying about making mistakes while also trying to build connections with classmates.

Environmental Stressors

Environmental stressors arise from physical or logistical aspects of daily life that challenge comfort, safety, or efficiency. Loud noises, crowded or chaotic living spaces, and shared or unfamiliar housing situations—such as having a roommate for the first time—can disrupt focus, sleep, and relaxation. Poor public transportation, long commutes, or unsafe neighborhoods can add logistical stress that compounds academic and social pressures. Even seemingly minor annoyances, like noisy dorms or a cluttered study space, can elevate stress levels over time if they persist. A student who shares a small dorm room may find it difficult to concentrate on homework because of constant noise from neighbors, while also feeling stressed about managing chores and privacy with a new roommate.

Social Media as a Stressor

In addition to in-person interactions, social media has become a significant source of stress for many college students. While social media allows students to stay connected, share experiences, and build communities, it can also create pressure, comparison, and anxiety. Seeing curated highlights of peers' lives may lead to feelings of inadequacy or **fear of missing out (FOMO)**. Constant notifications and the expectation to respond promptly can make it difficult to disconnect, contributing to mental fatigue (Zheng & Wang, 2025). [70] Social media can also amplify experiences of cyber-bullying, exclusion, or harassment, which may intensify stress and affect both emotional and academic functioning (Liu & Zhang, 2024). [37]

Social media has become an integral part of college life, offering platforms for connection, self-expression, and information sharing. However, excessive or maladaptive use can contribute significantly to stress among college students. Research indicates that passive social media use, such as scrolling through feeds without active engagement, is positively correlated with increased social anxiety (Liu & Zhang, 2024). [37] In contrast, active use, which involves meaningful interactions like messaging or commenting, may help alleviate feelings of isolation and anxiety by enhancing communication skills and providing social support. Moreover, high levels of social media engagement have been linked to academic procrastination and reduced sleep quality, both of which can elevate academic stress (Zheng & Wang, 2025). [70] Students may find themselves distracted by notifications or compelled to check social media during study sessions, leading to decreased productivity and increased feelings of stress. A student who frequently checks social media during study sessions may experience interruptions that disrupt their focus, leading to procrastination and heightened stress about impending deadlines.

Additionally, the curated nature of content on platforms like Instagram and Facebook can lead to social comparison, where students measure their own lives against the idealized portrayals of others. This can result in feelings of inadequacy, loneliness, and increased anxiety (Cheng & Zhang, 2023). [14] A student scrolling through Instagram may feel anxious upon seeing peers attending social events or achieving academic success, leading to self-doubt and stress about their own social and academic standing. To mitigate these effects, students can adopt strategies such as setting time limits for social media use, engaging in active rather than passive interactions, and curating their feeds to include positive and supportive content. Developing digital literacy and mindfulness about one's social media habits can also help in reducing the stress associated with online platforms.

Social Media as a Positive Coping Tool

While social media is often criticized for contributing to stress, anxiety, or FOMO, it can also serve as a positive coping tool when used intentionally and mindfully. Platforms allow individuals to maintain social connections, access support networks, and share experiences during challenging times. For example, someone dealing with academic stress, illness, or mental health challenges can join online communities or support groups where members exchange advice, encouragement, and resources. This sense of belonging and understanding can buffer the negative effects of stress and help individuals feel less isolated (Naslund et al, 2020). [39]

Social media can also be used to promote mental wellness by providing access to educational content, guided mindfulness exercises, or mental health campaigns. Following accounts that share motivational posts, relaxation techniques, or tips for healthy routines can reinforce positive behaviors and coping strategies. Additionally, creative expression through posting artwork, journaling, or videos can help individuals process emotions and relieve stress. (Naslund et al, 2020). [39] By setting boundaries,

curating content thoughtfully, and using social media intentionally, it can become a tool for connection, education, and emotional regulation rather than a source of anxiety.

Question

Think about how you use social media and how it might contribute to your stress levels. Consider some of these questions:

- How does scrolling through social media affect your mood or self-perception?
- Do you notice feeling more connected, or more pressured to "measure up" to what you see online?
- When you feel stressed, do you turn to social media for distraction or connection?
- Does it actually help reduce your stress, or sometimes make it worse?
- Have you ever felt "FOMO" (fear of missing out) after seeing what others post online? How might that influence your mood or sense of belonging
- In what ways can social media be used as a positive coping tool (for example, connecting with support groups or mental health resources) instead of a source of stress?

Interactions Between Social and Environmental Stressors

Social and environmental stressors often overlap. For instance, a competitive classroom environment (social) combined with a noisy dorm or long commute (environmental) can make it more difficult to concentrate, study, or participate effectively. Recognizing these combined effects helps students develop strategies to reduce stress, such as setting boundaries, finding quiet study spaces, or seeking social support. A student may cope with environmental noise by using noise-canceling headphones, while also reaching out to supportive classmates to navigate the pressures of group assignments and competitive grading.

Thoughts

Stress is not only caused by external events or physical conditions; the way individuals think about situations can itself be a major source of stress. Cognitive sources of stress arise when thoughts, beliefs, or interpretations amplify challenges or create worry and anxiety. How a person perceives a situation often determines whether it feels manageable or overwhelming, which is why two students can face the same event yet experience very different levels of stress.

Negative thought patterns, such as **catastrophizing**, **overgeneralizing**, or assuming the worst, can intensify stress and make problems seem larger than they are. Rumination, the repeated focus on distressing thoughts or past mistakes, keeps the mind engaged with stressors long after the event has passed. Additionally, irrational or perfectionistic beliefs, such as "I must get perfect grades, or I am a failure," can create ongoing pressure and prevent individuals from coping effectively.

Cognitive stressors are closely linked to the general stress response. When thoughts interpret a situation as threatening or uncontrollable, the brain signals the hypothalamic-pituitary-adrenal (HPA) axis to release stress hormones, increasing heart rate, blood pressure, and alertness. Even if the external event is minor, negative thinking can trigger the same physiological response as a major stressor. For example, a student preparing for a presentation might think, "If I mess up, everyone will think I'm incompetent." This interpretation activates anxiety, raises cortisol levels, and makes it harder to focus, even if the presentation itself is straightforward. Another student viewing the same presentation as an opportunity to share knowledge and grow from feedback may experience only mild stress or even motivation.



Figure 10.4.4: Negative thought patterns can intensify stress. (CC BY 4.0; Gan Khoon Lay via Wikimedia Commons)

By becoming aware of thought patterns and learning to reframe or challenge unhelpful beliefs, individuals can reduce cognitive sources of stress and strengthen resilience. Techniques such as cognitive restructuring, mindfulness, and self-compassion are effective strategies for managing stress that originates in the mind.

Table 10.4.1: Common Cognitive Distortions That Increase Stress

Cognitive Distortion	Description	Example
Catastrophizing	Expecting the worst possible outcome	A student thinks, "If I fail this exam, I'll never graduate."
All-or-Nothing Thinking	Viewing situations as completely good or bad, with no middle ground	"If I don't get an A, I'm a total failure."
Overgeneralization	Making broad conclusions based on a single event	"I got rejected from this internship, so I'll never get a job."
Personalization	Believing external events are directly caused by oneself	"My friend didn't text back; I must have done something wrong."
Mind Reading	Assuming you know what others are thinking	"Everyone must think I'm unprepared for this presentation."
Should Statements	Imposing rigid expectations on oneself or others	"I should never make mistakes in class; I must always be perfect."

For example, a student notices they are constantly worrying that a small mistake will ruin their grade. By identifying that this is catastrophizing, they can reframe their thought to, "One mistake won't define my performance; I can recover and learn from it,"

which reduces stress and improves focus.

Question

Think about your thought pattern and how cognitive distortion may be impacting your life. Commonly, you have applied one of these thought processes to a situation you've experienced.

Everyday stress and Self-Talk

- When you get a poor grade or miss a deadline, what kinds of thoughts automatically go through your mind?
- Do you ever catch yourself saying things like “I’m just not smart enough” or “I’ll never get this right”?
- How might that thinking affect your motivation?

Social Comparisons

- How often do you compare yourself to others on social media or in class?
- What assumptions do you make about other students’ success, confidence, or happiness?
- How might those assumptions distort reality?

All-or-Nothing Thinking

- Do you ever feel like you have to be perfect in your academics, fitness, or relationships - or else you’ve failed?
- How could seeing things in shades of gray instead of “success or failure” change how you handle challenges?

Overgeneralization and Catastrophizing

- Have you ever had a small setback (like missing an assignment) and assumed it meant you’d “ruined everything” or “might as well give up”?
- What are examples of times when your thoughts made a situation seem worse than it really was?

Mind Reading and Personalization

- When someone doesn’t text you back or greet you on campus, do you automatically assume they’re upset with you or don’t like you?
- How often do you take responsibility for things that may not actually be your fault?

Emotional Reasoning

- Have you ever thought, “I feel anxious, so something must be wrong,” even when nothing bad has happened?
- How might relying on emotions alone to interpret situations lead to distorted thinking?

Reframing and Growth

- Think about a recent stressful situation. How might you reframe your thoughts to see it more realistically or compassionately?
- What are some healthier, more balanced thoughts you could use when you start to notice distorted thinking patterns?

Physiological

While many stressors come from life circumstances or thought patterns, the body itself can also be a direct source of stress. Physiological stressors are physical conditions or changes within the body that trigger the stress response. These may include illness, injury, chronic health conditions, lack of sleep, poor nutrition, or substance use. Because the body and mind are closely connected, physical stressors can intensify psychological distress and make it harder to cope with everyday challenges.

Physiological stressors activate the same systems involved in the general stress response, including the hypothalamic-pituitary-adrenal (HPA) axis and the release of stress hormones such as cortisol and adrenaline. For example, lack of sleep not only impairs concentration and memory but also increases cortisol levels, making stressful situations feel more overwhelming. Chronic pain

or illness, such as migraines or asthma, places continuous demands on the body, heightening feelings of frustration, anxiety, or helplessness. Even positive physical changes, like pregnancy or intense athletic training, can stress the body as it works to adapt.

Recognizing physiological stressors is important because they often go unnoticed until they reach a tipping point. A student who consistently skips meals or relies on caffeine and energy drinks may not realize how much these habits contribute to fatigue, irritability, and reduced focus. By addressing physical needs through proper sleep, balanced nutrition, exercise, and medical care, individuals can reduce the burden of physiological stress and improve their overall capacity to cope with other stressors. For example, a college student recovering from the flu may find even small academic tasks overwhelming, not only because of missed work but also because their body's weakened state amplifies the stress response, making concentration, memory, and emotional regulation more difficult.

Key Points

- Stress arises from many sources, including major life changes, daily hassles, social pressures, and environmental challenges.
- Change is often the underlying stress factor, since both positive and negative events require adjustment and adaptation.
- Large life experiences such as starting college, moving, or graduating are clearly recognized as stressful because of the uncertainty they bring.
- Daily hassles, though small, can accumulate throughout the day and become significant sources of stress that affect health and well-being.
- Research shows that everyday hassles not only predict current well-being but also influence long-term mental health outcomes.
- Job and financial pressures are persistent stressors that affect both students and adults, with links to burnout, anxiety, and health problems.
- College students face unique stressors, including academic demands, financial strain, time management challenges, and concerns about the future.
- Non-traditional students often experience additional stress because they are expected to meet the same academic standards while balancing work and family responsibilities.
- Social stressors such as friendships, romantic relationships, and family pressures can both provide support and create conflict that adds to overall stress.
- Environmental stressors, including noise, crowded living spaces, poor transportation, and excessive social media use, can compound other stressors and intensify their effects.

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10.5: Managing Stress



Figure 10.5.1: Finding ways to wind down, relax and tune out can help reduce stress. (Woman floating on body of water; Haley Phelps via Unsplash)

Introduction

Comprehensive stress management involves addressing both the mind and body to maintain overall health and well-being. While everyone encounters stress, the key to preventing its harmful effects lies in understanding and managing the body's physiological responses as well as one's thoughts and emotions. Effective strategies combine physical, behavioral, and cognitive approaches to reduce tension and build long-term resilience. Physiological techniques, such as regular exercise, relaxation training, controlled breathing, and adequate sleep, help calm the body's stress response and restore balance. Cognitive approaches, including reframing negative thoughts, practicing mindfulness, and cultivating self-compassion, promote emotional regulation and healthier coping patterns. Additionally, meaningful connections and activities, such as volunteering, spending time with supportive friends, or pursuing hobbies can strengthen social and emotional well-being. In contrast, maladaptive coping behaviors like avoidance, substance use, or emotional suppression may provide temporary relief but increase stress over time. By integrating both cognitive and physiological strategies, individuals can better manage daily pressures, enhance performance, and improve overall quality of life.

Cognitive Strategies

Cognitive strategies involve mental processes that help a person plan, monitor, and regulate behavior to achieve desired outcomes. These strategies work by structuring thought processes, improving **perceived control**, and reducing **cognitive overload**, which lowers physiological and emotional stress reactions.

Goal Setting

Goal setting requires thinking ahead, prioritizing, and making decisions about what is important, which are all cognitive processes. Effective goal setting is a powerful tool for reducing stress and promoting a greater sense of control over one's life. Stress often arises when demands feel overwhelming or unmanageable, but setting clear, realistic goals helps break large challenges into smaller, achievable steps. Goals provide direction and motivation, turning abstract worries into concrete action plans. For college students, this might mean setting weekly academic targets, such as completing reading assignments or studying for a set number of hours, rather than feeling anxious about an entire semester's workload. The process of setting specific, measurable, attainable, relevant, and time-bound, S.M.A.R.T. goals (as introduced in **Chapter 1**) creates structure and clarity, helping individuals focus their energy more efficiently and minimize feelings of chaos or uncertainty. Goal setting

enhances self-efficacy, the belief in one's ability to succeed. As people meet their goals and manage time more effectively, they gain confidence in handling challenges, which reduces feelings of helplessness and stress.

Benefits of Goal-Setting:

- Clarifies priorities: By defining clear, achievable goals, you reduce uncertainty and mental clutter, which are major sources of stress.
- Enhances focus and motivation: Cognitive focus on specific targets helps the brain organize attention and effort efficiently.
- Promotes a sense of control: Feeling in control of your objectives reduces anxiety because the mind perceives problems as manageable rather than overwhelming.

Time Management

Time management involves planning, organizing, and regulating one's schedule to accomplish tasks efficiently. Time management complements goal setting by helping individuals prioritize their responsibilities and allocate time for rest and personal activities. Poor time management often leads to last-minute stress, missed deadlines, and sleep deprivation, all of which contribute to anxiety and burnout. Using tools such as planners, calendars, or digital apps can make it easier to organize tasks, track progress, and visualize upcoming commitments. One effective strategy is the "time-blocking" method, where specific blocks of time are reserved for focused work, study, self-care, and relaxation. By intentionally scheduling breaks and leisure activities, individuals prevent fatigue and maintain steady productivity throughout the day (Shankland & Beauvais, 2024). [52]

In academic settings, for example, students who create structured study schedules and realistic deadlines often experience less test anxiety and improved performance. Similarly, working adults who set daily priorities and delegate tasks can prevent overload and maintain a healthier work-life balance. These practices transform stressful situations into manageable challenges rather than overwhelming obstacles. Ultimately, learning to manage time effectively supports not only productivity but also overall well-being. When individuals feel organized and purposeful, they experience fewer moments of panic or guilt about unfinished tasks. This sense of control fosters calmness and emotional stability, which are essential for coping with daily pressures. Incorporating time management into one's routine promotes balance, reduces stress, and allows time for personal growth, rest, and meaningful connections, all vital components of a healthy, fulfilling life.

Benefits of Time Management:

- Organizes tasks mentally: Planning the day or week helps the brain allocate attention and resources, reducing cognitive overload.
- Prevents last-minute stress: Anticipating deadlines and scheduling appropriately lowers the anxiety associated with rushing or feeling unprepared.
- Supports self-regulation: The mind monitors progress and adjusts actions, which strengthens a sense of mastery and reduces stress responses.

Self-Awareness Strategies

Self-awareness strategies focus on helping individuals recognize and understand their physical, emotional, and behavioral responses to stress. Recognizing signs of stress is an important step in coping effectively, particularly when it involves increasing awareness of one's own physical and emotional reactions and making intentional decisions based on those signals. Common signs of stress may include muscle tension, fatigue, irritability, headaches, difficulty concentrating, changes in sleep patterns, or feelings of anxiety and overwhelm.

By becoming aware of these stress signals, individuals can adjust their behaviors, thoughts, or daily routines before stress becomes more severe or difficult to manage. For example, recognizing early signs of stress may encourage an individual to practice relaxation techniques, improve time management, seek social support, or prioritize rest and recovery. This process requires cognitive awareness and interpretation of bodily and emotional cues, which is why self-awareness strategies are often connected to cognitive and mindfulness-based approaches to stress reduction.

Developing self-awareness may also improve emotional regulation and decision-making by helping individuals better understand how stress affects their health, relationships, and behavior. Over time, increased self-awareness can support healthier coping patterns, greater resilience, and improved overall well-being.

Listen to Your Body

Self-awareness can be as simple as "listening to your body", which involves recognizing signs of stress, such as:

- muscle tension
- fatigue
- headaches
- irritability
- changes in breathing
- sleep disturbances

Other Cognitive strategies to reduce stress

Cognitive strategies to reduce stress focus on patterns of thinking. These strategies help individuals develop healthier perspectives and attitudes regarding stress in their lives (Falcone, 2022). [19]

Cognitive Stratgies to Try

Become a problem solver:

- Make a list of the things that cause you 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.
- 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.

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.

Reward accomplishments:

- Recognize what you have accomplished at the end of the day, not what you have been unable to do.

Build your Resilience: Resilience refers to the ability of an individual, family, organization, or community to cope with adversity and adapt to challenges or change. Everyone will experience hardships in life, from everyday challenges to traumatic events, and each person reacts to the challenges differently. Being resilient does not mean that a person does not experience difficulty or distress, but it may help them adapt well over time to stressful situations.

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

Healthy Lifestyle Choices

Adopting a healthy lifestyle plays a vital role in managing stress and maintaining overall well-being. The way individuals move, eat, and rest directly influences how their bodies and minds respond to daily challenges. Regular physical activity helps release built-up tension, boosts mood through the release of endorphins, and improves sleep quality. Adequate sleep allows the body and brain to recover, regulate emotions, and maintain focus, while balanced nutrition provides the energy and nutrients needed to cope with stress effectively. Together, these habits form the foundation for resilience—helping individuals manage pressure, enhance performance, and promote a greater sense of calm and control in everyday life.

Physical Activity

To receive the greatest benefits from exercising, try to include at least 2.5 hours of moderate-intensity physical activity (e.g., brisk walking) each week, 1.25 hours of vigorous-intensity activity (such as jogging or swimming laps), or a combination of the two (Flynn et al, 2018). [21]

- **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 suggest that frequency is most important.
- **Find forms of exercise** that are enjoyable. Extroverted people often like classes and group activities. More introverted people 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.

Nutrition

Adequate nutrition plays an essential role in managing and reducing stress by supporting both physical and mental well-being. When the body is properly nourished, it functions more efficiently, helping to stabilize energy levels, mood, and concentration, all of which are often disrupted by stress. Nutrient-dense foods such as fruits, vegetables, whole grains, lean proteins, and healthy fats provide the vitamins and minerals the body needs to regulate hormones and maintain a balanced nervous system. For example, complex carbohydrates can increase serotonin production, promoting calmness and emotional stability, while foods rich in magnesium and B vitamins help reduce fatigue and anxiety.

Conversely, poor eating habits, such as skipping meals, overconsuming caffeine, or eating highly processed foods, can intensify stress responses. These choices may cause blood sugar fluctuations, irritability, and difficulty concentrating, all of which make it

harder to cope with everyday pressures. Maintaining consistent eating patterns and choosing balanced meals can help prevent these physiological stress triggers. In addition, staying hydrated and limiting stimulants like caffeine and added sugars supports steady energy and a clearer mind. Overall, proper nutrition provides the body and brain with the foundation needed to handle stress effectively and promote long-term emotional resilience.

Sleep

Sleep plays a crucial role in managing stress by allowing the body and mind to recover from daily demands and maintain emotional balance. During sleep, the brain processes experiences, consolidates memories, and regulates hormones that influence mood and stress responses, such as cortisol. Adequate sleep enhances cognitive functioning, improves problem-solving skills, and helps individuals respond more calmly to challenging situations. Conversely, insufficient or poor-quality sleep can intensify stress, impair judgment, and increase the risk of anxiety and depression. Prioritizing consistent, restorative sleep is therefore essential for building resilience, maintaining mental health, and effectively coping with stress in both daily life and high-pressure situations. The importance of sleep is discussed in detail in **Section 10.7** of this chapter.

Spiritual Wellness

Stress affects individuals physically, mentally, emotionally, and socially. An often-overlooked component of managing stress is spiritual wellness. **Spiritual wellness** refers to the ability to develop meaning, purpose, values, and connection in life. While spirituality may include religious beliefs or practices for some individuals, it is not limited to religion. Spiritual wellness can also involve personal reflection, connection with nature, mindfulness, gratitude, service to others, or a sense of belonging to something greater than oneself.

Spiritual wellness is important because it can help individuals cope more effectively with stress and adversity. People who feel a sense of meaning and purpose in life often demonstrate greater emotional resilience and improved psychological well-being. Spiritual wellness may provide comfort during difficult situations, promote optimism, and help individuals maintain perspective when facing academic, personal, or professional challenges.

Research suggests that practices associated with spiritual wellness may help reduce stress, anxiety, and feelings of isolation while improving overall life satisfaction and emotional balance. Spiritual wellness can also support healthier lifestyle behaviors and improve interpersonal relationships by encouraging empathy, compassion, and self-awareness.

Ways to Develop Spiritual Wellness

Spiritual wellness is highly individualized, and different practices may be meaningful for different people. Common strategies for developing spiritual wellness include:

- **Mindfulness and meditation:** Practicing mindfulness or meditation may help individuals focus on the present moment, reduce stress, and improve emotional regulation.
- **Reflection and journaling:** Taking time to reflect on personal values, goals, and experiences can increase self-awareness and provide a greater sense of purpose.
- **Participation in religious or spiritual practices:** For some individuals, prayer, worship, or involvement in faith-based communities provides support, guidance, and connection.
- **Connecting with nature:** Spending time outdoors may promote relaxation, perspective, and feelings of connectedness.
- **Acts of service and helping others:** Volunteering and supporting others can foster meaning, compassion, and social connection.
- **Developing supportive relationships:** Building positive relationships with friends, family, or community members can strengthen emotional and spiritual well-being.
- **Practicing gratitude:** Regularly recognizing and appreciating positive aspects of life may improve mood and reduce stress.

Spiritual wellness is one dimension of overall wellness and interacts closely with emotional, mental, physical, and social health. Managing stress effectively often requires attention to multiple dimensions of wellness rather than focusing on physical health alone. By developing spiritual wellness, individuals may improve their ability to cope with stress, maintain emotional balance, and develop a stronger sense of purpose and well-being throughout life.

Social Strategies to Reduce Stress

Connecting with others is a helpful strategy for stress reduction.

Healthy Relationships and Social Life

Healthy relationships and social connections play a vital role in managing stress and promoting overall well-being. Supportive relationships provide emotional comfort, practical help, and a sense of belonging that can buffer the effects of stress. When individuals share their thoughts and feelings with trusted friends or family members, it can help them gain perspective, feel understood, and reduce feelings of isolation. Social support has been shown to lower stress hormone levels, such as cortisol, and improve cardiovascular and immune function. Simply knowing that someone cares and is available to offer help can make challenging situations feel more manageable and less overwhelming.

Positive social interactions also contribute to resilience, the ability to recover from setbacks and adapt to change. Engaging in healthy relationships encourages the development of coping skills, fosters emotional regulation, and promotes positive behaviors like physical activity and laughter, which further reduce stress. People who maintain strong social networks are more likely to engage in proactive coping strategies, such as problem-solving or seeking advice, rather than resorting to avoidance or withdrawal. These interactions not only provide immediate relief from stress but also strengthen long-term emotional health.

In contrast, social isolation or unhealthy relationships can heighten stress and negatively impact mental and physical health. Conflict, lack of communication, or toxic relationships can increase anxiety and contribute to depression or burnout. Therefore, it is important to cultivate supportive, respectful, and balanced relationships that encourage growth and understanding. Building and maintaining a healthy social life, through family, friendships, community involvement, or group activities, can serve as one of the most effective and natural ways to manage stress, enhance happiness, and sustain overall life satisfaction.

Share Your Stress

When feeling stressed or overwhelmed, talking with someone trusted can be an effective way to cope with stress and gain support. To practice this strategy, try the following:

- Identify a trusted friend, family member, mentor, or support person who is willing to listen without judgment.
- Choose a comfortable time and place to talk openly about your thoughts, feelings, or concerns
- Try to honestly describe what is causing stress and how it is affecting them physically or emotionally.
- During the conversation, it is important to actively listen to feedback and remain open to different perspectives or suggestions.
- Sometimes simply expressing concerns out loud can reduce stress and may help you feel less isolated.
- In other situations, your trusted support persons may offer advice, encouragement, or possible solutions that had not previously been considered.

Regular communication and social support can strengthen emotional well-being and improve stress management skills.

Get Professional Help

Seeking professional help can be an important and effective strategy for managing stress, particularly when stress becomes persistent, overwhelming, or difficult to manage independently. Mental health professionals, counselors, psychologists, physicians, and other trained specialists can help individuals identify sources of stress, develop healthy coping strategies, and address emotional or behavioral concerns that may be contributing to stress. Professional support may also help individuals recognize symptoms of anxiety, depression, burnout, or other stress-related conditions that require additional care. Seeking help should be viewed as a positive and proactive step toward improving overall health and well-being rather than as a sign of weakness. Early intervention and support can improve coping skills, emotional resilience, and quality of life.

Helping others can be an effective and meaningful strategy for reducing stress and improving overall well-being. Engaging in acts of kindness, volunteering, or providing support to friends, family members, or community organizations can shift attention away from personal stressors and create a sense of purpose and connection. When individuals focus on the needs of others, they may experience a reduction in negative thought patterns and an increase in positive emotions such as gratitude, empathy, and

satisfaction.

Helping behaviors can also strengthen social relationships, which are an important source of emotional support during stressful times. Feeling connected to others may reduce feelings of isolation and increase resilience when facing challenges. In addition, contributing to the well-being of others often enhances self-esteem and reinforces a sense of competence and value.

Research in positive psychology suggests that prosocial behaviors, actions intended to benefit others, are associated with lower levels of stress and improved mood (Post, 2005). [44] Even small acts, such as offering encouragement, listening to someone, or performing simple acts of kindness, can contribute to improved emotional balance. Overall, helping others not only benefits the recipient but can also serve as a powerful tool for managing personal stress and enhancing mental health.

Relaxation Techniques

Managing stress effectively requires more than simply avoiding stressful situations; it involves learning ways to calm both the body and the mind. Relaxation techniques are proven methods that help reduce physiological tension, slow the heart rate, lower blood pressure, and quiet racing thoughts. These techniques activate the body's relaxation response, the opposite of the fight-or-flight reaction, promoting a sense of balance and calm.

Practicing relaxation regularly can improve concentration, enhance emotional regulation, and increase resilience to future stressors. From deep breathing and progressive muscle relaxation to meditation, yoga, and mindfulness practices, these techniques can be tailored to individual preferences and lifestyles. Incorporating relaxation into daily routines not only reduces immediate stress but also supports long-term physical and mental health, improving overall quality of life. Taking time to relax is a helpful response to stress in life. There are many ways to purposefully relax. Below are a few techniques to try.

The demands of daily life, tasks, worries, and packed schedules can make everything feel urgent. This constant urgency can actually trigger the fight-or-flight response, resulting in physical responses such as headaches, muscle tension, or a racing heart rate. When an individual experiences stress, the body often responds with shallow, rapid breathing, a physiological reaction that can heighten feelings of tension and anxiety. Deep, slow breathing acts as a powerful antidote to this response, helping to calm the nervous system by "turning off" the stress reaction and activating the body's relaxation response. This simple but effective technique is the foundation of many other relaxation practices, including meditation, yoga, and mindfulness-based stress reduction.

Deep breathing enhances the delivery of oxygen throughout the body and promotes a sense of calm and clarity. By consciously controlling the breath, individuals can slow their heart rate, lower blood pressure, and reduce muscle tension. Regular practice can improve focus, emotional stability, and resilience to stress over time. If one becomes aware of those sensations, take some slow, deep breaths. A nice pattern can be to breathe in for 4 counts and out for 6 counts - which helps to trigger the opposite response to the fight-or-flight: the parasympathetic nervous system's rest-and-digest response.

Deep Breathing Activity

1. Sit or lie down in a comfortable position.
2. Place one hand on the stomach, just below the rib cage.
3. Inhale slowly through the nose, allowing the stomach to rise and expand outward.
4. Exhale slowly through the mouth, feeling the stomach fall as the lungs empty completely.
5. Repeat this pattern several times until a sense of relaxation is achieved.

Practicing deep breathing for a few minutes several times a day can help maintain balance and reduce the physical and emotional effects of stress. Over time, this technique can become a natural tool for restoring calm during moments of tension or anxiety.

Guided imagery is a relaxation technique that uses mental visualization to evoke feelings of calm and well-being. In this practice, individuals imagine peaceful scenes, objects, or experiences that help reduce tension and promote emotional balance. By engaging the senses and focusing attention on soothing mental images, guided imagery can help quiet the mind, slow breathing, and trigger the body's relaxation response. It is often used to manage stress, anxiety, and pain, and can enhance focus and emotional resilience.

Guided Imagery Activity

Use this exercise to help calm your mind and body through visualization. Follow these steps:

1. Find a quiet space where you won't be interrupted. Sit or lie down in a comfortable position.
2. Close your eyes and take a few deep, slow breaths to help yourself relax.
3. Picture a peaceful, calming place. This could be a beach, forest, meadow, or any scene that makes you feel safe and at ease.
4. Begin to fill in the details of this place.
5. What do you see around you?
6. What sounds do you hear—waves, birds, wind?
7. What can you feel—the warmth of the sun, the coolness of the air, the softness of the ground?
8. Are there any scents, like flowers, salt air, or pine trees?
9. Imagine yourself moving gently through this place. You might walk along a path, sit by the water, or simply rest in the grass.
10. As you explore, let yourself feel more relaxed with each breath.
11. When you feel calm and centered, choose a simple word or sound, like "peace," "calm," or "breathe", to remind yourself of this feeling later.
12. When you're ready to return, take a deep breath and tell yourself that you will bring this sense of relaxation with you.
13. Count slowly to three, open your eyes, and take a moment to notice how you feel—peaceful, refreshed, and grounded.

In Progressive Muscle Relaxation, one can reduce muscular tension and negative feelings by learning how to relax and relieve the muscular tension. The key to the relaxation process is taking some deep breaths and then proceeding to tense, then relax a group of muscles in a systematic order.

Progressive Muscular Relaxation

Practice this activity for reducing stress, relaxing muscular tension, and calming the mind:

1. Sit or lay down in a comfortable position, with eyes closed. Take a few deep breaths, expanding your belly as you breathe air in and contracting it as you exhale.
2. Begin at the top of your body, and go down. Start with your head, tensing your facial muscles, squeezing your eyes shut, puckering your mouth, and clenching your jaw. Hold, then release and breathe.
3. Tense as you lift your shoulders to your ears, hold, then release and breathe.
4. Make a fist with your right hand, tighten the muscles in your lower and upper arm, hold, then release. Breathe in and out. Repeat with the left hand.
5. Concentrate on your back, squeezing your shoulder blades together. Hold, then release. Breathe in and out.
6. Suck in your stomach, hold, then release. Breathe in and out.
7. Clench your buttocks, hold, then release. Breathe in and out.
8. Tighten your right hamstring, hold, then release. Breathe in and out. Repeat with the left hamstring.
9. Flex your right calf, hold, then release. Breathe in and out. Repeat with the left calf.
10. Tighten toes on your right foot, hold, then release. Breathe in and out. Repeat with the left foot.

Try this guided video for Progressive Muscle Relaxation, as sometimes a guided activity can help you further relax.

Meditation is very beneficial. The regular practice of meditation can actually change your brain to make you more open to positive emotions such as happiness. The process of meditation has been shown to actually increase gray-matter concentration in areas of your brain related to well-being. However, as we know, meditation is not easy. Let's start to try to build more meditative moments into our day.

Meditation is about clearing your mind. There are many types of meditation, but most have four elements in common: a quiet location with as few distractions as possible; a specific, comfortable posture (sitting, lying down, walking, or in other positions); a focus of attention (a specially chosen word or set of words, an object, or the sensations of the breath); and an open attitude (letting distractions come and go naturally without judging them).

Meditation can be practiced in simple moments of one's life, wherever you are. It is the act of noticing what is going on with each

of the 5 senses: touch, taste, feel, sight, and smell, while you take a few deep breaths and slow down your breathing. You can develop meditation into a habit in your daily life, taking time in moments such as waiting in line at the grocery store.

Simple Meditation Activity

Use this exercise to relax and calm your mind and body through meditation:

1. Sit in a comfortable position, with eyes closed.
2. Set a time limit such as one, two, five or 10 minutes.
3. Notice how your body feels
4. Focus on your breath. Follow the sensation of your breath as it goes in and as it goes out.
5. Notice when your mind has wandered and simply return your attention to your breath. It is normal for your mind to wander; just come back.
6. When time is up, take a moment and notice any sounds in the environment. Notice how your body feels right now. Notice your thoughts and emotions. Show yourself kindness and appreciation.

Try this guided video for 5 Minute Mindful Meditation to be More Calm

Meditation does not always have to be done with eyes closed. It is about being connected to the 5 senses.

Walking Meditation Activity

Try this outdoor meditation activity to reduce stress and increase your sense of calm:

- Instead of having an afternoon coffee, try a walking meditation.
- Start a short, 10-minute walk and allow your pace to be slightly slower than your normal pace, but not so slow that anyone would notice.
- Now, using your 5 senses of touch, taste, feel, sight, and smell, pay attention to the experience. This is what makes it a meditation.
- As you move along, notice what's in front of you and notice the sensation of your feet against the ground.
- Whenever you realize that your mind has strayed, take a breath and return your mind to your senses.
- Refocus on the experience of the walk. Integrating the mind and body with a conscious walk lets you cultivate concentration, engage your muscles, bring fresh air into the lungs, and take your brain off of your worries.
- Try to remember to walk comfortably, not super-slow, but to take your time.
- This walk will not take you anywhere but inward.
- See how you feel after about 10 minutes of this openness to the world around you.

Stretching can also help relax your muscles and make you feel less tense. Stretching can be an effective relaxation technique because it helps reduce muscle tension, improve circulation, and promote a sense of physical and mental calmness. Stress often causes muscles to tighten, particularly in areas such as the neck, shoulders, and lower back. Gentle stretching helps release this tension and may decrease feelings of discomfort and fatigue. Stretching also encourages controlled breathing and mindfulness, which can help slow heart rate and reduce stress-related physiological responses. In addition to promoting relaxation, regular stretching may improve flexibility, posture, and overall physical comfort, making it a valuable strategy for managing daily stress and supporting overall wellness.

Massage therapy can be an effective technique for reducing stress and promoting relaxation. Massage helps decrease muscle tension, improve circulation, and stimulate the body's relaxation response, which may lower heart rate, blood pressure, and stress hormone levels. Many individuals experience reduced feelings of anxiety and improved mood following massage therapy because it promotes both physical and mental relaxation. Massage may also help relieve headaches, muscle soreness, and fatigue that are commonly associated with chronic stress. In addition to its physical benefits, massage can provide individuals with time to slow down, focus on self-care, and improve overall emotional well-being.

Having someone massage the muscles in the back of your neck and upper back can help you feel less tense.

Participate in Enjoyable Activities

Taking time to participate in enjoyable activities can be an important strategy for relaxation and stress management. Many individuals spend much of their time focusing on responsibilities, obligations, and daily demands while neglecting activities they genuinely enjoy. Engaging in personally meaningful activities, such as listening to music, reading, creating art, spending time outdoors, watching a movie, or participating in hobbies, can help reduce stress and improve emotional well-being. Doing something enjoyable provides an opportunity to mentally recharge, promote relaxation, and create balance between work and leisure. Prioritizing enjoyable activities should be viewed as an important part of maintaining overall health and wellness rather than as an unnecessary luxury.

Do Something You Love

Take time to do something you want to do. Personally meaningful activities that you genuinely enjoy can be effective stress reducers, such as:

- Listen to music
- Read a good book
- Go to a movie
- Create art
- Garden
- Color

Effective Strategies for Coping with Stress

Stress is a normal part of life, but when it becomes frequent or overwhelming, it can negatively affect physical health, emotional well-being, academic performance, relationships, and overall quality of life. According to the Anxiety and Depression Association of America, effective stress management involves developing healthy coping strategies that help individuals respond to challenges in productive ways. These strategies may include regular physical activity, relaxation techniques, mindfulness, adequate sleep, healthy nutrition, social support, and time management. Learning to recognize stress and apply positive coping skills can improve resilience, reduce anxiety, and support both mental and physical health over time.

Effective Strategies for Coping with Stress

The Anxiety and Depression Association of America (ADAA) provides a list of effective strategies for coping with stress (Anxiety and Depression Association of America, n.d.). [5]

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.

Ineffective Strategies for Coping

While stress is a normal part of life, not all coping strategies are healthy or effective. According to the Anxiety and Depression Association of America, some individuals respond to stress in ways that may provide temporary relief but ultimately increase emotional, psychological, or physical strain over time (n.d.). [5] Ineffective coping strategies may include avoidance, procrastination, social withdrawal, overeating, substance use, excessive screen time, or relying on alcohol or drugs to manage emotions. Although these behaviors may reduce stress temporarily, they often fail to address the underlying cause of stress and can contribute to anxiety, depression, sleep disturbances, poor academic or work performance, and long-term health problems. Recognizing unhealthy coping behaviors is an important step in developing healthier stress management skills and improving overall well-being.

Ineffective Strategies for Coping with Stress

Here is a list of **ineffective or maladaptive strategies for coping with stress**:

- Avoiding or denying the problem instead of addressing it
- Using alcohol, drugs, or nicotine to escape or relax
- Overeating or undereating in response to stress
- Excessive screen time or social media scrolling as a distraction
- Withdrawing from friends, family, or social support
- Procrastinating or neglecting responsibilities
- Taking out frustration on others (verbal or physical aggression)
- Overworking or becoming a "workaholic" to avoid emotions
- Engaging in self-harm or reckless behaviors
- Ruminating or obsessively worrying without taking action
- Suppressing or ignoring emotions rather than expressing them
- Engaging in negative self-talk or self-blame
- Avoiding decision-making or problem-solving
- Escaping through excessive shopping, gambling, or spending
- Using unhealthy sleep patterns (sleeping too much or too little)
- Relying solely on others to solve one's problems

It is recognized that everyone experiences stress in their lives, and a moderate amount of stress can be beneficial; however, excessive stress can contribute to illness. Individuals need to recognize sources of stress and take appropriate action to manage it in healthy, constructive ways to prevent negative effects on health.

Key Points

- Stress management requires an integrated approach that addresses cognitive, emotional, behavioral, and physiological responses to stress.
- Cognitive strategies such as goal setting, time management, and problem-solving help individuals increase control and reduce perceived stress.
- Self-awareness is essential for identifying early signs of stress and making intentional adjustments before stress escalates.
- Healthy lifestyle behaviors, including regular physical activity, balanced nutrition, and adequate sleep, support the body's ability to regulate stress.
- Spiritual wellness, including meaning, purpose, mindfulness, gratitude, and connection, contributes to emotional resilience and stress reduction.
- Relaxation techniques such as deep breathing, meditation, guided imagery, stretching, and progressive muscle relaxation activate the body's relaxation response.

- Effective stress management involves using adaptive coping strategies, such as seeking support, reframing thoughts, and engaging in enjoyable activities.
- Social support and strong relationships reduce stress by providing emotional comfort, perspective, and practical assistance.
- Maladaptive coping strategies (e.g., avoidance, substance use, or withdrawal) may temporarily reduce stress but worsen long-term outcomes.
- Helping others and engaging in prosocial behaviors can improve mood, enhance meaning, and reduce perceived stress levels.

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10.6: Stress - Or Something More Serious?

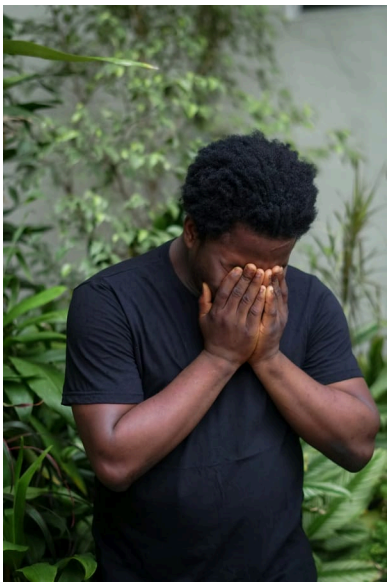


Figure 10.6.1: (A man covers his face with his hands; Francis Odeyemi via Unsplash)

Introduction

Stress is a normal and even necessary part of life. It helps people stay alert, motivated, and ready to respond to challenges. College students, for example, often experience stress when managing heavy coursework, balancing social commitments, or preparing for exams. However, there is a point when ordinary stress becomes more than just a temporary response to pressure. When feelings of worry, sadness, or exhaustion persist and begin to interfere with daily life, they may signal a deeper concern such as anxiety, depression, or another mental health disorder.

Recognizing the difference between manageable stress and a mental health condition is essential for maintaining overall well-being. While stress typically eases once the situation improves or the challenge passes, mental health disorders often persist and may intensify without proper care. Learning to identify the warning signs, such as changes in mood, sleep, or behavior, can help individuals know when to seek additional support. Understanding this distinction not only promotes self-awareness but also reduces stigma and encourages early intervention. The following section examines how to identify when normal stress transitions into something more severe and what steps can be taken to support mental health and resilience.

Stress or Something More Serious?

Stress and **mental health disorders,** which were discussed in Chapter 1, share many overlapping features, which can make it difficult to tell them apart. Both can affect mood, thinking, and behavior, but they differ in duration, intensity, and the extent to which they interfere with daily life. Stress is a normal reaction to challenges or demands and usually subsides once the situation improves. However, when stress becomes overwhelming or long-lasting, it can contribute to or reveal deeper mental health conditions such as anxiety disorders or depression. Stress becomes dangerous when someone no longer has the ability to live normally. Unlike temporary stress, mental disorders persist, often leading to significant emotional pain, isolation, and difficulty functioning in everyday roles. In severe cases, untreated mental health disorders can lead to self-destructive behaviors or even suicide. Recognizing when ordinary stress has crossed the line into something more serious is essential for seeking help early and preventing these tragic outcomes.

Table 10.6.1: Key Differences Between Stress and Mental Health Disorders

Feature	Stress	Mental Health Disorder
Definition	A normal psychological and physical response to life's demands or challenges.	A clinically significant disturbance in mood, thinking, or behavior that impairs daily functioning.
Duration	Usually short-term and linked to a specific situation or event.	Long-lasting or recurring, often continuing after the original stressor is gone.
Cause	Triggered by identifiable external pressures (e.g., exams, deadlines, relationship issues).	May develop from a combination of genetic, biological, psychological, and environmental factors.
Symptoms	Tension, worry, irritability, fatigue, sleep problems; symptoms improve when the stressor resolves.	Persistent sadness, hopelessness, excessive fear, loss of interest, or changes in thinking, behavior, or functioning.
Impact on Functioning	Temporary difficulty focusing or relaxing, but daily responsibilities can usually still be managed.	Significant impairment in work, school, or social functioning may make daily life feel unmanageable.
Physical Effects	Headaches, muscle tension, increased heart rate, and upset stomach.	Can include chronic fatigue, appetite or sleep changes, and somatic symptoms that persist even without stressors.
Resolution	Improves with rest, coping strategies, or problem-solving.	Usually requires professional evaluation and treatment (e.g., therapy, medication, or both).
Risk if Untreated	Can lead to burnout or contribute to mental health problems if prolonged.	May worsen over time, leading to severe emotional distress, self-destructive behavior, or even suicide.
When to Seek Help	When stress feels unmanageable or interferes with health and relationships.	When symptoms persist, worsen, or include hopelessness, withdrawal, or thoughts of self-harm.

Red Flags: When Stress May Be Something More

Everyone experiences stress, but there are times when stress responses start signaling a deeper mental health concern. It's

important to pay attention to emotional, behavioral, and physical warning signs that suggest ordinary stress may be progressing into a disorder such as anxiety or depression. These red flags include:

- Persistent feelings of sadness, emptiness, or hopelessness that do not improve with rest or time.
- Loss of motivation or interest in once enjoyable activities.
- Difficulty functioning in daily life, such as trouble focusing, keeping up with responsibilities, or maintaining relationships.
- Changes in sleep or appetite, such as sleeping too much or too little, or significant weight gain or loss.
- Withdrawal from friends, family, or social activities.
- Increased use of alcohol or drugs as a way to cope with stress or emotions.
- Intense feelings of worthlessness, guilt, or failure.
- Frequent physical symptoms such as headaches, digestive issues, or chronic fatigue with no clear medical cause.
- Thoughts of self-harm or suicide.

If these warning signs appear or persist, it may indicate that the problem goes beyond temporary stress. Reaching out to a trusted friend, counselor, or mental health professional can make a life-saving difference.

How to help yourself or others

If you or someone you know is showing warning signs that stress may have escalated into a mental health concern, there are many options!

- Reach out to a trusted person – a friend, family member, mentor, or spiritual advisor.
- Contact a mental health professional, such as a counselor, therapist, or psychiatrist, for assessment and support.
- Use crisis resources if needed:

National Suicide Prevention Lifeline: 1-800-273-TALK (8255)

Crisis Text Line: Text HOME to 7417414.

- Don't ignore persistent symptoms – early intervention improves outcomes and can prevent more serious consequences.
- Stay connected and follow up – ongoing support from peers and professionals is critical for recovery and resilience.

Remember: Seeking help is a sign of strength, not weakness, and can make a life-saving difference.

Barriers to Seeking Help: Stigma, Shame, and Rationalization

Despite the prevalence of mental health challenges, a significant number of individuals, particularly men, never seek treatment. In 2021, only 40% of men with a recent mental illness received treatment, compared to 52% of women (Fischer & Good, 2024). [22] This disparity is partly due to societal expectations around masculinity, which often discourage emotional expression and vulnerability. Many men rationalize their symptoms, convincing themselves that their feelings are temporary, that they should be able to handle problems on their own, or that seeking help is unnecessary. Some may fear being judged by peers, family members, or coworkers, or worry about the potential impact on their professional or personal lives (Seidler et al, 2020). [50] This reluctance can delay intervention, allowing symptoms to worsen and increasing the risk of serious outcomes, including suicide.

Addressing these barriers requires promoting awareness that mental illness is common and treatable, normalizing help-seeking behavior, and creating supportive environments where individuals feel safe discussing their emotional health. Encouraging conversations, sharing experiences, and highlighting stories of recovery can reduce stigma and empower men and others who struggle to seek the care they need.

Getting Help

Failing to seek help for mental health challenges can have profound emotional and psychological consequences. When symptoms of depression, anxiety, or other disorders go untreated, they often intensify over time, leading to feelings of hopelessness, irritability, and emotional exhaustion. Individuals may begin to withdraw from friends and family, lose interest in activities that once brought joy, and struggle to concentrate or perform at school or work. Prolonged distress can also erode self-esteem and

create a sense of isolation or failure, especially in those who believe they should be able to “handle it” on their own (Lu et al, 2022). [38] Over time, untreated mental illness can contribute to substance misuse, relationship strain, and physical health problems such as insomnia or chronic pain. In the most serious cases, despair and hopelessness may escalate into thoughts of self-harm or suicide. Seeking help early not only prevents these outcomes but also restores hope, connection, and the possibility of recovery.

Recognizing that an individual may be struggling with a mental health disorder can be overwhelming, but seeking help is a crucial and empowering first step toward recovery. Mental illnesses are common and treatable, yet many people delay reaching out due to fear, stigma, or uncertainty about where to begin. Effective strategies for obtaining support include learning to identify signs of distress, knowing when to involve a trusted friend or family member, and connecting with mental health professionals or campus counseling services. Early intervention can significantly improve outcomes by supporting recovery, restoring daily functioning, and preventing crises. Providing support to others is also important; noticing changes in behavior, expressing concern, and encouraging professional help can be life-saving.

Steps for Seeking Help

Taking action when facing a mental health challenge can feel intimidating, but breaking it down into clear steps makes the process more manageable.

1. **Recognize the Signs**

- Pay attention to changes in mood, behavior, sleep, appetite, or daily functioning.
- Notice persistent feelings of sadness, anxiety, irritability, or hopelessness

2. **Reach Out to Trusted People**

- Talk to a friend, family member, mentor, or peer who makes you feel safe.
- Sharing your feelings can reduce isolation and provide emotional support.

3. **Connect with Professional Help**

- Seek guidance from a mental health professional such as a counselor, psychologist, or psychiatrist.
- Campus counseling centers, local clinics, and telehealth services are available options.

4. **Use Crisis Resources if Needed**

If you or someone you know is in immediate danger or thinking about self-harm, contact crisis services:

- **National Suicide Prevention Lifeline:** 1-800-273-TALK (8255)
- **Crisis Text Line:** Text HOME to 741741
- For the deaf or hard of hearing, TTY: 1-800-799-48895.

5. **Follow Up and Maintain Support**

- Continue attending therapy or counseling appointments.
- Stay connected with supportive friends, family, or support groups.
- Monitor your own mental health and be proactive in seeking help if symptoms return or worsen.

Suicide

Suicide is a significant public health concern and a leading cause of death in the United States. In 2020, an estimated 12.2 million American adults seriously considered suicide, 3.2 million planned a suicide attempt, 1.2 million attempted suicide, and 45,979 people died by suicide. Among people aged 10–64, suicide ranked among the top nine leading causes of death, and it was the second leading cause of death for individuals aged 10–14 and 25–34 (Brådvik, 2018). [10]

Mental disorders are a major risk factor for suicide, with depression, substance use disorders, and psychotic disorders being the most strongly associated. Anxiety disorders, personality disorders, eating disorders, and trauma-related disorders can also

increase risk. Studies suggest that up to 90% of people who die by suicide have experienced a mental disorder. Although suicide is complex and tragic, it is often preventable, and recognizing warning signs and seeking help can save lives.

Warning Signs of Suicide

Immediate risk warning signs include:

- Talking about wanting to die or kill themselves
- Expressing feelings of hopelessness, emptiness, or having no reason to live
- Feeling trapped or that there are no solutions
- Experiencing unbearable emotional or physical pain
- Talking about being a burden to others
- Withdrawing from family, friends, and social activities
- Giving away prized possessions or saying goodbye
- Taking steps to put affairs in order, such as making a will
- Engaging in risky behaviors that could lead to death
- Frequent thoughts or discussions about death

Other serious warning signs may include:

- Sudden mood changes, such as switching from very sad to calm or happy
- Making plans or seeking ways to end their life, including searching online, stockpiling pills, or acquiring a firearm
- Expressing feelings of guilt or shame
- Increased use of alcohol or drugs
- Heightened anxiety or agitation
- Changes in sleeping or eating habits
- Displaying anger or talking about revenge

Risk Factors of Suicide

Many factors can increase the likelihood of suicidal thoughts or behaviors, including:

- Experiencing depression, other mental health disorders, or substance use disorders
- Living with chronic physical pain or serious medical conditions
- Having a personal history of suicide attempts
- A family history of mental health disorders or substance use
- A family history of suicide
- Exposure to family violence, including physical, emotional, or sexual abuse
- Access to firearms or other lethal means in the home
- Recent release from prison or jail, which can increase vulnerability
- Exposure to suicidal behaviors in others, whether through family members, peers, or public figures (Favril et al, 2023) [20]

It is important to remember that the presence of risk factors does not mean someone will attempt suicide, but awareness can guide early intervention and support.

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 1-800-273-TALK (8255), 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.
   - People who are deaf or 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.

Key Points

- Stress is normal and sometimes beneficial, helping people stay alert and motivated, but when it becomes chronic or overwhelming, it can lead to anxiety, depression, or other mental health disorders.
- The difference between stress and a mental disorder lies in duration, intensity, and impact on daily life. Stress fades when challenges resolve, while mental health conditions persist and often worsen without care.
- Warning signs that stress may have become a disorder include ongoing sadness, hopelessness, loss of motivation, withdrawal from others, sleep or appetite changes, physical complaints, and thoughts of self-harm.
- Mental health disorders affect thinking, mood, and behavior, and include mood disorders (like depression or bipolar disorder), anxiety disorders, psychotic disorders, and eating disorders.
- Severe and untreated mental health disorders can lead to self-destructive behaviors or suicide. Suicide remains a major public health issue and is often preventable through awareness, early intervention, and access to care.
- Stigma and shame often prevent people, especially men, from seeking help. Many rationalize symptoms or fear judgment, delaying treatment and increasing risk for worsening illness or suicide. Promoting open discussion and early help-seeking can save lives.

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10.7: The Importance of Sleep

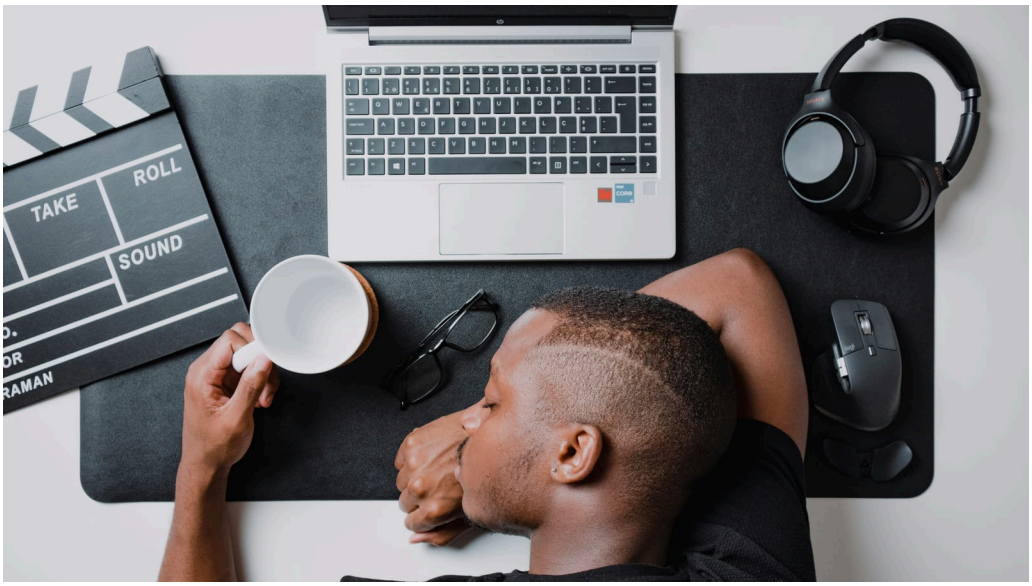


Figure 10.7.1: Roughly one in three adults doesn't get enough sleep. (A man sitting at his laptop; Nubelson Fernandes via Unsplash)

Introduction

Sleep is a critical component of a healthy lifestyle, alongside nutrition and physical activity. While it is not specifically listed as a recommended behavior in the Physical Activity Guidelines for Americans or the World Health Organization's guidelines on physical activity and sedentary behavior, sleep is recognized as an important health outcome that affects overall well-being. Getting enough healthy sleep improves physical health, mental functioning, stress regulation, and quality of life.

On average, people spend about one-third of their lives sleeping, yet many do not get enough rest. It is estimated that roughly one in three adults, and an even higher proportion of adolescents, experience insufficient sleep. Not getting enough sleep can increase the risk of serious health problems such as obesity, diabetes, heart disease, stroke, dementia, and cancer. Poor sleep also impairs concentration, learning, memory, emotional regulation, and performance at work or school. Additionally, insufficient sleep can exacerbate stress, creating a cycle where stress makes it harder to sleep, and poor sleep increases stress reactivity. In the United States, drowsy driving contributes to approximately 100,000 motor vehicle accidents each year. Improving sleep habits and creating a better sleep environment can therefore support both health and safety. Healthy People 2030 highlights sleep as a priority for enhancing overall health, productivity, stress management, and quality of life (U.S. Department of Health and Human Services, n.d.). [61]

Healthy sleep involves more than just getting enough hours; it also includes sleep quality, timing, regularity, and the absence of disturbances or disorders. Achieving both sufficient duration and good-quality sleep is essential for maintaining energy, focus, emotional balance, and long-term health.

Benefits of Adequate Sleep

Adequate sleep provides essential benefits for both physical and mental health, supporting overall well-being and daily functioning. Physiologically, sufficient sleep allows the body to repair tissues, regulate hormones, and maintain cardiovascular and metabolic health. During deep sleep stages, the body releases growth hormone, which aids in tissue growth and repair, strengthens the immune system, and supports healthy metabolism. Inadequate sleep disrupts these processes, increasing the risk of chronic conditions such as heart disease, diabetes, obesity, and weakened immunity. In this way, sleep serves as a critical recovery period that helps the body maintain balance and resilience (Ramar & Malhotra, 2021). [46]

Sleep also plays a crucial role in cognitive functioning and learning. REM sleep, in particular, supports memory consolidation,

allowing new information to be processed and stored in long-term memory. This is especially important for students and professionals who rely on learning, problem-solving, and decision-making in their daily lives. Adequate sleep improves attention, focus, and creativity, making it easier to perform complex tasks efficiently. Conversely, sleep deprivation impairs cognitive performance, reaction time, and the ability to process information, often leading to mistakes and reduced productivity (Ramar & Malhotra, 2021). [46]

Beyond physical and cognitive benefits, sleep contributes significantly to emotional and mental health. Sufficient sleep helps regulate mood, reduces irritability, and enhances the ability to cope with stress. During sleep, the brain processes emotions and stressors, which can prevent negative emotions from building up and affecting mental health. Poor sleep, on the other hand, is strongly linked to anxiety, depression, and emotional instability. In sum, adequate sleep is a cornerstone of health, supporting the body's physical repair, the brain's learning and memory processes, and overall emotional resilience (Ramar & Malhotra, 2021). [46]

The Physiology of Sleep

Sleep is a complex biological process essential for maintaining physical, cognitive, and emotional health. It involves coordinated activity across multiple systems in the body, including the nervous, endocrine, and immune systems. During sleep, the body undergoes important restorative functions such as tissue repair, memory consolidation, hormone regulation, and immune system strengthening. Understanding the physiological mechanisms that govern sleep—including the roles of brain structures, neurotransmitters, and circadian rhythms—helps explain why adequate, high-quality sleep is crucial for overall wellness and optimal daily functioning.

Sleep Regulation

Sleep is regulated by two key physiological processes: homeostatic sleep pressure and circadian rhythms. **Homeostatic sleep** refers to the body's drive to balance sleep and wakefulness based on prior sleep history. The longer a person stays awake, the stronger the pressure to sleep becomes, ensuring the body gets the rest it needs to recover from physical and mental activity. Substances like adenosine accumulate during wakefulness and promote sleep, helping restore energy, consolidate memories, and support overall functioning.

Circadian rhythms, on the other hand, regulate the timing of sleep and wakefulness across a roughly 24-hour cycle. Controlled by the brain's suprachiasmatic nucleus in the hypothalamus, these rhythms respond to external cues such as light and darkness. They influence hormone release, body temperature, and alertness levels. For example, **melatonin** secretion increases in the evening, signaling the body that it is time to sleep, while cortisol levels rise in the morning to promote wakefulness. Together, homeostatic pressure and circadian rhythms coordinate to ensure adequate, high-quality sleep. Disruptions to either process, such as irregular sleep schedules, shift work, or jet lag, can lead to sleep disturbances, impaired cognitive function, and negative effects on overall health. For example, after pulling an all-nighter for studying, a student will feel a strong homeostatic drive to sleep until the body restores its balance.

The Sleep Cycle

A breakthrough in sleep science occurred in the 1950s, fundamentally changing our understanding of what happens during sleep. Before this time, scientists believed that the brain essentially "shut down" during sleep. However, research conducted by Dr. Nathaniel Kleitman, often called the Father of American Sleep Research, and his students revealed that the brain remains active and cycles through different stages of sleep throughout the night. They discovered what is now known as rapid eye movement (REM) sleep, showing that the brain experiences distinct patterns of activity rather than being inactive. Over the course of a typical night, the body cycles through sleep stages approximately every 90 minutes. The duration of each stage varies with age, but generally, non-REM sleep cycles are longer earlier in the night, while REM cycles increase in length later in the night (Aserinsky & Kleitman, 1953). [6]

Sleep is divided into two main types: non-REM and REM sleep. Non-REM sleep includes three stages: Stage 1, Stage 2, and Stage 3, each characterized by specific patterns of brain activity. Stage 3, also called deep sleep, is particularly important for physical restoration, with one to two hours per night typically sufficient to help adults feel refreshed and healthy. REM sleep, in contrast, involves even higher levels of brain activity and is considered a "wakeful" stage, as heart rate and blood pressure rise close to awake levels. REM sleep plays a critical role in consolidating new information, maintaining mood, and supporting cognitive function. Both deep sleep and REM sleep are essential for overall health, and individuals who consistently wake up feeling unrefreshed may not be getting adequate amounts of these restorative stages. Consulting a healthcare provider can help

address persistent sleep difficulties.

The Four Sleep Stages (Cycles)

Sleep is composed of two main types: **non-REM (NREM)** and **REM** sleep, and cycles through these stages roughly every 90 minutes. Each stage has distinct characteristics, brain activity patterns, and functions (National Sleep Foundation, 2021). [41]

Non-REM Sleep

Non-REM sleep is divided into three stages:

- **Stage 1 (N1):** This is the lightest stage of sleep and marks the transition from wakefulness to sleep. Muscle activity slows, eye movements are minimal, and the brain produces theta waves. Stage 1 typically lasts **5–10 minutes** per cycle. People awakened during this stage may feel like they haven't slept at all.
- **Stage 2 (N2):** This stage is deeper than Stage 1 and accounts for approximately **50% of total sleep time** in adults. Eye movements stop, heart rate and body temperature decrease, and brain activity shows sleep spindles and K-complexes, which help protect sleep and facilitate memory consolidation. Stage 2 usually lasts **20–40 minutes** in the first cycle and becomes longer with each successive cycle.
- **Stage 3 (N3):** Also called deep sleep or slow-wave sleep, this stage is critical for physical restoration, tissue repair, and immune system support. Delta waves dominate the brain's activity. Stage 3 typically lasts **20–40 minutes** in the first cycle and becomes shorter in later cycles. Missing deep sleep can leave a person feeling groggy and unrested.

REM Sleep

REM (Rapid Eye Movement) sleep is a stage characterized by high brain activity that closely resembles wakefulness in terms of brain waves, while most voluntary muscles are temporarily paralyzed. This stage is named for the rapid, back-and-forth movements of the eyes beneath closed eyelids. REM sleep typically begins about 90 minutes after sleep onset, with the first period lasting approximately 10 minutes and progressively lengthening to up to an hour in later cycles. Dreaming primarily occurs during REM, reflecting the brain's intense neural activity. Physically, REM sleep involves faster and irregular breathing, increased heart rate, and elevated blood pressure, while muscular paralysis prevents the acting out of dreams.

REM sleep is essential for multiple cognitive and physiological processes. It plays a key role in memory consolidation, learning, emotional regulation, and maintaining daytime focus and concentration. In infants, REM is thought to support central nervous system development, which helps explain why infants require more REM sleep than adults. Adequate REM sleep also contributes to immune system functioning, cellular growth, and tissue repair. Disruptions in REM sleep, such as those caused by insomnia or obstructive sleep apnea, can impair memory, mood, pain perception, and overall cognitive performance. Across the night, REM stages increase in duration with each successive cycle, reinforcing their critical role in overall health and well-being.

The Full Sleep Cycle

A full sleep cycle, which includes both NREM and REM sleep, lasts approximately 90–110 minutes, and adults typically experience 4–6 cycles per night. Deep sleep (Stage 3) predominates in the earlier cycles, while REM sleep gradually increases in duration toward morning. Adequate amounts of both Stage 3 and REM sleep are essential for feeling refreshed, maintaining physical health, consolidating memories, and supporting emotional well-being. Understanding the timing, duration, and function of each sleep stage helps individuals appreciate the importance of consistent, high-quality sleep and recognize potential disruptions that could negatively impact overall health.

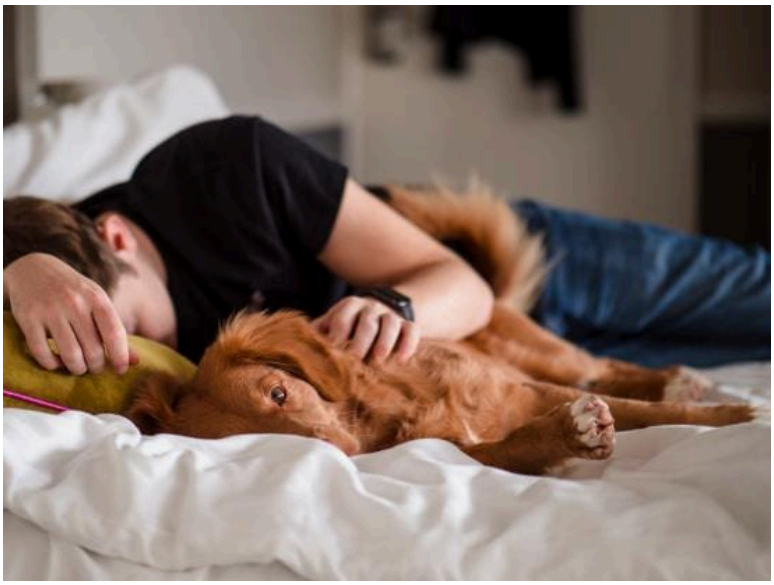


Figure 10.7.2: (Person in black shirt lying on bed; Jaime Street via Unsplash)

Adequate Sleep and Health

Sleep is a vital component of overall health and well-being, playing a crucial role in both physical and mental functioning. Just as adequate sleep, both in quality and quantity, supports immune function, cardiovascular health, metabolic regulation, cognitive performance, and emotional balance, insufficient or poor-quality sleep is linked to a wide range of health problems. These include obesity, diabetes, heart disease, stroke, weakened immunity, mood disorders, and impaired cognitive performance. Chronic sleep deprivation or disrupted sleep patterns can also contribute to accidents, decreased productivity, and lower quality of life. Sleep disorders, such as insomnia, sleep apnea, and restless leg syndrome, can further disrupt sleep quality and duration, exacerbating these health risks. Understanding how sleep influences health highlights the importance of prioritizing good sleep habits as part of a comprehensive approach to wellness.

Health Problems from Lack Of Sleep

Sleep deprivation occurs when an individual consistently fails to get sufficient sleep, either in terms of duration or quality, to support optimal functioning. It can be acute, resulting from a single night of poor or shortened sleep, or chronic, developing over weeks or months of insufficient rest. Sleep deprivation negatively impacts both mental and physical performance, impairing attention, memory, decision-making, and problem-solving skills, while also reducing coordination, reaction time, and immune function. For example, a college student who stays up late for several nights in a row to study for exams may find it difficult to concentrate during lectures, retain information while studying, or react quickly during daily activities, while also feeling fatigued and more susceptible to illness. Over time, prolonged sleep deprivation can increase the risk of serious health issues such as cardiovascular disease, obesity, diabetes, and mood disorders, highlighting the critical role of adequate sleep in maintaining overall well-being (Ren et al, 2025). [47]

A study published in *Psychological Science* found that individuals who slept for 5 hours or less in one night were more likely to form false memories, suggesting that even a single night of insufficient sleep can impair cognitive function (Frenda et al, 2014). [23] Additionally, the AAA Foundation for Traffic Safety reported that drivers who slept less than 5 hours had a crash risk comparable to that of driving under the influence of alcohol, highlighting the severe consequences of acute sleep deprivation (Tefft, 2018). [59] These findings underscore the importance of obtaining adequate sleep, as even a single night of insufficient rest can have significant effects on cognitive performance and safety. While **chronic sleep deprivation** is a well-known concern, **acute sleep deprivation,** defined as obtaining less than 4–5 hours of sleep in 24 hours, can also lead to immediate and potentially dangerous consequences.

Question

- Knowing that even a single night of poor sleep can impair reaction time and problem-solving, why might someone still choose to sacrifice sleep to study longer?
- Do you think the trade-off is really worth it?

Not getting enough sleep, both in quality and quantity, has increasingly been shown to raise the chances of developing serious health problems. A meta-analysis by F.P. Cappuccio et al found that people who sleep 5 to 6 hours or less per night have approximately a 28% higher risk of developing type 2 diabetes than those who sleep 7 hours (2010). [11] Chronic sleep deprivation is also associated with cardiovascular risks. For example, one study showed that sleeping fewer than six hours per night is linked to a 20% higher risk of heart attack (American Heart Association, 2020) [4] while another found that people with non-restful sleep have approximately a 13-22% increased risk of cardiovascular disease (American College of Cardiology, 2025). [3] Regarding brain health, a study by D. Z. Carvalho et al showed that people with long-term insomnia (defined as trouble sleeping at least 3 nights a week for 3 months or more) had a 40% higher risk of developing mild cognitive impairment or dementia than those without insomnia (2025). [12]

Sleep and Immunity

Adequate sleep is essential for a strong and effective immune system. When people consistently do not get enough sleep, their bodies produce fewer infection-fighting cells and antibodies, making them more vulnerable to illnesses. Research has shown that sleep deprivation increases susceptibility to the common cold; for example, individuals who sleep fewer than 7 hours per night are nearly three times as likely to develop a cold after being exposed to a virus as those who sleep 8 hours or more. Poor or insufficient sleep can also reduce the effectiveness of vaccines, as the immune system is less able to mount a strong and lasting response (Prather et al, 2015). [45]

Chronic sleep loss does more than just increase the chances of catching a cold; it also weakens overall immune function. Over time, this can contribute to slower recovery from illness, greater susceptibility to infections, and a higher risk of chronic health conditions related to immune dysfunction. Because the immune system relies on sleep to restore and strengthen its defenses, making sleep a priority is one of the simplest ways to support long-term health and disease resistance.

The Stress-Sleep Relationship

Stress and sleep are deeply interconnected, with each influencing the other in significant ways. When an individual experiences stress, the body activates the sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis, increasing the release of stress hormones such as cortisol and adrenaline. These physiological changes, while adaptive in short-term stress situations, can interfere with the onset and maintenance of sleep. High stress levels often make it difficult to fall asleep, increase nighttime awakenings, and reduce overall sleep quality, particularly impacting deep sleep and REM stages that are crucial for physical restoration and cognitive functioning.

Conversely, inadequate or poor-quality sleep can exacerbate stress responses. Sleep deprivation heightens emotional reactivity and impairs the prefrontal cortex's ability to regulate the amygdala, the brain region responsible for detecting threats and triggering fear or anxiety responses. As a result, people who do not get sufficient restorative sleep are more likely to feel irritable, anxious, or overwhelmed, even in situations that might otherwise be manageable. Over time, this cycle of stress and insufficient sleep can become self-reinforcing, leading to chronic sleep disturbances, increased allostatic load, and greater susceptibility to physical and mental health problems.

Maintaining healthy sleep habits can therefore play a critical role in managing stress. Consistent sleep schedules, minimizing exposure to screens and bright lights before bed, and creating a relaxing sleep environment can help reduce cortisol levels and improve sleep quality. Adequate sleep, in turn, allows the body and mind to recover from daily stressors, supports immune function, and enhances cognitive performance and emotional regulation. Understanding and addressing the bidirectional relationship between stress and sleep is essential for overall health, well-being, and resilience in the face of daily challenges.

Sleep Disorders

Not everyone who struggles with sleep simply needs better habits; for many, sleep is disrupted by clinical sleep disorders. These conditions interfere with sleep quality, duration, or timing and can have significant effects on physical and mental health if left untreated (Karna, 2023). [33]

Insomnia is a common sleep disorder characterized by difficulty falling asleep, staying asleep, or waking up too early despite having adequate opportunity for sleep. People with insomnia often experience non-restorative sleep, leaving them feeling fatigued, irritable, or unable to concentrate during the day. Insomnia can be acute, lasting a few days to weeks and often triggered by short-term stress or life events, or chronic, persisting for months and significantly impacting daily functioning. Underlying causes of insomnia are diverse. Emotional stress is a major contributor, as worries and anxiety can prevent the mind from relaxing at bedtime. Hormonal fluctuations, such as those related to pregnancy, menopause, or thyroid disorders, can also disrupt sleep. Certain medications, stimulants like caffeine, and substances such as alcohol can interfere with sleep quality. Additionally, mental health disorders, including depression, anxiety disorders, and post-traumatic stress disorder (PTSD), are strongly associated with chronic insomnia. Addressing insomnia often requires identifying and managing these underlying factors, in addition to practicing healthy sleep habits (Karna, 2023). [33]

Sleep apnea is another major disorder, marked by repeated interruptions in breathing during sleep. Obstructive sleep apnea, the most common form, occurs when the airway collapses or becomes blocked. These pauses in breathing reduce oxygen levels, disrupt sleep cycles, and are linked to an increased risk of high blood pressure, heart disease, stroke, and type 2 diabetes.

Other sleep disorders also disrupt restorative rest. **Restless legs syndrome (RLS)** causes uncomfortable sensations in the legs that create an urge to move, making it difficult to fall asleep. **Narcolepsy**, a neurological disorder, leads to sudden and uncontrollable episodes of daytime sleepiness, sometimes accompanied by muscle weakness triggered by emotions (cataplexy). **Circadian rhythm sleep-wake disorders** occur when a person's internal body clock is misaligned with the external environment, leading to challenges in maintaining regular sleep and wake times.

Together, these disorders highlight that poor sleep is not always a matter of choice or behavior but can stem from underlying medical conditions. Proper diagnosis and treatment—whether through behavioral therapy, lifestyle adjustments, or medical interventions—are essential for restoring healthy sleep and protecting long-term well-being.

Improving Sleep

Improving both the quality and duration of sleep is essential for overall health and well-being. The amount of sleep needed varies by age, with infants and children requiring the most, adolescents needing slightly less, and adults typically needing 7–9 hours per night for optimal functioning. Beyond quantity, the quality of sleep is equally important, including factors such as regularity, timing, and the absence of disturbances. Developing healthy sleep habits and using practical strategies to improve sleep can enhance overall wellness, support cognitive performance, regulate mood, and reduce the risk of chronic health conditions. This section explores recommended sleep durations, evidence-based habits for better sleep, and strategies to optimize both sleep quality and duration.

Recommended Sleep Quantity

The American Academy of Sleep Medicine recommends that adults sleep 7 hours or more per night regularly to promote optimal health and reduce the risk of adverse health outcomes (Watson et al, 2015). [63]

Table 10.7.1: How much sleep do I need?

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)

Age Group	Recommended Hours of Sleep Per Day
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

Table 10.7.1 shows the recommended amount of sleep for from infancy through older adulthood. Sleep needs change throughout the human lifespan, reflecting developmental, physiological, and cognitive demands at different ages. Infants and young children require the most sleep to support rapid brain development, growth, and physical maturation, with recommended sleep durations gradually decreasing as children grow. School-aged children and teenagers still need substantial sleep to support learning, memory consolidation, emotional regulation, and overall health, though adolescents often experience shifts in their circadian rhythms that can make early bedtimes challenging (Paruthi et al, 2016). [43] Adults typically require less sleep than children and adolescents, with most needing at least seven hours per night to maintain optimal physical and mental health, while older adults may experience lighter, more fragmented sleep but still benefit from sufficient total sleep duration. Across all stages of life, both the quantity and quality of sleep are critical for cognitive functioning, mood regulation, immune system support, and overall well-being (Watson et al, 2015). [63]

Question

- Do you feel tired all the time? Or do you feel rested and energetic?
- How often do you stop to question whether your fatigue is simply from being busy, or if it actually reflects a deeper problem with sleep quantity and quality?
- If constant tiredness has become your "normal," could it be a sign that you're not getting enough restorative sleep?
- How might this be impacting your daily life without you even realizing it?

Healthy Sleep Habits

Sleep is essential for overall health, supporting physical, mental, and emotional well-being. Developing consistent, restorative sleep habits can improve sleep quality, help maintain energy and focus, and reduce the risk of health problems. Below are key strategies to promote healthy sleep:

- Maintain a consistent sleep schedule: Go to bed and wake up at the same time every day, including weekends.
- Get adequate sleep: Aim for 7–8 hours per night.
- Go to bed only when sleepy: If you don't fall asleep within 20 minutes, get up and do a quiet, low-light activity—avoid screens.
- Establish a relaxing bedtime routine: Examples include a warm shower, herbal tea, reading, or calming exercises.
- Use your bed only for sleep and sex.
- Optimize your sleep environment: Keep your bedroom quiet, cool, and dark; limit disruptions from pets or others.
- Limit evening light exposure: Avoid bright lights and turn off electronic devices at least 30 minutes before bedtime.
- Be mindful of food and drink: Avoid large meals, caffeine, and alcohol before bed, and reduce fluid intake to prevent nighttime awakenings.
- Exercise regularly: Moderate-to-vigorous physical activity improves sleep quality, reduces time to fall asleep, decreases nighttime awakenings, increases deep sleep, and reduces daytime sleepiness.
- Maintain a healthy diet: A balanced diet complements physical activity to support restorative sleep (Baranwal, 2023). [9]

Napping

While it is not possible to fully "catch up" on sleep after a period of insufficient rest, short naps can provide meaningful benefits for alertness, cognitive function, and overall well-being. **Power naps**, typically lasting 10 to 30 minutes, are especially effective at boosting alertness, improving mood, and enhancing performance without causing the grogginess or sleep inertia that can occur after longer naps. These brief naps can also help reduce stress levels, improve memory consolidation, and support learning and creativity.

Longer naps, up to 90 minutes, allow the body to complete a full sleep cycle, including both non-REM and REM sleep, which can further improve memory, emotional regulation, and physical recovery. However, it is important to avoid napping too late in the day or for excessively long periods, as this can interfere with nighttime sleep. Incorporating regular, appropriately timed naps can be a valuable strategy for maintaining energy, managing stress, and supporting mental and physical performance, especially during periods of high demand or sleep restriction.

Question

- How might scrolling through social media or checking emails before bed affect your ability to fall asleep and the quality of your rest?
- Could reducing screen time in the hour before sleep improve not just your sleep, but also your mood, focus, and overall health the next day?

Key Points

- Sleep is essential for health because it supports physical, cognitive, and emotional well-being alongside nutrition and physical activity.
- Roughly one-third of adults and an even higher proportion of adolescents do not get enough sleep, which increases the risk of chronic health problems.
- Chronic sleep deprivation is associated with obesity, diabetes, cardiovascular disease, stroke, dementia, and impaired cognitive performance.
- Inadequate sleep weakens the immune system, making individuals more susceptible to infections and reducing the effectiveness of vaccines.
- REM sleep is critical for memory consolidation, learning, attention, focus, and problem-solving.
- Sufficient sleep improves mood, reduces irritability, and helps people manage stress, while poor sleep increases emotional reactivity and anxiety.
- Sleep involves cycles of non-REM and REM stages, each playing a role in physical restoration, cognitive processing, and emotional regulation.
- Sleep needs change with age, ranging from 14–17 hours for infants to 7–9 hours for most adults, reflecting developmental and physiological demands.
- Sleep disorders such as insomnia, sleep apnea, restless legs syndrome, narcolepsy, and circadian rhythm disorders can disrupt restorative sleep and increase health risks.
- Healthy sleep habits, including consistent schedules, bedtime routines, optimized sleep environments, regular exercise, balanced nutrition, and appropriately timed naps, support overall wellness, alertness, and stress management.

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10.8: Mental Health and Wellness



Figure 10.8.1: (A woman's head with colorful beads in it; Igor Omilaev via Unsplash)

Introduction

Emotional and mental health are vital components of overall well-being, influencing how individuals think, feel, and behave in daily life. Together, they shape how people handle stress, relate to others, and make decisions. Emotional health refers to a person's ability to recognize, understand, and manage emotions in healthy and constructive ways. It involves expressing feelings appropriately, maintaining positive relationships, and adapting to life's challenges with resilience. Mental health, on the other hand, encompasses a person's broader psychological, emotional, and social functioning. It affects how individuals process information, make decisions, and respond to the world around them. While the two are deeply interconnected, they are not the same. Strong emotional health supports mental stability, and good mental health promotes emotional balance. It is easy to confuse the two because both influence how people experience and respond to their internal and external worlds.

A wide range of factors, including genetics, life experiences, social support, and lifestyle habits, can influence both emotional and mental well-being. Understanding emotional and mental health involves not only recognizing common disorders but also developing strategies that promote resilience and inner balance. Approaches such as practicing self-compassion, managing emotions effectively, challenging irrational thoughts, facing fears rather than avoiding them, and applying cognitive strategies to reduce anxiety can all support overall wellness. By strengthening both emotional and mental health, individuals can enhance their ability to cope with challenges and lead more meaningful, fulfilling lives.

What is Emotional Health?

Emotional health refers to the ability to recognize, understand, and manage one's emotions in healthy and adaptive ways. It involves expressing emotions appropriately, coping effectively with life's challenges, and maintaining balance during both positive and stressful times. Someone with good emotional health can acknowledge difficult feelings such as sadness, anger, or fear without becoming overwhelmed by them and can use these emotions constructively to make thoughtful decisions and build positive relationships. While emotional health and mental health are closely related, they are not the same. Mental health is a broader concept that encompasses emotional health as well as psychological and social well-being. It encompasses how people think, feel, and behave, and influences how they manage stress, interact with others, and make decisions. In contrast, emotional health focuses more specifically on managing emotions and maintaining emotional stability.

It is common for people to confuse emotional health with mental health because the two are deeply interconnected. For example, changes in emotional health, such as prolonged sadness, irritability, or emotional numbness, can be signs of a mental health

concern like depression or anxiety. Likewise, poor mental health can make it harder to regulate emotions effectively. The overlap between the two can make it difficult to distinguish where one ends and the other begins, but understanding the distinction helps individuals recognize when emotional support, coping strategies, or professional intervention may be needed. In short, emotional health can be considered a crucial dimension of mental health. Maintaining emotional health supports overall mental well-being, just as taking care of one's mental health helps promote emotional balance. Both are essential to leading a fulfilling, resilient, and well-adjusted life.

What is Mental Health?

Mental health encompasses an individual's emotional, psychological, and social well-being. It influences how people think, feel, and behave, as well as how they handle stress, build relationships, and make daily decisions. Maintaining good mental health enables individuals to manage challenges, work productively, and contribute meaningfully to their communities. Just as physical health requires ongoing care, mental health depends on achieving balance and resilience across various life situations. For instance, a student who manages academic responsibilities, part-time work, and social activities while ensuring adequate rest is more likely to maintain good mental health than one who isolates themselves or neglects sleep during stressful periods.

Mental health is essential at every stage of life, from childhood through adulthood, and serves as a foundation for thinking clearly, managing emotions, and engaging positively with others. It supports one's ability to adapt, problem-solve, and find satisfaction in personal and professional pursuits. Although society often emphasizes physical wellness, mental and physical health are equally important components of overall well-being and are closely interconnected.

It is important to note that poor mental health and mental illness are not the same, even though the terms are sometimes used interchangeably. A person may experience poor mental health without having a diagnosed mental disorder, just as someone living with a mental illness can experience periods of stability and well-being. Recognizing this distinction helps promote a more accurate and compassionate understanding of mental health across all aspects of life.



Figure 10.8.2: The words, "mental health" spelled out in Scrabble® squares. (CC0 1.0; Wokandapix via Wikimedia Commons)

According to the World Health Organization:

- Mental health is more than the absence of mental disorders.
- Mental health is an integral part of health; there is no health without mental health.
- Mental health is determined by a range of socioeconomic, biological, and environmental factors (2025). [67]

Table 10.8.1: A Comparison of Emotional Health and Mental Health

Aspect	Emotional Health	Mental Health
Definition	The ability to recognize, understand, and manage one's emotions in positive and adaptive ways.	The overall state of a person's psychological, emotional, and social well-being.
Focus	Managing and expressing emotions appropriately.	How individuals think, feel, and behave in daily life.
Key Skills	Self-awareness, emotional regulation, empathy, resilience.	Problem-solving, decision-making, coping with stress, and maintaining relationships.
Indicators of Good Health	Ability to express feelings constructively, recover from setbacks, and maintain emotional balance.	Ability to function effectively, adapt to change, handle challenges, and contribute to community or work.
Example	Feeling angry but choosing to communicate calmly and seek a resolution.	Managing anxiety through therapy, healthy lifestyle habits, and social support.
Relationship Between the Two	A component of mental health, strong emotional health supports mental stability.	Encompasses emotional health along with cognitive and social dimensions.

Factors Affecting Mental Health

Mental health does not exist in isolation. It is shaped by an interaction of biological, psychological, and social influences. Biological factors, including genetics and brain chemistry, can make some individuals more susceptible to certain disorders. Psychological factors involve patterns of thought, coping skills, and past experiences that influence how stress is managed. Social factors such as supportive relationships, community belonging, and access to resources also play a crucial role. Additionally, lifestyle choices, including sleep, exercise, and nutrition, can strengthen or weaken mental well-being. For more details, please review **Chapter 1**.

Mental Health and Wellness

Mental health is a critical component of overall well-being. Just as individuals work to maintain physical health, it is equally important to cultivate mental, emotional, and social health. Positive mental health enables individuals to manage life's challenges effectively, maintain physical health, build and sustain meaningful relationships, and contribute constructively to their communities. Furthermore, it supports productive work, personal growth, and the realization of one's full potential. By prioritizing mental health, individuals can navigate stress more successfully, enhance their quality of life, and achieve a balanced, fulfilling existence.

Managing Mental Health

Maintaining mental wellness involves both preventing difficulties and developing tools to handle challenges. Cognitive strategies can help individuals identify and challenge unhelpful thoughts that worsen stress. Self-compassion fosters kindness toward oneself during setbacks, reducing shame and self-criticism. Relieving anxiety and worry often involves learning techniques to calm the mind and body, while refuting irrational ideas helps to break negative thought patterns. Facing fears, rather than avoiding them, strengthens resilience and reduces long-term anxiety. Together, these approaches support a healthier and more balanced mental state.

A student who fails a quiz might think, “I’m a failure and will never pass this class.” Using cognitive strategies, they can reframe this into, “I didn’t do well on this quiz, but I can study differently for the next one.” Practicing self-compassion, they remind themselves that one bad grade does not define their worth. Instead of avoiding difficult assignments out of fear, they gradually build confidence by completing smaller tasks, reducing stress over time.

Cognitive Strategies

Cognitive strategies are tools and techniques that help individuals manage their thoughts, beliefs, and perceptions in ways that support mental health and well-being. The way people think about themselves, others, and the world can have a profound impact on their emotions and behaviors. Negative or distorted thinking patterns, such as overgeneralizing, catastrophizing, or focusing only on problems, can increase stress, anxiety, and depression. By learning to identify and adjust these unhelpful thought patterns, individuals can reduce emotional distress, improve problem-solving skills, and enhance resilience. Cognitive strategies are often used in therapeutic approaches such as cognitive-behavioral therapy (CBT), but they can also be practiced independently in daily life. Techniques may include reframing negative thoughts, setting realistic goals, practicing mindfulness, and applying problem-focused thinking. Understanding and applying cognitive strategies empowers individuals to take an active role in maintaining their mental health, respond more effectively to challenges, and foster a more balanced and positive mindset.

Practical Cognitive Strategies for Better Mental Health

Cognitive Reframing:

- Identify negative or unhelpful thoughts and consciously replace them with more balanced or positive perspectives.
- Example: Instead of thinking, “I always fail,” reframe to, “I didn’t succeed this time, but I can learn and improve.”

Challenging Cognitive Distortions:

- Recognize common thinking errors such as catastrophizing, overgeneralizing, or “all-or-nothing” thinking and question their accuracy.
- Example: Ask yourself, “Is this thought based on facts or assumptions?”

Goal Setting and Planning:

- Break larger tasks into smaller, manageable steps to reduce overwhelm and increase feelings of accomplishment.
- Example: Create a study schedule with realistic daily goals rather than trying to tackle everything at once.

Mindfulness and Present-Focused Thinking:

- Practice observing thoughts without judgment and focus attention on the present moment to reduce rumination and anxiety.
- Example: Use deep breathing or guided meditation to stay grounded.

Positive Self-Talk:

- Replace self-criticism with supportive, encouraging internal dialogue.
- Example: Tell yourself, “I can handle this challenge,” instead of, “I’m not good enough.”

Problem-Solving:

- Approach challenges methodically by identifying the problem, brainstorming solutions, evaluating options, and taking action.
- Example: When feeling stressed about an assignment, list solutions such as prioritizing tasks, asking for help, or breaking it into smaller sections.

Gratitude and Strength-Focused Thinking:

- Focus on personal strengths, achievements, and positive aspects of life to foster optimism and resilience.
- Example: Keep a daily journal of things you are grateful for or personal successes.

Thought-Stopping Techniques:

- Interrupt persistent negative thoughts by consciously redirecting attention to a constructive activity.
- Example: When ruminating on a mistake, take a short walk, listen to music, or engage in a hobby.

Self-Compassion

Self-compassion is a powerful tool for promoting mental health and overall emotional wellness. It involves treating oneself with the same kindness, understanding, and patience that one would offer a close friend during times of difficulty, rather than engaging in harsh self-criticism. For individuals experiencing stress, anxiety, or symptoms of depression, practicing self-compassion can help reduce feelings of shame and guilt, improve emotional regulation, and foster resilience. By acknowledging that suffering and imperfection are part of the shared human experience, self-compassion encourages perspective, self-acceptance, and a non-judgmental approach to challenges. Techniques to cultivate self-compassion include mindful awareness of difficult emotions, reframing negative self-talk, and offering oneself reassuring statements during times of distress. Regular practice not only supports mental health but can also enhance motivation, interpersonal relationships, and the capacity to cope with life's inevitable setbacks.

Facing Fear and Avoidance

Facing fear and avoiding avoidance behaviors are essential strategies for improving mental health and building resilience. Many anxiety-related disorders, including phobias, social anxiety, and panic disorder, are maintained or worsened by patterns of avoidance, in which individuals steer clear of situations, people, or activities that trigger fear. Gradually confronting these fears through structured, step-by-step approaches—often called exposure techniques—can help reduce anxiety over time and increase confidence in managing distressing situations. Other strategies include setting realistic and manageable goals, practicing relaxation or mindfulness before and during exposure, and challenging unhelpful thoughts that exaggerate risk or danger. Support from a trusted friend, family member, or mental health professional can further reinforce progress. By systematically facing fears rather than avoiding them, individuals can regain control, expand their comfort zones, and decrease the hold that anxiety has over daily life.

Relieving Anxiety and Worry

Relieving anxiety and worry is an important component of maintaining positive mental health, as chronic anxiety can interfere with daily functioning, relationships, and overall well-being. Effective strategies include practicing relaxation techniques such as deep breathing, progressive muscle relaxation, or mindfulness meditation, which help calm the body's stress response and reduce physiological symptoms of anxiety. Cognitive approaches, such as identifying and challenging unhelpful or catastrophic thoughts, can also decrease persistent worry and promote more balanced thinking. Establishing healthy routines, like regular exercise, sufficient sleep, and balanced nutrition, further supports emotional regulation. Additionally, setting aside specific times to process worries, rather than ruminating throughout the day, can prevent anxiety from becoming overwhelming. By actively managing anxiety and worry, individuals can improve focus, emotional stability, and resilience, fostering a greater sense of control and overall mental wellness.

Strategies for Positive Mental Health

Ways to maintain positive mental health include:

Cultivate a Positive Outlook

- Balance Emotions: Recognize and experience both positive and negative emotions. Acknowledge challenges without allowing them to dominate your mindset.
- Cherish Positive Moments: Savor uplifting experiences and emotions when they occur.
- Limit Negative Exposure: Be mindful of how much distressing news or social media you consume. Engage in these platforms for connection and support, but avoid harmful comparisons or unverified information.

Practice Daily Gratitude

- Acknowledge the Good: Regularly reflect on and appreciate the positive aspects of your life, whether significant or minor.
- Journal Your Gratitude: Consider maintaining a gratitude journal to document and reinforce these positive reflections.

Prioritize Physical Health

- Stay Active: Engage in regular physical activity to enhance mood and reduce stress.
- Ensure Restful Sleep: Maintain a consistent sleep schedule to support emotional regulation.
- Maintain a Balanced Diet: Consume a nutritious diet to support overall well-being and potentially alleviate symptoms of anxiety and depression.

Foster Social Connections

- Build Relationships: Cultivate and maintain meaningful relationships with family, friends, and community members.
- Seek Support: Don't hesitate to reach out for help when needed; social support is crucial for mental health.

Engage in Relaxation Practices

- Explore Techniques: Consider practices such as progressive muscle relaxation, guided imagery, or deep-breathing exercises to reduce stress.
- Utilize Resources: Explore apps or wellness programs that offer guided relaxation sessions.

Seek Professional Assistance When Necessary

- Consult Healthcare Providers: If you experience persistent mental health challenges, consult a healthcare professional.
- Explore Treatment Options: Treatment may include therapy, medication, or a combination, tailored to individual needs.

Key Points

- Emotional health is the ability to recognize, understand, and manage emotions, while mental health encompasses broader psychological, emotional, and social functioning. Although they are interconnected, they are not the same.
- Strong emotional health supports resilience, constructive decision-making, and positive relationships, helping individuals cope effectively with challenges.
- Mental health influences thoughts, feelings, behavior, stress management, relationships, and decision-making, and it is essential for functioning across all stages of life.
- Mental well-being is affected by biological factors such as genetics and brain chemistry, psychological factors like coping skills and past experiences, social factors including support systems and community, and lifestyle choices such as sleep, exercise, and nutrition.
- Focusing on positive experiences, gratitude, and meaningful engagement promotes happiness and overall mental wellness more effectively than simply pursuing happiness as a goal.
- Adaptive coping strategies, including problem-focused, emotion-focused, meaning-focused, and social-focused approaches, support mental health, while maladaptive strategies like substance use, avoidance, and denial can be harmful.
- Practices such as self-compassion, confronting fears, and reducing avoidance behaviors improve resilience, emotional regulation, and long-term mental health outcomes.
- Cognitive strategies, including reframing negative thoughts and practicing mindfulness, help reduce worry and anxiety while correcting distorted thinking patterns, which supports balance and well-being.

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10.9: Comprehension Check

Summary

Stress is a natural response to challenges and demands, and it can be either beneficial or harmful depending on its intensity and duration. Short-term stress, or acute stress, can improve focus and motivate action, while chronic stress can negatively affect both physical and mental health. Stress arises from a variety of sources, including major life changes, daily hassles, environmental pressures, social interactions, and digital influences like social media. Physical, emotional, and behavioral responses to stress highlight the importance of managing stress and maintaining balance for overall well-being. Personality traits, gender, cognitive processes, and life experiences influence how individuals perceive and cope with stress.

The body's response to stress can be explained through concepts like the Yerkes–Dodson law, which links arousal to performance, and Selye's General Adaptation Syndrome, which describes the stages of physiological stress response. Stress can be categorized as eustress, which is positive and motivating, or distress, which is harmful when prolonged. Chronic stress contributes to allostatic load, impacting physical, mental, and immune system functioning. Stress affects daily life through sources such as work pressures, academic demands, financial concerns, and interpersonal relationships, all of which can elevate tension and strain emotional health.

Effective stress management is essential for maintaining health and resilience. Positive coping strategies include regular exercise, balanced nutrition, sufficient sleep, relaxation techniques, goal setting, and time management. Cognitive approaches, such as reframing negative thoughts and practicing self-compassion, further support mental balance. In contrast, maladaptive coping, like avoidance, substance use, or neglecting self-care, can intensify stress. Persistent or overwhelming stress that interferes with daily functioning may require professional support, including counseling or access to mental health services.

Mental health plays a central role in overall well-being by influencing thoughts, emotions, and behaviors. Factors such as genetics, life experiences, social support, and lifestyle habits shape mental health outcomes. Strategies that promote resilience, including self-compassion, cognitive techniques, and facing fears, can reduce anxiety, worry, and emotional distress. Sleep is also critical for health, affecting cognitive functioning, emotional regulation, and stress management. Prioritizing quality sleep alongside healthy coping strategies helps maintain energy, focus, and long-term physical and mental wellness.

Test Your Understanding

1. How can stress affect individuals differently, and why is it important to consider both physical and emotional/cognitive responses when understanding stress?
2. Explain how anger, fear, and anxiety can be both adaptive and harmful. Include examples of rational versus irrational fear or anxiety in your response.
3. How do internal factors such as personality traits and cognitive patterns, along with external factors like life experiences and generational influences, shape how individuals perceive and respond to stress?
4. Explain how the Transactional Model of Stress and Attribution Theory help us understand the way people evaluate stressors and choose coping strategies. Include how these models relate to emotional outcomes and resilience.
5. What is the difference between eustress, distress, acute stress, and chronic stress, and how can moderate stress sometimes improve performance?
6. Describe Hans Selye's General Adaptation Syndrome and explain how chronic stress and allostatic load can negatively impact physical health and immune function.
7. Identify and explain the different types of stressors (major life changes, daily hassles, social pressures, and environmental factors) and describe how they can individually and collectively impact overall stress levels.
8. Why is change considered a central source of stress, and how do cumulative daily hassles and ongoing stressors such as financial, academic, or social pressures contribute to long-term health and well-being?
9. Why is stress management considered an integrated process, and how do cognitive, behavioral, physiological, and social strategies work together to reduce stress?
10. Compare adaptive and maladaptive coping strategies. Provide examples of each and explain how self-awareness, lifestyle behaviors, and social support contribute to effective stress management.

11. How does normal stress differ from a mental health disorder in terms of duration, intensity, and impact on daily functioning, and what warning signs may indicate that stress has become more serious?
12. Why is it important to reduce stigma around mental health disorders, and how can early intervention and help-seeking behaviors improve outcomes and reduce risks such as suicide?
13. How does insufficient sleep affect both physical health (e.g., disease risk and immune function) and mental functioning (e.g., mood, stress, and cognition), and why are both REM and non-REM sleep important?
14. What factors can disrupt healthy sleep, and what evidence-based habits can individuals use to improve sleep quality and support overall health and stress management?
15. How do emotional health and mental health differ, and in what ways do they work together to influence a person's ability to cope with stress and maintain overall well-being?
16. What factors influence mental well-being, and how do adaptive coping strategies and cognitive approaches (such as mindfulness and reframing thoughts) support resilience and long-term mental health?

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Chapter 10 Glossary

- **Acute Sleep Deprivation**: Short-term, temporary loss of sleep that impairs performance, alertness, and mood.
- **Acute Stress:** A short-term physiological and psychological response to an immediate perceived threat or challenge.
- **Adrenaline (Epinephrine):** A hormone and neurotransmitter released by the adrenal glands during stress or excitement that increases heart rate, blood pressure, and energy availability.
- **Agreeableness:** A personality trait reflecting compassion, cooperation, trust, and a tendency to prioritize social harmony.
- **Allostatic Load:** The cumulative wear and tear on the body's systems caused by chronic stress and repeated activation of the stress response.
- **Anger:** An emotional response to perceived threats, frustration, or injustice, often involving physiological changes and the urge to take action.
- **Anhedonia**: The inability to experience pleasure or interest in once enjoyable activities.
- **Anxiety:** A feeling of unease, worry, or apprehension about a potential future threat or uncertain outcome.
- **Anxiety Disorders**: Mental health disorders characterized by excessive fear, worry, or nervousness that interfere with daily functioning.
- **Attribution Theory:** A psychological theory that examines how individuals explain the causes of behavior and events, attributing outcomes to internal factors (like ability or effort) or external factors (like luck or situational influences).
- **Autonomic Nervous System (ANS):** The branch of the PNS that regulates involuntary body functions such as heart rate, digestion, and respiratory rate, operating automatically without conscious control.
- **Beta-Blockers**: Medications that reduce physical symptoms of anxiety, such as rapid heart rate and trembling, by blocking the effects of adrenaline on the body.
- **Bipolar Disorder**: A mood disorder characterized by extreme mood swings, including manic episodes of elevated energy and activity, depressive episodes of sadness and low energy, and sometimes mixed episodes with symptoms of both.
- **Catastrophizing**: A cognitive distortion in which an individual assumes the worst possible outcome will occur, often blowing a situation out of proportion and expecting disaster even when it is unlikely.
- **Central Nervous System (CNS):** The part of the nervous system consisting of the brain and spinal cord, responsible for processing information and controlling most functions of the body and mind.
- **Chronic Sleep Deprivation**: Persistent lack of adequate sleep over an extended period, which can negatively affect health, mood, and cognitive function.
- **Chronic Stress:** Long-term exposure to stressors that persist over weeks, months, or years, often leading to negative health effects.
- **Chronically High Cortisol Levels:** A prolonged state of elevated cortisol in the body, often resulting from ongoing stress, which can negatively affect immune function, metabolism, and mental health.
- **Circadian Rhythms**: Biological processes that follow a roughly 24-hour cycle, regulating sleep-wake patterns, hormone release, body temperature, and other physiological functions.
- **Circadian Rhythm Sleep-Wake Disorders**: Sleep disorders caused by misalignment between an individual's internal clock and the external environment, resulting in disrupted sleep patterns.
- **Cognitive Behavioral Therapy (CBT)**: A form of psychotherapy that helps individuals identify and change unhelpful thought patterns and behaviors to improve emotional regulation and coping skills.
- **Cognitive Overload**: When the brain is given more information or tasks than it can effectively process at one time.
- **Cognitive Strategies**: Mental techniques used to organize thinking, solve problems, and improve learning or performance.
- **Cognitive Therapy**: A form of psychotherapy that helps individuals identify, challenge, and modify unhelpful or distorted thought patterns that contribute to emotional distress and dysfunctional behavior.
- **Conscientiousness:** A personality trait reflecting organization, responsibility, reliability, and goal-directed behavior.
- **Cortisol:** A hormone released by the adrenal glands in response to stress that helps regulate metabolism, immune response, and blood sugar levels.
- **Daily Hassles:** Minor, everyday irritations or challenges, such as traffic, deadlines, or household chores, that can accumulate and contribute to stress over time.
- **Delusions**: Strongly held false beliefs that persist despite evidence to the contrary, often seen in schizophrenia and other psychotic disorders.
- **Depression**: A common mood disorder marked by persistent sadness, loss of interest in activities, changes in sleep or appetite, fatigue, and difficulty concentrating, which interferes with daily life.
- **Disordered Fear:** Fear that is excessive, persistent, or maladaptive, interfering with normal daily functioning.
- **Distress**: A negative form of stress that occurs when demands exceed coping abilities, potentially leading to physical, emotional, or behavioral health problems.

- **Eating Disorders**: Serious mental health conditions involving abnormal eating behaviors, thoughts, and emotions related to food, weight, or body image.
- **Emotional Health**: The ability to recognize, understand, and manage one's emotions in healthy and constructive ways, including expressing feelings appropriately, coping with challenges, and maintaining balance during positive and stressful times.
- **Environmental Stressors:** External conditions or situations in a person's surroundings that cause stress, such as noise, pollution, extreme weather, overcrowding, or unsafe living conditions.
- **Eustress**: A positive form of stress that enhances motivation, focus, and performance, often associated with growth and achievement.
- **Exposure Therapy**: A therapeutic technique in which individuals gradually confront feared objects, situations, or memories in a controlled and safe manner to reduce anxiety and avoidance behaviors.
- **Extraversion:** A personality trait characterized by sociability, assertiveness, and positive emotionality.
- **Fear:** An emotional response to an immediate, real, or perceived threat that prepares the body for action.
- **Fight-or-Flight Response:** The body's automatic physiological reaction to a perceived threat, preparing an individual to either confront or escape danger. It involves increased heart rate, rapid breathing, heightened alertness, and the release of stress hormones such as adrenaline.
- **Five-Factor Model:** A widely accepted framework for describing personality using five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism.
- **Flat Affect**: A severe reduction or absence of emotional expression, often observed in schizophrenia and other mental health disorders.
- **FOMO (Fear of Missing Out):** Anxiety or worry that others are having rewarding experiences without you, often fueled by social media or comparisons, which can increase stress and reduce life satisfaction.
- **Gender Dysphoria:** Psychological distress resulting from a mismatch between an individual's gender identity and their assigned sex at birth.
- **General Adaptation Syndrome (GAS):** A model describing the body's three-stage response to prolonged stress: alarm, resistance, and exhaustion.
- **Generalized Anxiety Disorder (GAD):** A mental health condition characterized by chronic, excessive worry about multiple aspects of daily life for six months or longer, accompanied by physical and emotional symptoms.
- **Hallucinations**: Perceptions of sights, sounds, or sensations that are not present in reality, commonly associated with psychotic disorders.
- **Homeostasis**: The process by which an organism automatically regulates its internal conditions (such as temperature, pH, and chemical balance) to maintain stability despite changes in the external environment.
- **Homeostatic Sleep**: The body's natural process of regulating sleep intensity and duration based on prior wakefulness, ensuring balance between sleep and wakefulness.
- **Hypothalamic-Pituitary-Adrenal (HPA) Axis:** A complex system involving the hypothalamus, pituitary gland, and adrenal glands that controls the body's stress response and regulates cortisol production.
- **Immunosuppressant:** Any substance or factor that reduces or inhibits the effectiveness of the immune system, often increasing susceptibility to infections or disease.
- **Insomnia**: A sleep disorder characterized by difficulty falling asleep, staying asleep, or obtaining restorative sleep, despite adequate opportunity.
- **Irrational Anxiety:** Persistent worry or apprehension that is disproportionate to the actual likelihood or severity of a threat.
- **Irrational Fear:** An excessive or unreasonable fear of a situation or object that poses little or no actual danger.
- **Learned Helplessness:** A condition in which repeated exposure to uncontrollable or adverse events leads an individual to believe they have no control over outcomes, often resulting in passive behavior and feelings of resignation.
- **Long-Term Stressors:** Stressful events or conditions that persist over an extended period, often weeks, months, or even years. They can have ongoing effects on physical and emotional health and may contribute to chronic stress, anxiety, or other mental health concerns.
- **Maladaptive Coping Strategies**: Unhealthy or ineffective methods of managing stress, emotions, or challenges, such as substance use, avoidance, or denial, which may provide temporary relief but worsen long-term mental health.
- **Melatonin**: A hormone produced by the pineal gland that helps regulate sleep-wake cycles and signals the body when it is time to sleep.
- **Mental Health**: A person's overall psychological, emotional, and social well-being, influencing how they think, feel, and behave, as well as their ability to manage stress, maintain relationships, and make decisions.
- **Mental Health Disorders**: A group of conditions that affect a person's thinking, mood, behavior, or overall psychological well-being, often interfering with daily life, relationships, and the ability to cope with stress.
- **Mood Disorders**: A category of mental health conditions that primarily affect a person's emotional state, causing persistent feelings of sadness, emptiness, or excessive elation.
- **Narcolepsy**: A neurological disorder that causes excessive daytime sleepiness, sudden sleep attacks, and, in some cases,

muscle weakness triggered by strong emotions.

- **Natural Killer (NK) Cells:** A type of immune cell that identifies and destroys virus-infected or cancerous cells without prior exposure.
- **Neuroticism:** A personality trait associated with emotional instability, anxiety, moodiness, and susceptibility to stress.
- **Neurotransmitters**: Chemical messengers in the brain and nervous system that transmit signals between neurons, influencing mood, behavior, and bodily functions.
- **Non-REM (NREM) Sleep**: The portion of the sleep cycle characterized by slower brain waves, physical restoration, and memory consolidation, divided into stages 1 through 3.
- **Noradrenaline (Norepinephrine):** A hormone and neurotransmitter similar to adrenaline that plays a role in alertness, attention, and the body's stress response by increasing heart rate and blood flow to muscles.
- **Overgeneralizing**: A cognitive distortion where a person draws broad, sweeping conclusions based on a single event or limited evidence, often leading to negative thinking patterns and reinforced anxiety or self-doubt.
- **Overlearning:** The practice of continuing to study or rehearse material even after it has been initially mastered, which can improve retention and performance under stress.
- **Oxytocin:** A hormone and neurotransmitter involved in social bonding, trust, and stress regulation.
- **Panic Disorder**: An anxiety disorder defined by recurrent, unexpected panic attacks, sudden periods of intense fear or discomfort, often accompanied by physical symptoms such as rapid heartbeat, shortness of breath, and dizziness.
- **Parasympathetic Nervous System:** The division of the ANS that promotes relaxation, recovery, and energy conservation, often referred to as the "rest-and-digest" system.
- **Passive-Aggressive Behavior:** Indirect expression of anger or resentment through subtle, obstructive, or nonverbal actions rather than openly addressing the issue.
- **Perceived Control**: The belief that one can influence outcomes and events in one's life.
- **Perinatal Depression**: A type of depression that occurs during pregnancy or within the first year after childbirth, affecting emotional well-being and daily functioning.
- **Peripheral Nervous System (PNS):** The network of nerves outside the brain and spinal cord that connects the CNS to the rest of the body, transmitting signals to and from organs, muscles, and sensory receptors.
- **Persistent Depressive Disorder (Dysthymia)**: A chronic form of depression characterized by a consistently low mood lasting for at least two years, often with less severe but long-lasting symptoms compared to major depression.
- **Personality:** The enduring patterns of thoughts, feelings, and behaviors that characterize an individual and influence how they interact with the world.
- **Personality Traits:** Consistent characteristics or qualities that influence an individual's thoughts, emotions, and behaviors across situations.
- **Phobia:** An intense, irrational fear of a specific object, situation, or activity that leads to avoidance behavior.
- **Positive Psychology**: A branch of psychology that focuses on understanding and promoting factors that contribute to optimal human functioning, well-being, and happiness rather than on illness or dysfunction.
- **Post-Traumatic Stress Disorder (PTSD):** A mental health condition that develops after exposure to a traumatic event, causing intrusive memories, avoidance behaviors, heightened arousal, and negative changes in mood or cognition.
- **Power Naps**: Short naps, usually 10–30 minutes, intended to restore alertness, improve mood, and enhance cognitive performance without causing sleep inertia.
- **Psychological Stressors:** Internal or cognitive factors that create stress, including worry, fear, perfectionism, low self-esteem, or negative thinking patterns.
- **Psychoneuroimmunology (PNI):** The interdisciplinary study of how psychological factors, the nervous system, and the immune system interact and influence overall health.
- **Psychotic Disorders**: Severe mental health conditions that affect thinking, perception, and awareness of reality. Individuals may experience hallucinations, delusions, or disorganized thought patterns.
- **Rational Anxiety:** A normal, proportionate reaction to a stressful or challenging situation that motivates problem-solving or caution.
- **Rational Fear:** A reasonable and appropriate response to a real, identifiable danger.
- **REM Sleep**: A sleep stage marked by rapid eye movement, vivid dreaming, increased brain activity, and critical roles in emotional regulation and memory processing.
- **Seasonal Affective Disorder (SAD)**: A type of depression that occurs at specific times of the year, usually during fall and winter, and is associated with symptoms such as low energy, social withdrawal, and changes in sleep or appetite.
- **Restless Leg Syndrome (RLS)**: A neurological condition causing uncomfortable sensations in the legs and an irresistible urge to move them, often interfering with sleep.
- **Self-Compassion**: The practice of treating oneself with kindness, understanding, and patience during times of difficulty, rather than engaging in self-criticism, to improve emotional resilience and mental wellness.
- **Schizophrenia**: A chronic and severe mental disorder that affects thinking, emotions, and behavior, often including hallucinations, delusions, disorganized speech, and impaired functioning.

- **Short-Term Stressors:** Stressful events or situations that are temporary and typically resolved quickly. They may cause immediate physical or emotional reactions, such as increased heart rate, tension, or worry, but usually subside once the situation is over.
- **Sleep Apnea**: A disorder in which breathing repeatedly stops and starts during sleep, leading to disrupted rest and daytime fatigue.
- **Sleep Deprivation**: A condition resulting from insufficient sleep, leading to cognitive, emotional, and physical impairments.
- **Social Anxiety Disorder**: A mental health condition involving extreme fear or anxiety in social situations, often due to concern about being judged or embarrassed.
- **Social Stressors:** Stress arising from relationships or interactions with others, such as conflict with friends or family, social isolation, peer pressure, or workplace challenges.
- **Specific Phobias**: Intense, irrational fears of specific objects, animals, or situations that lead to avoidance and distress.
- **Spiritual Wellness**: A sense of purpose, meaning, and connection to something greater than oneself.
- **Stress**: The body's physiological and psychological response to any demand or challenge, involving activation of the nervous and endocrine systems to promote adaptation.
- **Stressors:** Events, situations, or demands that challenge an individual's ability to cope, potentially causing physical, emotional, or mental strain. Stressors can be short-term, long-term, or recurring, and may include things like exams, work deadlines, major life changes, or interpersonal conflicts.
- **Stress Response:** The body and mind's reaction to a stressor, involving physiological, emotional, and behavioral changes. This response prepares an individual to face or adapt to challenges, often triggering increased heart rate, heightened alertness, rapid breathing, and the release of stress hormones such as cortisol and adrenaline.
- **Suicide**: The act of intentionally ending one's own life, often associated with mental health disorders such as depression or severe anxiety.
- **Suppressed Anger:** The conscious or unconscious inhibition of expressing anger, which can lead to stress, resentment, or negative health outcomes.
- **Sympathetic Nervous System:** The division of the ANS that prepares the body for rapid action in stressful or threatening situations, often called the "fight-or-flight" response.
- **Tend-and-Befriend:** A stress response, often observed in females, involving nurturing behaviors and seeking social support as a coping strategy.
- **Time Management**: The practice of planning and organizing how one allocates time to tasks and responsibilities.
- **Transactional Model of Stress:** A framework that explains stress as a dynamic process resulting from the interaction between an individual and their environment, emphasizing how personal appraisal of a situation influences the stress response.
- **Traumatic Brain Injury (TBI)**: A disruption in normal brain function caused by an external force, such as a blow or jolt to the head, which can result in cognitive, emotional, and physical impairments.
- **Type A Individuals:** People who are competitive, ambitious, impatient, and prone to high stress and urgency.
- **Type B Individuals:** People who are relaxed, patient, easygoing, and less prone to stress-related behaviors.
- **Type C Personality:** Individuals who tend to suppress emotions, especially negative ones, and may exhibit a high need for approval and compliance.
- **Type D Personality:** Individuals characterized by high negative emotions (e.g., worry, irritability) and social inhibition, often linked to increased health risks.
- **Yerkes-Dodson Law:** A principle stating that there is an optimal level of arousal for performance, with too little or too much stress impairing effectiveness.

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11: CARDIOVASCULAR DISEASE, DIABETES AND CANCER



Figure 11.1: A heart nestled between two stethoscopes on a desk. (A Stethoscope and a Heart by Marek Studzinski on Unsplash)

Introduction to Cardiovascular Health, Diabetes and Cancer

This chapter examines three major health concerns, cardiovascular disease, diabetes, and sexually transmitted infections (STIs), that affect millions and carry serious health consequences if left untreated. While these conditions vary in cause and presentation, they share common themes: all are highly prevalent, often preventable, and strongly influenced by lifestyle choices.
Students will explore the causes, symptoms, risk factors, and long-term impacts of each condition, as well as practical strategies for prevention, early detection, and self-care. By understanding how behaviors like diet, physical activity, safe sex, and routine screenings can reduce risk, learners are empowered to make informed decisions that support lifelong health.

Learning Objectives

- Define cardiovascular disease (CVD) and identify its most common forms, including coronary artery disease, stroke, hypertension, and heart failure.
- Explain the major risk factors for cardiovascular disease, distinguishing between modifiable and non-modifiable factors.
- Describe the role of lifestyle behaviors, such as diet, physical activity, tobacco use, and alcohol consumption, in the development and prevention of CVD.
- Recognize the signs and symptoms associated with various types of cardiovascular disease.
- Discuss strategies for prevention and management of cardiovascular disease, immunity, and cancer at both individual and public health levels.
- Analyze the social and economic impact of cardiovascular disease, immunity, and cancer on individuals and society.
- Explain the physiological mechanisms of glucose regulation and describe how disruptions in insulin production or utilization lead to different types of diabetes.
  Evaluate key strategies for the prevention and management of diabetes, including nutrition, physical activity, medication adherence, and glucose monitoring.
- 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.

11.1: The Cardiovascular System
11.2: What is Cardiovascular Diseases
11.3: Risk Factors for Cardiovascular Disease
11.4: Treatment and Prevention of Cardiovascular Diseases
11.5: Women and Heart Disease
11.6: Stroke
11.7: Diabetes
11.8: About Cancer
11.9: Cancer Screening and Symptoms
11.10: Cancer Risk and Prevention
11.11: Comprehension Check
11.12: Glossary
11.13: References
11.14: Detailed Accessible Description

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11.1: The Cardiovascular System



Figure 11.1.1: (Heart monitor; Jair Lázaro via unsplash)

Introduction

The cardiovascular system is one of the body's most vital and tireless systems, working around the clock to keep every cell, tissue, and organ alive. This chapter explores how the heart and blood vessels work together as a closed-loop system to circulate blood throughout the body, delivering oxygen and nutrients while removing waste. You'll learn about the structure of the heart, the roles of arteries, veins, and capillaries, and how blood pressure reflects the health of this system. The chapter also covers what happens when the heart fails and how CPR can serve as a lifesaving intervention. Understanding these fundamentals is especially important given that cardiovascular disease remains the leading cause of death in the United States, making heart health a topic that affects nearly everyone.

Why the Cardiovascular System Matters

Cardiovascular disease (CVD) continues to be the leading cause of death in the United States, resulting in 919,032 deaths in 2023, approximately one in every three deaths nationwide. Heart disease alone claimed 680,909 lives, while stroke remains the fifth leading cause of death. On average, someone dies from cardiovascular disease every 34 seconds. The annual economic impact of heart disease exceeds $417.9 billion, including costs for healthcare services, medications, and lost productivity. Trends show that overall heart attack deaths have declined due to medical advances, yet risk factors like high blood pressure and obesity are increasing, and 1 in 20 adults now live with coronary artery disease (CAD). Notably, about one out of six CVD deaths in 2023 occurred in adults under the age of 65, highlighting the broad impact of these conditions across all age groups.

Activity: Your Heart and Breath

In Chapter 3, we discussed cardiovascular endurance, the heart, and breathing. Take a moment to feel your heart and your breathing.

- Take your pulse.
  - Count how many times your heart beats in one minute.
  - On 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.
- Multiply 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, every day, 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, which weighs less than a pound.

Cardiovascular System

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 parts 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 enters 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 11.1.2 illustrates the anatomical position of the heart within the thoracic cavity. Situated between the lungs and above the diaphragm, the heart is enclosed in the pericardial cavity and lies slightly to the left of the midline. Understanding the heart's location and neighboring anatomy is essential for interpreting cardiovascular function and how diseases may impact nearby systems.

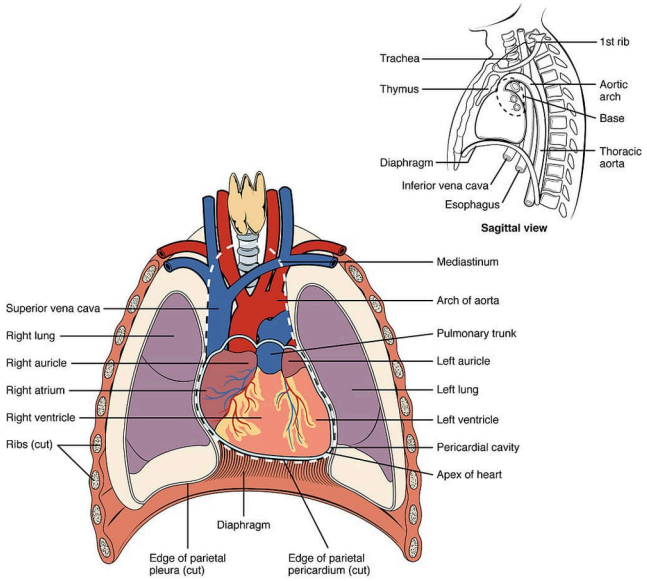


Figure 11.1.2: Thoracic anatomy of heart, lungs, and vessels essential for understanding circulation and cardiorespiratory fitness. (CC BY 4.0; OpenStax via Wikimedia Commons) Alternative text description.

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 deliver 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. Figure 11.1.3 is a visual representation of this. 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 11.1.4 illustrates the blood flow through the heart.

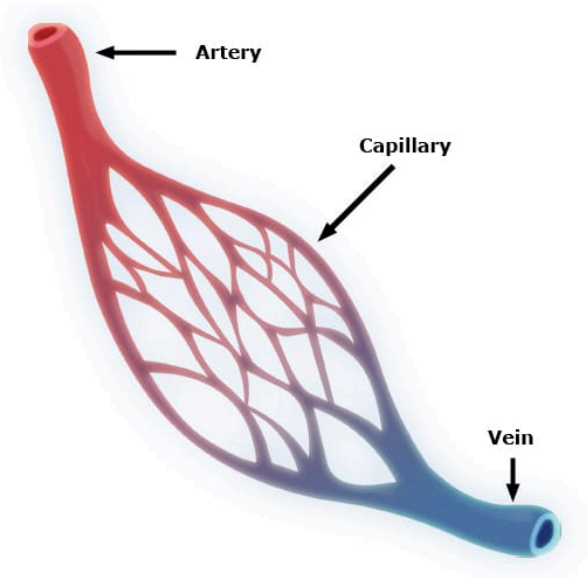


Figure 11.1.3: Arteries, capillaries, and veins. (Public Domain via Wikimedia Commons) Alternative text description.

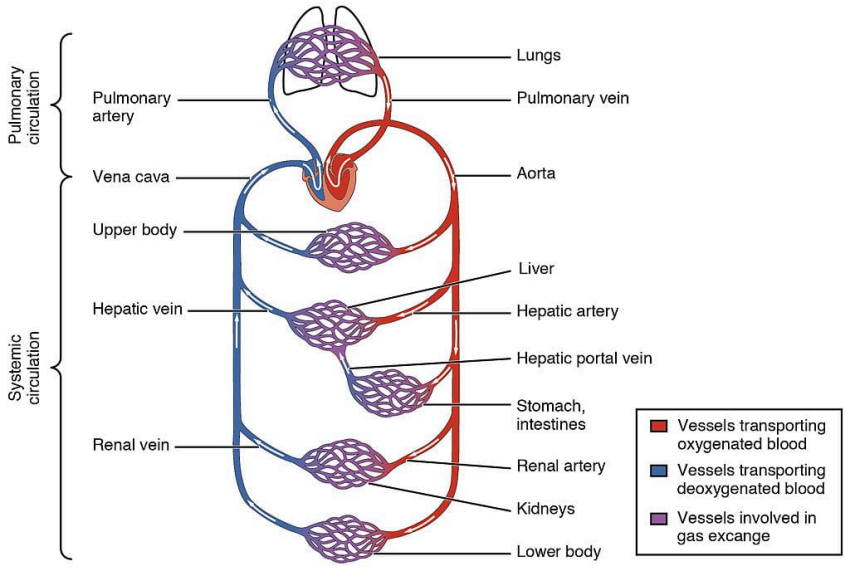


Figure 11.1.4: Blood flow through the body. The human circulatory system consists of two major loops: pulmonary circulation (to and from the lungs) and systemic circulation (to and from the body's tissues and organs). Red vessels carry oxygen-rich blood, blue vessels carry oxygen-poor blood, and purple networks represent capillaries where gas and nutrient exchange takes place. This dual-circuit design ensures that oxygen is delivered to the body and carbon dioxide is removed efficiently. (CC BY 4.0 via Wikimedia Commons) Alternative text description.

Figure 11.1.4 shows the flow of blood through the pulmonary and systemic circulation. Deoxygenated blood travels to the lungs via pulmonary arteries, becomes oxygenated, and returns to the heart through pulmonary veins. The heart then pumps oxygen-rich blood through the aorta to organs like the liver, kidneys, and intestines. Color coding highlights oxygenated (red), deoxygenated (blue), and gas exchange (purple) vessels. 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 like 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 11.1.5 illustrates the movement of blood through the heart.

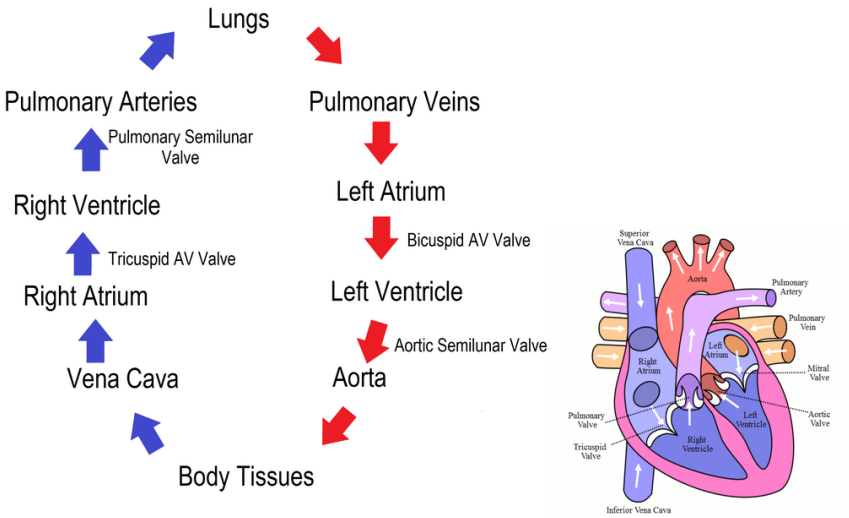


Figure 11.1.5: Circulation of blood through the heart. Blood flows through the heart in a coordinated cycle: deoxygenated blood returns from the body to the right atrium, passes through the right ventricle, and is pumped to the lungs via the pulmonary arteries. After picking up oxygen in the lungs, blood returns to the left atrium through the pulmonary veins, moves into the left ventricle, and is pumped out through the aorta to supply the body. Valves ensure one-way flow throughout this circulation. (CC BY SA 4.0 via WikiMedia) Alternative text description.

You do not tell your heart to beat; rather, your heart beats automatically. For example, when your body needs more oxygen, such as when exercising, your body's 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 11.1.6 is an image of the heart, highlighting in yellow the SA node showing the electrical signal for the heart's contraction.

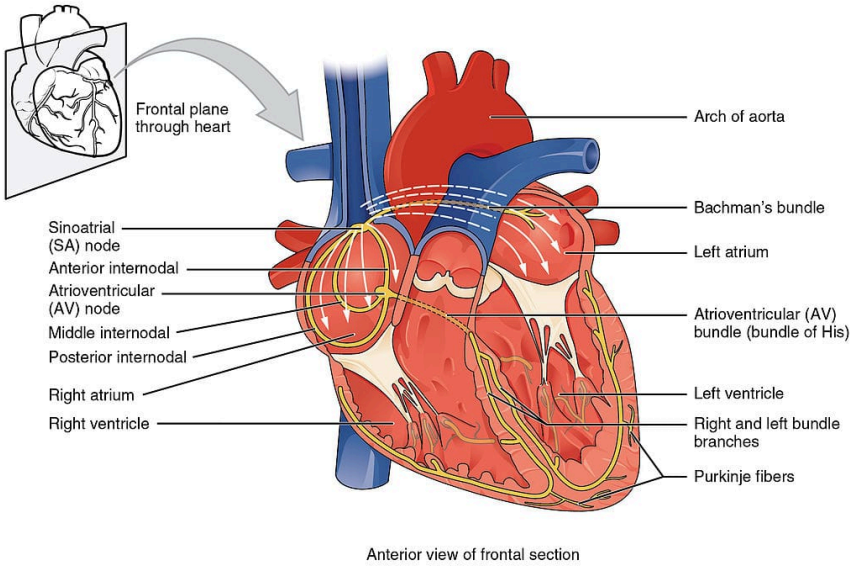


Figure 11.1.6: Conduction System of the Heart. (CC BY 4.0 via Wikimedia) Alternative text description.

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 represents 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,l we can better understand the health of the heart and blood vessels. Measuring the pressure created in the blood vessels is known as **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. Position the heel of one hand on the lower half of the sternum, between the nipples, then interlace your other hand on top. Lock your elbows and position your shoulders directly over your hands.
3. Push hard and fast in the center of the sternum.

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.

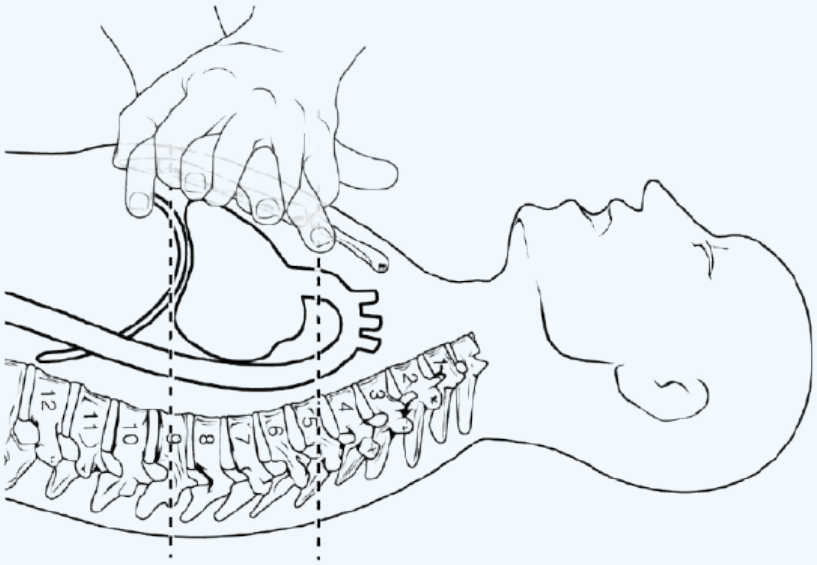


Figure 11.1.7:

For effective adult CPR, place the heel of one hand on the lower half of the sternum, between the nipples, then interlace your other hand on top. Lock your elbows and position your shoulders directly over your hands. (CC BY 4.0 via Wikimedia)

- Cardiovascular disease (CVD) is the leading cause of death in the United States, claiming one life every 36 seconds and accounting for 1 in every 4 deaths annually.
- The heart and blood vessels form a closed-loop system, working together to circulate oxygenated and deoxygenated blood throughout the body via pulmonary and systemic circulation.
- The heart functions as a muscular pump, beating over 100,000 times per day to circulate approximately 2,000 gallons of blood, delivering oxygen and nutrients while removing waste products.
- The cardiovascular system includes three major types of blood vessels: arteries (which carry blood away from the heart), veins (which return blood to the heart), and capillaries (which facilitate gas and nutrient exchange at the tissue level).
- Blood pressure reflects the force of blood on artery walls during heart contraction (systole) and relaxation (diastole). A normal blood pressure is around 120/80 mmHg, with high blood pressure diagnosed at 140/90 mmHg or higher.
- The heartbeat is regulated by the autonomic nervous system and the SA node, or natural pacemaker, which sends electrical signals through the heart's conduction pathway to coordinate contraction.
- In the event of cardiac arrest, CPR can sustain life by manually pumping blood through the heart and lungs. Compression-only CPR performed by bystanders can be lifesaving and should be initiated immediately at a rate of 100–120 compressions per minute.

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11.2: What is Cardiovascular Diseases

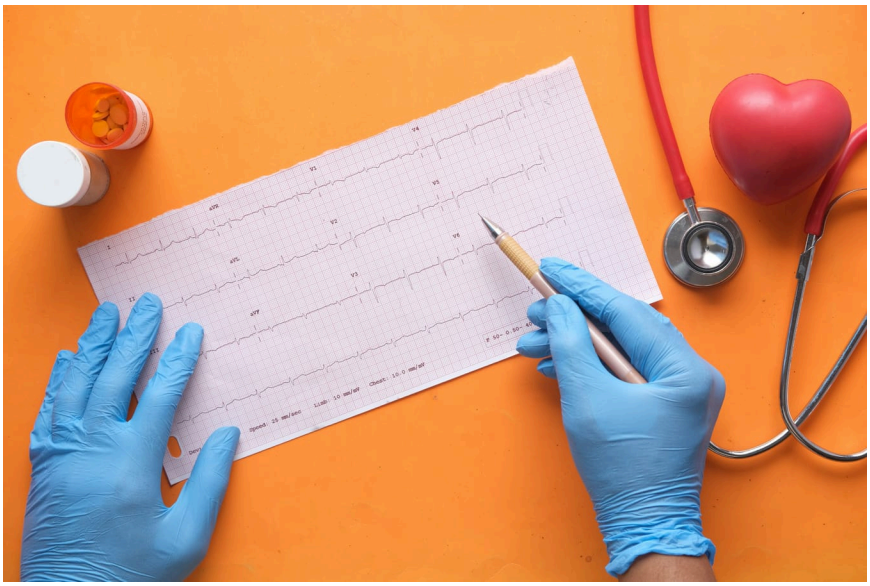


Figure 11.2.1: (Image of an EKG; Towfiqu barbhuiya via Unsplash)

Introduction

Cardiovascular disease is an umbrella term covering a wide range of conditions that affect the heart and blood vessels, from coronary artery disease and heart attacks to stroke and heart failure. This chapter examines the most common forms of cardiovascular disease, what causes them, and how they progress. You will explore how lifestyle factors like diet, physical inactivity, and smoking contribute to conditions such as atherosclerosis and how these conditions can lead to life-threatening events like cardiac arrest and stroke. Understanding these diseases, their risk factors, and their warning signs is an essential step toward making informed choices that protect your long-term heart health.

What Is Cardiovascular Disease?

The Centers for Disease Control and Prevention defines cardiovascular disease as a collective term used to describe various conditions of the heart, including its structure, function, blood vessels, and electrical system. CVD remains the leading cause of death in the United States, accounting for 919,032 deaths in 2023, equivalent to approximately one in every three deaths, with someone dying from cardiovascular disease every 34 seconds (2024). [14]

While the term is frequently used interchangeably with heart disease, it actually encompasses a broader range of disorders, including stroke, high blood pressure, angina (chest pain), and rheumatic heart disease. The cardiovascular system is a complex network, and each component, from the heart itself to the vast network of blood vessels, plays a vital role in delivering oxygen and nutrients throughout the body. Diseases of this system may affect the structure and function of the heart or impair the flow of blood through arteries and veins.

Heart Disease

Heart disease is a general term that refers to a variety of conditions affecting the heart's structure and function, most commonly involving the blood vessels that supply the heart. While some forms of heart disease are congenital, many develop over time due to lifestyle factors such as poor diet, lack of exercise, smoking, and high stress. The most common type of heart disease in the United States is coronary artery disease (CAD), which occurs when the coronary arteries, the vessels that supply oxygenated blood to the heart muscle, become narrowed or blocked. This restriction in blood flow can lead to a heart attack, or myocardial infarction, which happens when the heart muscle is deprived of oxygen. Symptoms of a heart attack can include crushing chest

pain, shortness of breath, pain radiating to the left arm, jaw, or back, as well as nausea, fatigue, or dizziness. Immediate medical attention is critical. Signs of heart failure include shortness of breath, fatigue, and swelling in the lower extremities, while arrhythmias may present as palpitations or fluttering in the chest. In some cases, heart disease may be “silent” and go undiagnosed until serious events occur, such as a heart attack, heart failure, or arrhythmia.

The risk factors for the majority of cardiovascular diseases are high blood pressure, high blood cholesterol, and smoking. About half of the 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

Other Types of Heart Disease

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 buildup 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 loses 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. Figure 11.2.2 illustrates what atherosclerosis looks like. 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 begins in childhood and gradually progresses 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.

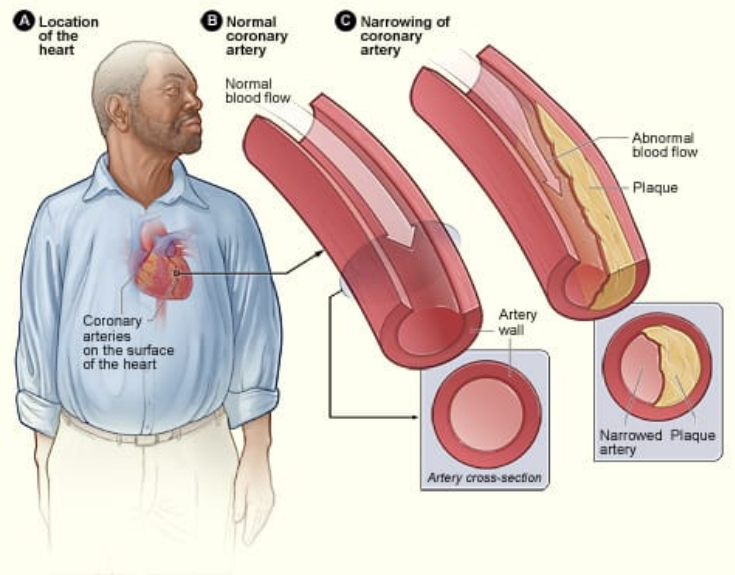


Figure 11.2.2: Part A shows the location of the heart in the body. Part B shows a normal coronary artery with normal blood flow. The inset image shows a cross-section of a normal coronary artery. Part C shows a coronary artery narrowed by plaque. The buildup of plaque limits the flow of oxygen-rich blood through the artery. The inset image shows a cross-section of the plaque-narrowed artery. (Public Domain via Wikimedia Commons)

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 gets blocked by debris, then a backup occurs. Just like in a house, debris that blocks the flow in a person's veins and arteries will cause similar issues in the circulatory system.

Angina

Angina, or chest pain and discomfort, is the most common symptom of CAD. Angina can happen when too much plaque builds up inside the 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 usually results from a lack of blood flow (ischemia) and oxygen (hypoxia) to a region of the heart, leading to the death of cardiac muscle cells. An MI often occurs when the buildup of atherosclerotic plaque blocks a coronary artery. 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. MI's 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. Figure 11.2.3 shows the symptoms of a heart attack in men and women. They include

- Chest pain or discomfort (angina)
- Shortness of breath
- Pain or discomfort in the jaw, neck, back, arm, or shoulder
- Women may experience weakness, light-headedness, nausea (feeling sick to their stomach), and feeling unusually tired.

MI's may trigger cardiac arrest, but the two are not synonymous.

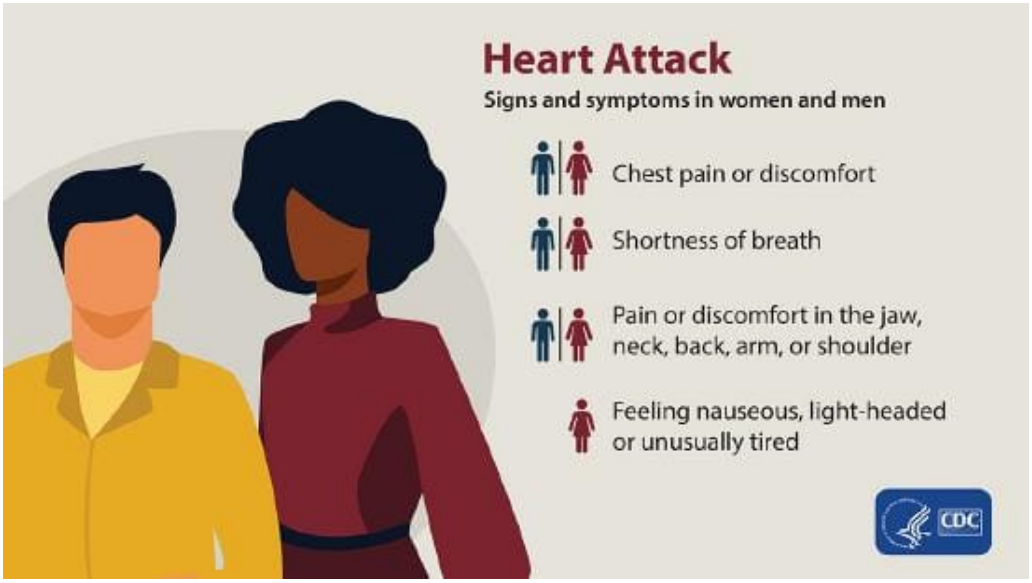


Figure 11.2.3: Graphic showing signs and symptoms of heart attack in women and men. A difference between signs and symptoms is that women will feel nauseous, light-headed, or unusually tired.(Public Domain via Center For Disease Control)

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, several things 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 a 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 to try to get the heart's electrical signal to reset and resume 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, where the blood leaves and returns to the heart. Healthy heart valves can fully open and close 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 the muscle is too weak to pump enough blood. Most 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"

Strokes are the fifth leading cause of death and a leading cause of disability in the United States. 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.

When a stroke occurs, time lost is brain lost, so 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. See Figure 11.2.4
- **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. see Figure 11.2.5

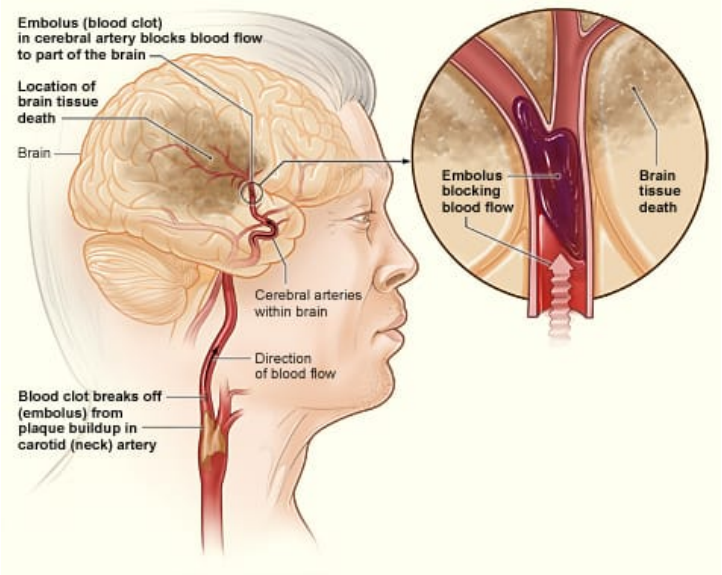


Figure 11.2.4: The illustration shows how an ischemic stroke can occur in the brain. If a blood clot breaks away from plaque buildup in a carotid (neck) artery, it can travel to and lodge in an artery in the brain. The clot can block blood flow to part of the brain, causing brain tissue death. (Public Domain via Wikimedia) Alternative text description.

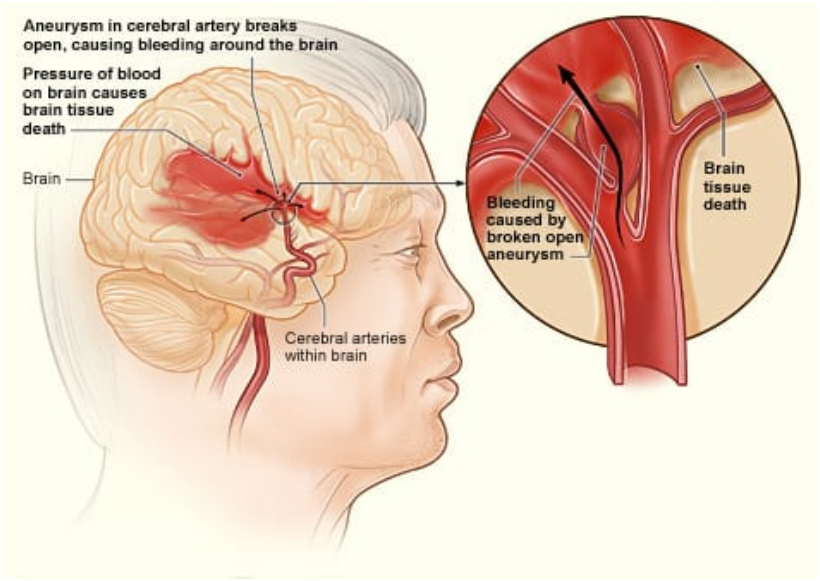


Figure 11.2.5: The illustration shows how a hemorrhagic stroke can occur in the brain. An aneurysm in a cerebral artery breaks open, which causes bleeding in the brain. The pressure of the blood causes brain tissue death. (Public Domain via Wikimedia) Alternative text description.

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.

Key Points

- Cardiovascular disease (CVD) includes a range of conditions that affect the heart and blood vessels, such as heart disease, stroke, high blood pressure, and angina. It is the leading cause of death in the U.S.
- Heart disease often results from blocked or narrowed blood vessels that limit oxygen to the heart. The most common form is coronary artery disease (CAD), which can lead to heart attacks (myocardial infarctions).
- Heart attacks occur when oxygen-rich blood is blocked from reaching heart tissue, often causing chest pain, shortness of breath, and discomfort in the arm, jaw, or back. Immediate medical attention is critical.
- Key risk factors for heart disease include high blood pressure, high cholesterol, smoking, poor diet, physical inactivity, obesity, diabetes, and excessive alcohol use.
- Atherosclerosis and arteriosclerosis reduce blood flow by hardening or thickening arteries due to aging and plaque buildup, increasing the risk of heart attack and stroke.
- Stroke is a “brain attack” caused by blocked or ruptured blood vessels in the brain. It can lead to brain damage, disability, or death. Ischemic strokes (clots) and hemorrhagic strokes (bleeding) are the two main types.
- Transient Ischemic Attacks (TIAs) are brief, stroke-like episodes caused by temporary blockages. They are serious warning signs and require immediate medical attention.

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11.3: Risk Factors for Cardiovascular Disease



Figure 11.3.1: (Group Exercise; Gabin Vallet via Unsplash)

Introduction

Understanding how the body manages fat, cholesterol, and blood sugar is essential to maintaining long-term cardiovascular health. This chapter explores two closely related topics: metabolic syndrome and high blood cholesterol. Metabolic syndrome affects roughly one in three American adults and is characterized by a cluster of conditions, including abdominal obesity, high blood pressure, elevated blood sugar, high triglycerides, and low HDL cholesterol, that together significantly raise the risk of heart disease, stroke, and type 2 diabetes. High blood cholesterol, one of the key drivers of cardiovascular disease, is equally common and equally silent, often causing no symptoms until serious damage has already occurred. By understanding what these conditions are, what causes them, and how they can be prevented or treated through lifestyle changes and medical care, individuals can take meaningful steps toward protecting their heart health and overall well-being.

Why Risk Factors Matter

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 has metabolic syndrome. The good news is that it is largely preventable.

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.

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 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. *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.
- **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 a heart attack or stroke. 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 blood sugar levels**(fasting): This can damage your blood vessels and raise your risk of getting blood clots. Blood clots can cause heart and blood vessel diseases. A normal fasting blood sugar level is less than 100 mg/dL. A fasting blood sugar level between 100 and 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.
- **High blood triglycerides** (tri-GLIH-seh-rides): 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. 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.)
- **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. 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.

Risk Factors You Can Control

- **Lifestyle habits**:
  - Being inactive
  - High blood pressure
  - Eating an unhealthy diet and large portion sizes
  - Diabetes
  - Obesity
  - 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

- **Age**: Your risk of metabolic syndrome increases as you get older.
- **Environment**: Environmental factors are increasingly recognized as significant contributors to heart disease. While individuals can take steps to reduce personal exposure, many aspects of the environment, such as air and noise pollution, nighttime light disturbance, and the effects of climate change, like extreme heat, wildfires, and severe weather, are beyond individual control. These environmental stressors are linked to increased rates of cardiovascular illness and death. [3]
- **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. A person's genes can be one of the strongest predictors of CVD, but they also have the smallest correlation to CVD overall. African Americans have the highest risk factor for CVD.
- **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 can also 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.

Questions

- List three of the five conditions used to diagnose metabolic syndrome.
- What is metabolic syndrome, and why is it considered a serious health concern?
- List three lifestyle-related risk factors for metabolic syndrome that individuals can control.

Cholesterol and High Blood Cholesterol

What Is Cholesterol?

Cholesterol is a waxy, fat-like substance produced by the liver and obtained from certain foods. It plays an essential role in the body, serving as a building block for cell membranes, sex hormones, vitamin D, protective sheaths around nerves, lung surfactants, and substances that aid in digestion. Because cholesterol is insoluble in water, it must travel through the bloodstream in small transport packages called lipoproteins, which are made of lipids (fat) surrounded by proteins.
Two major types of lipoproteins determine a person’s cholesterol health profile:

- **Low-Density Lipoproteins (LDL)**: Often referred to as “bad” cholesterol, LDL particles carry cholesterol throughout the body. While they deliver cholesterol where it is needed, excess LDL can deposit in the artery walls, forming plaque. Over time, plaque buildup narrows arteries, reduces blood flow, and contributes to coronary artery disease.
- **High-Density Lipoproteins (HDL)**: Known as “good” cholesterol, HDL particles help remove excess cholesterol from the bloodstream and artery walls, transporting it back to the liver for elimination. Higher levels of HDL are protective and associated with a reduced risk of heart disease (National Heart, Lung, and Blood Institute, 2024). [20]

In addition to cholesterol, blood tests also measure triglycerides, a type of fat packaged alongside cholesterol in lipoproteins. Triglycerides serve as an energy source and are stored in fat cells throughout the body. Elevated triglyceride levels are linked with an increased risk of coronary artery disease.
It is important to recognize that cholesterol itself is not inherently harmful. Rather, the balance between LDL, HDL, and triglycerides determines whether cholesterol contributes to health or disease.

What Is High Blood Cholesterol?

High blood cholesterol occurs when cholesterol levels in the bloodstream, particularly LDL cholesterol, are elevated. This condition usually produces no signs or symptoms, meaning many people are unaware that their cholesterol is too high until it is detected through a blood test.

Persistently high LDL cholesterol increases the likelihood of developing coronary heart disease (CHD), also called coronary artery disease. In this condition, cholesterol and other substances form plaque within the coronary arteries, a process known as atherosclerosis. Plaque buildup thickens arterial walls, narrows blood flow, and can eventually lead to chest pain (angina), heart attack, or other cardiovascular complications.
The relationship between cholesterol levels and heart disease risk is straightforward:

- Higher LDL cholesterol = higher risk of heart disease.
- Higher HDL cholesterol = lower risk of heart disease.

Because cholesterol imbalances are a major contributor to cardiovascular disease, the leading cause of death in the United States, regular screening and lifestyle management are critical for prevention and long-term health.

Cholesterol and Lipoprotein Pathways in the Body

The liver plays a central role in cholesterol regulation. The outline below summarizes how cholesterol is produced, transported, and managed in the body, and how different lipoproteins affect cardiovascular health.

1. The liver regulates the body's production of cholesterol, based in part on the types and amounts of fats that are consumed.
2. Saturated and trans fats in the diet act on the liver to increase the amount of LDL circulating in the blood. Thus, saturated and trans fats are more responsible than dietary cholesterol for raising blood cholesterol to unhealthy levels.
3. The liver packages cholesterol with triglycerides (fat) and sends it into the bloodstream as very low-density lipoproteins (VLDLs).
4. As VLDLs travel through the bloodstream, they are broken down into triglycerides (fat) and cholesterol-rich low-density lipoproteins (LDLs). Triglycerides are used for energy or are stored as fat.
5. LDLs deliver cholesterol to cells throughout the body. High LDL levels cause an excess of cholesterol to be delivered to cells.
6. Cholesterol not used by the cells spills out and collects on artery walls. The resulting plaque buildup inhibits blood flow and may result in a heart attack.
7. High-density lipoproteins (HDLs) seek out excess cholesterol and return it to the liver for disposal.
8. HDLs return cholesterol to the liver, where it is converted into bile acids for elimination or recycling.

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

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.

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 can also help you raise your HDL cholesterol level.



Figure 11.3.2: A phlebotomist collecting a blood sample. (Patient having blood drawn; Chang Duong via Unsplash)

Factors You Can't Control

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.

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. 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 11.3.1 Total 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

Table 11.3.2 LDL Cholesterol Levels

LDL Cholesterol Level	LDL Cholesterol Category
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

Table 11.3.3 HDL Cholesterol Levels

HDL Cholesterol Level	HDL Cholesterol Category
Less than 40 mg/dL	A major risk factor for heart disease
40–59 mg/dL	The higher, the better
60 mg/dL and higher	Considered protective against heart disease

Triglycerides can also 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.

Questions

- What is cholesterol, and why does the body need it?
- What is the difference between LDL and HDL cholesterol?
- Why is high blood cholesterol considered dangerous even though it has no symptoms?
- List at least two dietary sources of saturated fat and explain their effect on cholesterol.

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 the number of your 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

Therapeutic Lifestyle Changes (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 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 daily calories should come from all fats, including saturated, *trans,* monounsaturated, and polyunsaturated fats.

An individual should consume less than 200 mg of cholesterol per day. 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 are also 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 a person's 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, which may help protect the heart from blood clots and inflammation and reduce the risk of a heart attack. Try to have about two fish meals every week.

You should also try to limit the amount of sodium (salt) 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 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 an individual is 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, a 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.

Key Points

- Metabolic Syndrome Increases Disease Risk: It's diagnosed when three or more conditions are present: abdominal obesity, high blood pressure, high blood sugar, high triglycerides, or low HDL cholesterol.
- Some Risk Factors Are Modifiable: Diet, inactivity, smoking, and poor sleep can be improved; age, genetics, and medical conditions like PCOS are beyond personal control.
- Cholesterol Is Both Necessary and Risky: The body needs cholesterol, but too much—especially LDL—raises the risk of heart disease.
- High Cholesterol Has No Symptoms: Routine blood tests are needed to detect it, especially since it's silent but harmful.
- Activity and Weight Matter: Regular exercise and maintaining a healthy weight can improve cholesterol levels and reduce disease risk.
- Limit Alcohol and Avoid Smoking: Alcohol raises triglycerides and blood pressure; smoking lowers HDL and damages vessels.
- Medicine Helps, but Lifestyle Is Key: Cholesterol-lowering drugs can help, but long-term success depends on sustained lifestyle changes.

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11.4: Treatment and Prevention of Cardiovascular Diseases



Figure 11.4.1: A hand-stitched heart diagram. (Embroidered Human Heart; Magdaline John via Unsplash)

Introduction

Heart disease remains one of the leading causes of death worldwide, yet much of it is preventable. Understanding the risk factors that contribute to cardiovascular disease and knowing which ones you can control is the first step toward protecting your long-term health. This chapter explores the key drivers of heart disease, including high blood pressure, elevated blood sugar, unhealthy cholesterol levels, physical inactivity, smoking, and excess body weight. While some risk factors like age and genetics cannot be changed, many of the most significant ones are shaped by daily habits and choices. You will also learn about the medical treatments available when prevention falls short, from medications and minimally invasive procedures like balloon angioplasty to major interventions like coronary bypass surgery. Whether you are looking to reduce your personal risk or simply build a stronger foundation of health knowledge, this chapter will give you the tools to make informed, heart-healthy decisions every day.

Why Risk Factors Matter

Cardiovascular risk isn't random; it's the sum of everyday choices, underlying conditions, and a few factors we can't change. This page explains metabolic syndrome and the key drivers of heart disease, from blood pressure, blood sugar, and cholesterol to waist size and triglycerides. You'll see which risks are modifiable (diet, activity, sleep, tobacco, alcohol) and which aren't (age, genetics, some medical conditions), plus practical steps to lower your risk starting today. 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.

Prevention

- Choose healthy foods and drinks.
- Decrease intake of saturated fat and trans fat, as well as processed foods. Frozen meals and snack foods (chips, cookies) are two common examples of processed foods. These types of foods typically contain additives, which could make the product a less healthy option.
- Increase your intake of fruit and vegetables, as well as fiber. Fruits, vegetables, beans, and whole grains are good sources of fiber.
- Limit salt/sodium in your diet to help lower blood pressure.
- Limit sugar in your diet to help prevent diabetes and control blood sugar levels.

- Limit alcohol intake. The Centers for Disease Control and Prevention recommends that women have no more than 1 drink per day, and men should have no more than 2 drinks per day.
- Maintain a healthy body weight
- Overweight and obesity are associated with a greater risk for CVD. A Body Mass Index of 18.5-24.9 falls within the healthy weight range. You can access the CDC body mass index calculator to assess your body weight.
- Stay active
- Physical activity is associated with a wide range of health benefits, including improvements in mental health, aerobic fitness, muscular fitness, bone health, body composition, sleep, and balance/mobility. Current physical activity recommendations include 150 minutes of moderate-intensity activity per week (30 minutes a day, 5 days a week) or 75 minutes of vigorous-intensity activity per week.
- Don't smoke
- Quitting smoking, or not smoking, is one of the single most important strategies you can choose to decrease your risk of CVD. Cigarette smoking is the leading cause of preventable disease, disability, and death in the United States (Centers for Disease Control and Prevention, 2024). [8]

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 high 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 may be required.

Treatments for Cardiovascular Disease

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 decrease resistance, allowing blood to flow more easily and making the heart's work easier or more efficient.
- Beta blockers decrease the heart rate and force of contraction, lowering blood pressure and making the heart beat more slowly and with less force.

Angiogram

A coronary angiogram is one of many diagnostic tests used to determine the location and extent of coronary artery disease. It uses X-rays to examine the heart's blood vessels, called the coronary arteries.

Endarcterectomy

Endarterectomy is a surgical procedure to remove plaque buildup from the inside of a blood vessel, most commonly the carotid artery. This procedure aims to improve blood flow and reduce the risk of stroke. It's often performed to treat carotid artery stenosis, a narrowing of the arteries that supply blood to the brain.

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 mechanical valves can be used.

Heart transplant

A heart transplant is a surgical procedure where a diseased heart is replaced with a healthy heart from a deceased donor. It's a life-saving option for individuals with severe heart failure or other serious heart conditions.

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 11.4.2 is an image of a balloon-tipped catheter.

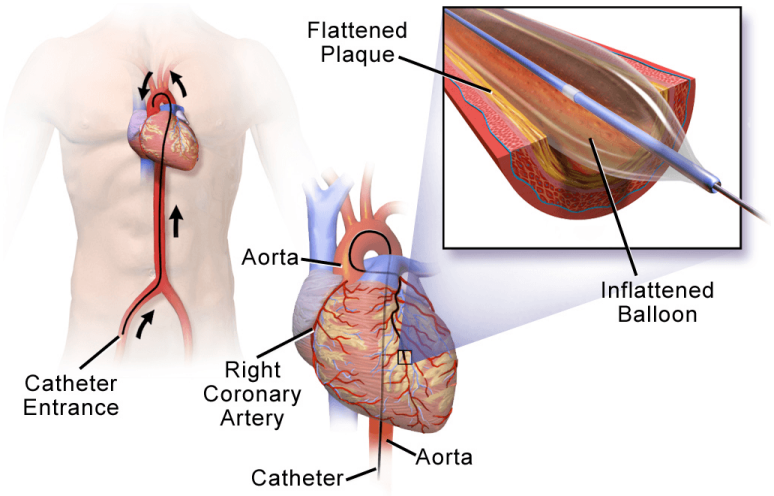


Figure 11.4.2: Balloon Angioplasty. A catheter with a small balloon at its tip is inserted into a blood vessel, typically through the femoral artery, and advanced towards the heart and affected artery. The balloon is then inflated at the site of blockage, compressing the plaque against the artery wall and restoring better blood flow. (CC BY-SA 4.0 via Wikimedia Commons) Alternative text description.

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 blocked coronary arteries.

The surgery creates a new path for blood to flow to the heart. Figure 11.4.3 illustrates what coronary bypass surgery looks like. 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. This used to be done only “open chest” or “open heart”; modern surgical practice allows for some blockages to be bypassed via a small opening in between the ribs (rather than sawing open the breast bone).

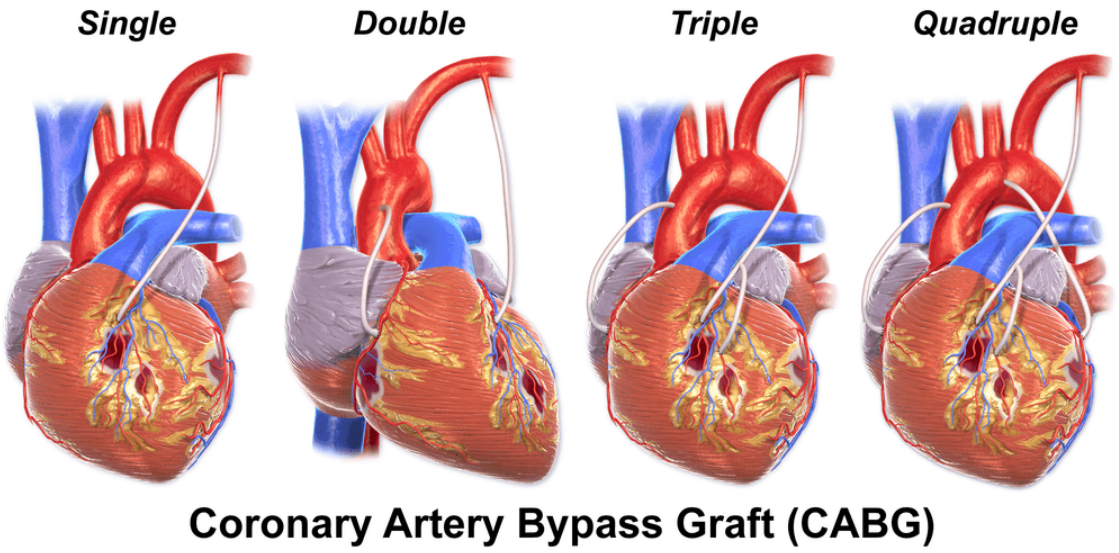


Figure 11.4.3: Coronary Artery Bypass Graft: Illustrating from left to right a single, double, triple, and quadruple bypass. (CC By 3.0 via Wikimedia Commons) Alternative text description.

Questions

- Think about your daily routine and habits.
  - What are two realistic changes you could make to improve your heart health?
  - What challenges might you face in making those changes?
- How do choices like drinking alcohol or smoking affect your long-term health?
  - What factors (social, cultural, or personal) influence your decisions around these behaviors?

Key Points

- The best way to treat heart disease is to prevent it from occurring. Living a healthy lifestyle can lower your risk.
- Healthy habits include eating nutritious foods, maintaining a healthy weight, staying physically active, and avoiding smoking.
- It's also important to understand your own health. Get your cholesterol, blood pressure, and blood sugar checked regularly. Many heart problems don't have symptoms, so regular doctor visits can help catch issues early.
- If you have heart disease, your doctor may prescribe medications. These can help prevent blood clots, relax blood vessels, or lower your heart rate and blood pressure.
- Some people may need procedures to improve blood flow. One common treatment is balloon angioplasty, where a small balloon is used to open a blocked artery, often followed by placing a stent to keep it open.
- If arteries are badly damaged, coronary bypass surgery may be needed. Doctors use a healthy blood vessel from another part of the body to create a new path for blood to flow around the blockage.

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11.5: Women and Heart Disease



Figure 11.5.1: (Stethoscope with red heart; Marek Studzinski via Unsplash)

Women and Heart Disease

Heart disease is the leading cause of death for women in the United States, claiming the lives of approximately 304,970 women in 2023, about 1 in every 5 female deaths. Despite its widespread impact, awareness remains alarmingly low. Only 56% of U.S. women recognize heart disease as their number one health threat. In total, more than 60 million women, about 44% of the female population, are living with some form of cardiovascular disease (Centers for Disease Control and Prevention, 2024). [7]

Understanding Heart Disease in Women

The most common type of heart disease affecting women is coronary artery disease (CAD), which occurs when plaque builds up in the walls of the arteries that supply blood to the heart. This condition often becomes more prevalent after menopause, as the protective effects of estrogen decrease (Centers for Disease Control and Prevention, 2024). [7] Another common condition is arrhythmia, an irregular heartbeat that may feel like the heart is fluttering or skipping beats. One of the most frequent forms of arrhythmia is atrial fibrillation, which can increase the risk of stroke.

While heart disease affects both men and women, the signs and symptoms can differ significantly between sexes. Women may experience the classic symptom of chest pain or discomfort, but they are also more likely to report more subtle symptoms, such as:

- Pain in the neck, jaw, shoulder, upper back, or abdomen
- Shortness of breath
- Nausea or vomiting
- Unusual or extreme fatigue
- Light-headedness or dizziness (Centers for Disease Control and Prevention, 2024). [7]

These symptoms are sometimes mistaken for less serious conditions such as acid reflux, the flu, or anxiety, which can delay diagnosis and treatment.

Risk Factors Specific to Women

Many of the traditional risk factors for heart disease affect both men and women, including high blood pressure, high cholesterol, smoking, diabetes, obesity, poor diet, physical inactivity, and excessive alcohol use (Centers for Disease Control and Prevention, 2024). [13] However, women also face several unique risks related to hormonal changes, reproductive health, and pregnancy. These factors can increase the likelihood of developing cardiovascular disease at various stages of life.

One of the most significant risk factors for women is high blood pressure. More than 58.9 million women in the United States (45.7%) have high blood pressure (defined as 130/80 mm Hg or higher) or take medication to manage the condition. This includes almost 1 in 5 women of reproductive age. High blood pressure not only increases the risk of heart disease and stroke but is also associated with early death. Despite these risks, fewer than 1 in 4 women (22.8%) with hypertension have their condition under control. Black women, in particular, are nearly 60% more likely to have high blood pressure than White women, reflecting important racial disparities in cardiovascular health outcomes. Hypertension during pregnancy is especially concerning, as women who develop this condition have twice the risk of heart disease later in life compared to women without it. In fact, in the United States, 1 in 8 pregnancies (13%) involves high blood pressure (Centers for Disease Control and Prevention, 2024). [7]

Other medical conditions and lifestyle choices also contribute to women's cardiovascular risk, including:

- High LDL (low-density lipoprotein) cholesterol
- Smoking and tobacco use
- Diabetes
- Excess body weight or obesity
- Unhealthy diet patterns
- Physical inactivity
- Excessive alcohol use
- Stress and depression (Centers for Disease Control and Prevention, 2024). [7]

Beyond these general risk factors, reproductive health and pregnancy-related conditions play a unique role in women's heart health. These include:

- Early first menstruation (before age 11)
- Early menopause (before age 40)
- Polycystic ovary syndrome (PCOS)
- Gestational diabetes (diabetes during pregnancy)
- Preterm delivery
- Delivery of a low birth weight or high birth weight infant
- Hypertensive disorders of pregnancy, such as preeclampsia or gestational hypertension (Centers for Disease Control and Prevention, 2024). [7]

Additionally, cardiovascular complications during pregnancy can have long-term consequences. One example is peripartum cardiomyopathy, a form of heart failure that develops in the final month of pregnancy or in the months after delivery. This condition not only affects maternal health during pregnancy but can also increase the risk of future cardiovascular disease (Centers for Disease Control and Prevention, 2024). [7]

Taken together, these findings underscore the importance of considering sex-specific risk factors in both prevention and treatment. By addressing reproductive health history, managing high blood pressure, and reducing lifestyle risks, women can significantly lower their chances of developing heart disease.



Figure 11.5.2: (Pregnant woman; Germs via Unsplash)

Questions

- How do women's heart disease symptoms differ from men's, and why might these differences lead to misdiagnosis?
- What percentage of U.S. women have high blood pressure, and how many have it under control?
- List at least three lifestyle or medical factors (other than high blood pressure) that increase women's risk of cardiovascular disease.

The Problem of Underdiagnosis

A significant challenge in addressing heart disease in women is the historical underdiagnosis and undertreatment of female patients, a phenomenon sometimes referred to as Yentl syndrome. This term refers to the tendency for women to be misdiagnosed or treated less aggressively unless their symptoms match the "male pattern" of heart disease (Wikipedia, 2024). [26] Because women are more likely to present with non-chest-pain symptoms, their concerns may be overlooked or attributed to anxiety, gastrointestinal distress, or hormonal fluctuations. As a result, women may experience delays in receiving lifesaving interventions such as cardiac catheterization, bypass surgery, or medications.

Prevention and Early Action

The good news is that many forms of heart disease are largely preventable. Adopting a heart-healthy lifestyle can significantly reduce the risk. Key prevention strategies include:

- Eating a nutritious, balanced diet low in saturated fat, trans fat, sodium, and added sugars
- Engaging in regular physical activity (at least 150 minutes of moderate-intensity aerobic exercise per week)
- Maintaining a healthy weight
- Not smoking or using tobacco products
- Managing stress effectively
- Regularly monitoring blood pressure, cholesterol, and blood glucose levels (Centers for Disease Control and Prevention, 2024). [7]

Women should also be proactive about seeking regular healthcare and advocating for cardiovascular screenings, especially if they have a family history of heart disease or other risk factors.

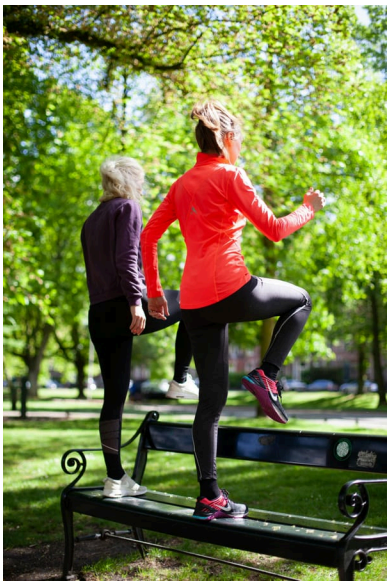


Figure 11.5.3: Mother and daughter exercising together. (Two women doing step-ups; Kenny Kennethh via Unsplash)

Questions

- What is “Yentl syndrome,” and how does it contribute to underdiagnosis in women?
- Identify at least three prevention strategies women can use to reduce their risk of heart disease.

Public Awareness and Advocacy

To raise awareness and address gender disparities in heart health, national campaigns have emerged.

The Heart Truth®

The National Heart, Lung, and Blood Institute (NHLBI) created *The Heart Truth®* in 2002. It is the first federally sponsored national health education program designed to raise awareness about heart disease as the leading cause of death in women. The Heart Truth® features the iconic red dress symbol and encourages women to know their risk (National Heart, Lung, and Blood Institute, n.d.). [19]

Million Hearts® 2027 Priorities

Million Hearts® is a national initiative to prevent 1 million heart attacks and strokes within 5 years. The CDC’s Division for Heart Disease and Stroke Prevention provides leadership and support for the Million Hearts® initiative, which began in 2012. It focuses on implementing a small set of evidence-based priorities and targets that can improve cardiovascular health for all. Learn more about the initiative and explore the priority areas below to get resources to help you take action. While Million Hearts addresses the cardiovascular health of the entire population, it does place particular emphasis on certain groups, including pregnant and postpartum women with hypertension. However, it also targets other groups who experience health inequities, such as racial/ethnic minority groups, people with behavioral health issues who use tobacco, people with lower incomes, and those living in rural areas or access deserts (U.S. Department of Health and Human Services, n.d.). [24]

Go Red for Women®

Since 2004, the American Heart Association’s signature women's initiative, Go Red for Women®, has addressed the awareness and clinical care gaps of women’s greatest health threat, cardiovascular disease (CVD). This initiative focuses on education, empowerment, and advocacy to help women prioritize their heart health. Events such as National Wear Red Day, celebrated on

the first Friday of February, have helped mobilize public attention and foster community engagement. Since 2014, this event has been in collaboration with The Heart Truth (American Heart Association, n.d.). [2]

WISEWOMAN

The Well-Integrated Screening and Evaluation for WOMen Across the Nation (WISEWOMAN) program extends preventive health services to achieve optimal cardiovascular health for women aged 35-64 who participate in the CDC-funded National Breast and Cervical Cancer Early Detection Program (NBCCEDP). The program helps participants understand and reduce their risk of CVD and benefit from early detection and treatment (Centers for Disease Control and Prevention, 2024). [6]

WomenHeart

WomenHeart is the first and only national patient-centered organization solely focused on supporting women with or at risk of heart disease. WomenHeart offers support networks, educational programs, and advocacy training for women with or at risk of heart disease (WomenHeart, n.d.). [27]

Key Points

- Heart disease is the leading cause of death for women in the U.S., responsible for about 1 in every 5 female deaths in 2023.
- Over 60 million women (44%) are living with some form of cardiovascular disease, yet only 56% recognize it as their top health risk.
- The most common types are coronary artery disease (CAD) and arrhythmias, such as atrial fibrillation, which raise the risk of stroke.
- Women's symptoms often differ from men's and may include chest pain, fatigue, shortness of breath, nausea, dizziness, or pain in the neck, jaw, or back.
- High blood pressure is a major risk factor. Nearly 59 million women (46%) have hypertension, but fewer than 1 in 4 have it under control.
- Reproductive and hormonal factors, such as early menstruation, early menopause, PCOS, gestational diabetes, and hypertensive pregnancy disorders, further increase risk.
- Women are often misdiagnosed or undertreated because their symptoms don't always match the typical "male pattern" of heart disease, a problem called Yentl syndrome.
- Many cases of heart disease are preventable through healthy lifestyle choices and awareness.

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11.6: Stroke



Figure 11.6.1: The displays show MRI images of a person's brain, which doctors can use to evaluate the risk of stroke in their patients. (Doctors looking at computer; Accuracy via Unsplash)

Introduction

Stroke is one of the most serious and time-sensitive medical emergencies a person can experience. It occurs when blood flow to the brain is suddenly interrupted, either by a blockage or a burst blood vessel, depriving brain tissue of the oxygen and nutrients it needs to survive. Within minutes, brain cells begin to die, making rapid recognition and response absolutely critical. In the United States, stroke is the fifth leading cause of death and a primary driver of long-term disability, affecting nearly 800,000 people every year. Despite these sobering statistics, many strokes are preventable. This chapter helps students understand the two main types of stroke, recognize early warning signs using the FAST scale, and explore the wide range of lifestyle choices and medical strategies that can significantly lower stroke risk. Students who engage with this material will gain valuable knowledge to help protect brain health, preserve independence, and support a higher quality of life for themselves and those around them.

Stroke Facts

Stroke is a serious medical emergency that occurs when the brain's blood supply is disrupted, either by a blockage or by bleeding, depriving brain tissue of oxygen and nutrients. This "brain attack" can swiftly lead to irreversible damage, long-term disability, or death. In the United States, stroke remains a leading public health concern: it is the fifth leading cause of death and a major driver of long-term disability.

Timeliness is paramount; brain cells begin to die within minutes of blood flow interruption. Prompt recognition and treatment, followed by appropriate rehabilitation and preventive care, are essential to maximize recovery potential, reduce complications, and support survivors in resuming healthy, productive lives.

What Is a Stroke?

A stroke occurs when blood flow to a part of the brain is blocked or reduced, preventing brain tissue from getting the oxygen and nutrients it needs. Figure 11.6.2 are images of the two main types of stroke, which are **ischemic** and **hemorrhagic**:

Ischemic Stroke

Most strokes in the United States fall into this category. Ischemic strokes happen when a blood clot blocks the blood supply to part of the brain, preventing cells from getting oxygen and nutrients. Within a few minutes, those cells may begin to die.

The underlying cause is usually atherosclerosis, a condition in which blood vessels have become narrowed or blocked by a buildup of fatty deposits called plaque. Atherosclerosis can lead to an ischemic stroke in one of two ways:

- It can cause a **cerebral thrombosis**, a clot in a blood vessel leading to the brain.
- It can cause a **cerebral embolism**, a clot that forms in a blood vessel somewhere other than the brain (usually the heart, neck, or chest) and then travels and lodges in an artery in the brain.

Hemorrhagic Stroke

This occurs when a blood vessel in the brain leaks or ruptures in one of two ways:

- **Intracerebral hemorrhage**: A blood vessel in the brain is bleeding into the surrounding tissue. Accumulating blood can exert pressure on the brain. High blood pressure is a common cause.
- **Subarachnoid hemorrhage**: This is bleeding in the space between the brain and the lining that surrounds it. The cause is usually an aneurysm, a weak area in the blood vessel wall that can stretch and burst.

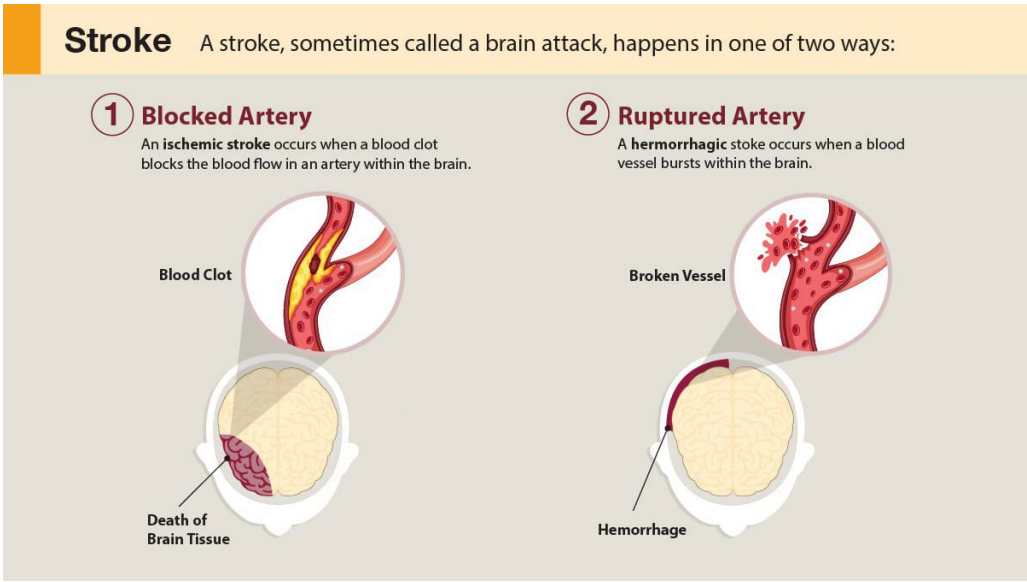


Figure 11.6.2: A stroke, sometimes called a brain attack, happens in one of two ways. 1 is an image of an ischemic stroke, which is when a blood clot blocks blood flow in an artery within the brain. 2 is an image of a hemorrhagic stroke, which is when a blood vessel bursts within the brain. (Public Domain via the Centers for Disease Control) Alternative text description.

Transient Ischemic Attack

It's also important to be aware of a stroke-related condition called a **transient ischemic attack (TIA)**.

A TIA is a stroke-like event that can cause temporary symptoms. TIAs occur when a narrowed artery or blood clot temporarily reduces the brain's blood supply. Possible symptoms include numbness, weakness, or tingling in one arm or leg, as well as problems with speech, vision, or balance.
A TIA usually resolves within a few minutes to a few hours and usually doesn't cause permanent brain injury. However, it may be a warning sign of an upcoming stroke, so don't ignore the symptoms. Individuals who experience symptoms of a TIA should seek immediate medical attention. Some treatments reduce an individual's chance of having another TIA or a stroke.

It is important to know that:

- A TIA is a medical emergency, just like a major stroke.

- Strokes and TIAs require emergency care. People should **call 9-1-1** immediately if they experience signs of a stroke or observe symptoms in someone nearby.
- 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 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.

Key Statistics (United States)

- In 2022, 1 in 6 deaths (17.5%) from cardiovascular disease were due to stroke. The national stroke death rate declined slightly from 39.5 per 100,000 people in 2022 to 39.0 per 100,000 in 2023.
- A stroke occurs every 40 seconds in the U.S.
- Someone dies of a stroke approximately every 3 minutes and 14 seconds.
- More than 795,000 people experience a stroke each year.
  - 610,000 are first-time strokes.
  - 185,000 are recurrent strokes (nearly 1 in 4).
- Ischemic strokes, caused by a blocked blood vessel, account for about 87% of all strokes.
- Stroke-related costs totaled nearly $56.2 billion between 2019 and 2020, including medical care, medications, and lost productivity.
- Stroke is a leading cause of long-term disability.
- More than half of stroke survivors aged 65+ experience reduced mobility (Centers for Disease Control and Prevention, 2024). [15]

Disparities by Geography and Race

Counties with the highest stroke death rates are concentrated in:

- Southern states such as Mississippi, Alabama, Georgia, Louisiana, Kentucky, and Arkansas
- Parts of Texas, the Carolinas, Ohio, and Michigan
- Territories like Guam and the Northern Mariana Islands (Centers for Disease Control and Prevention, 2024) [15]

Race and Ethnicity

- Stroke is a leading cause of death across all racial and ethnic groups.
- Non-Hispanic Black adults face nearly twice the risk of first stroke compared to White adults.
- Non-Hispanic Black and Pacific Islander adults have the highest stroke mortality rates (Centers for Disease Control and Prevention, 2024). [15]

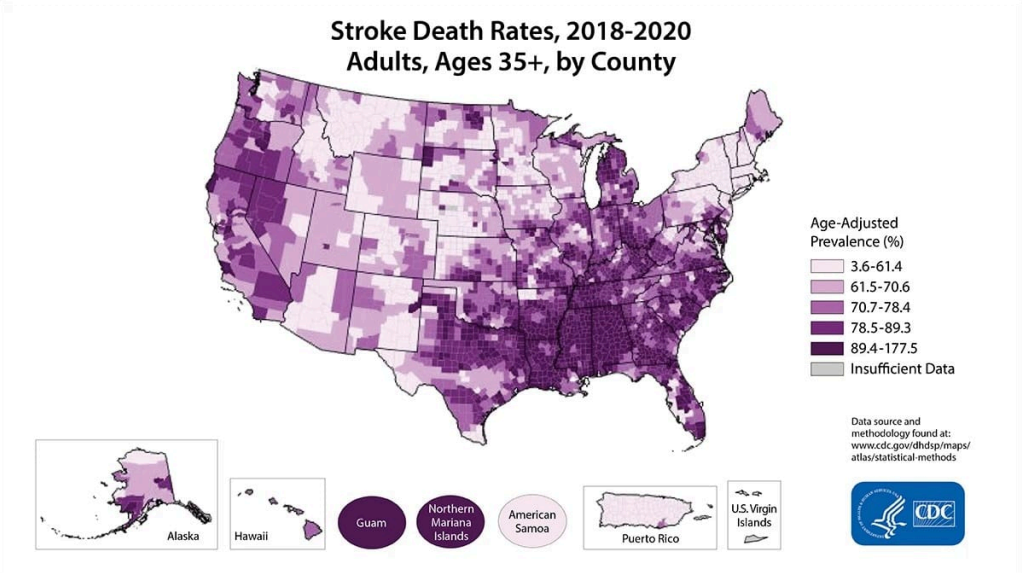


Figure 11.6.3: Map of U.S. stroke death rates by county, 2018-2020 for Adults Aged 35 Years and Older. (Public Domain via Center For Disease Control) Alternative text description.

Figure 11.6.3 visually reinforces the geographic disparities in stroke mortality. The map displays age-adjusted stroke death rates among adults aged 35 and older across U.S. counties from 2018 to 2020. Darker shades of purple indicate higher death rates, while lighter shades represent lower rates.

A clear pattern emerges: the highest concentration of stroke mortality is found in the southeastern United States, often referred to as the “Stroke Belt.” States such as Mississippi, Alabama, Louisiana, Arkansas, and parts of Georgia and Kentucky show consistently darker shading, indicating elevated risk. This visual clustering aligns with the regional disparities previously noted and highlights how stroke outcomes are not evenly distributed across the country.

In addition to the Southeast, pockets of higher stroke death rates appear in parts of Texas, the Carolinas, Ohio, and Michigan. The map also includes U.S. territories such as Guam and the Northern Mariana Islands, which show notably high rates, further emphasizing disparities beyond the mainland.

These geographic patterns are closely connected to underlying social and health factors, including access to healthcare, prevalence of high blood pressure and diabetes, socioeconomic conditions, and systemic inequities that disproportionately affect certain populations. The overlap between regions with higher stroke mortality and populations at greater risk—particularly non-Hispanic Black and Pacific Islander communities—illustrates how geography and race intersect to influence health outcomes.

By examining this map alongside the data, it becomes clear that stroke is not only a medical issue but also a public health challenge shaped by where people live and the resources available to them.

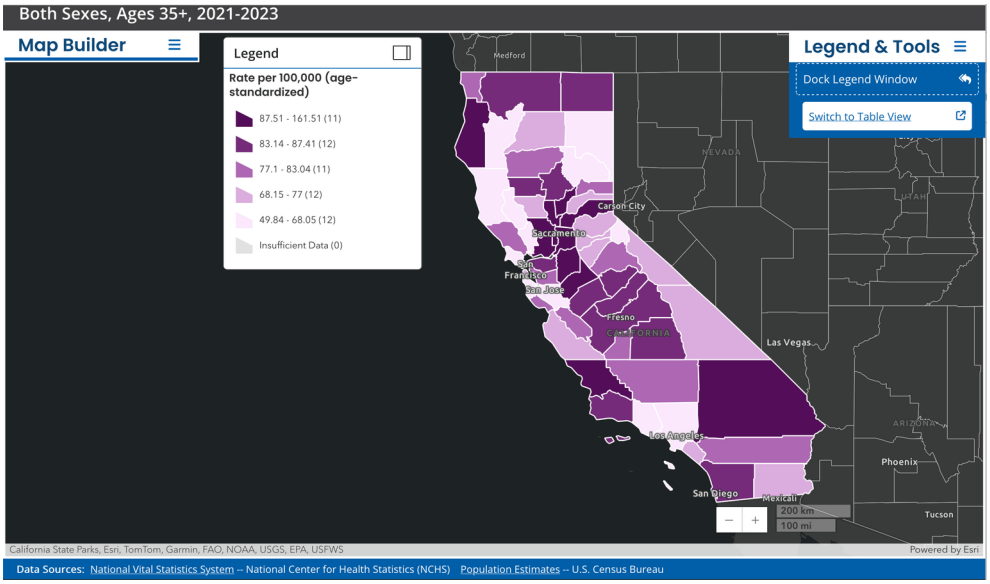


Figure 11.6.4: Map of California stroke death rates by county, 2021-2023 for Adults Aged 35 Years and Older. (Copyright; author via Interactive Atlas of Heart Disease and Stroke).

Regional Variation in Stroke Mortality: A Closer Look at California

To better understand how stroke risk can vary within a single state, California is used here as an example—partly because it is where the authors live and work. However, these patterns are not unique to California. Interested students are encouraged to explore other states using the Centers for Disease Control and Prevention Interactive Atlas of Heart Disease and Stroke, which allows users to examine county-level data across the United States.

Figure 11.6.4 provides a detailed look at age-adjusted stroke death rates (per 100,000 adults ages 35+) by county in California from 2021 to 2023. As in the national map, darker shades represent higher stroke death rates. Even within one state, the differences are striking. Several inland and rural counties—particularly in the Central Valley and parts of Southern California—show higher stroke mortality rates compared to many coastal and urban areas such as the San Francisco Bay Area.

These patterns highlight how stroke risk is influenced by more than geography alone. Counties with higher rates often face challenges such as reduced access to healthcare services, fewer preventive care resources, higher rates of chronic conditions like hypertension and diabetes, and socioeconomic barriers. In contrast, many coastal regions tend to have greater access to healthcare systems, higher average income levels, and more opportunities for physical activity and preventive care.

Importantly, these within-state differences reflect the broader national disparities discussed earlier. Populations at greater risk—including non-Hispanic Black, Hispanic/Latino, and some rural communities—are often overrepresented in areas with higher stroke mortality. This reinforces the idea that health outcomes are shaped by a combination of environment, access, and social conditions.

By zooming in on a single state, this figure emphasizes an important public health message: where you live, even within the same state, can significantly influence your risk for stroke and your access to prevention and treatment.

Interpreting County-Level Stroke Death Rates in California

The county-level data in Table 11.6.1 reveal substantial variation in stroke death rates across California, even within the same state. Rates range from approximately 50 deaths per 100,000 adults in counties such as Trinity (49.8) and Plumas (51.9), to over 160 deaths per 100,000 in Humboldt County (161.5), the highest reported rate in the state during this period.

Several counties stand out for particularly elevated stroke mortality. In addition to Humboldt County, Yuba County (143.5), San Luis Obispo County (118.7), Placer County (110.3), Solano County (109.8), and Sutter County (109.1) all report rates well above the state's lower range. Many of these counties are more rural or have smaller populations, which can influence both access to healthcare and the stability of statistical estimates. Table 11.6.2 presents age-adjusted stroke death rates (per 100,000 adults

ages 35 and older) for California counties from 2021 to 2023, ordered from lowest to highest to highlight the wide variation in stroke risk across the state.

In contrast, some of California's more urban and coastal counties show lower stroke death rates as illustrated in Table 11.6.2 . For example, Marin County (60.1), Santa Clara County (62.8), Los Angeles County (68.0), and San Francisco County (68.9) fall toward the lower end of the distribution. These areas often have greater access to healthcare services, including hospitals, stroke centers, and preventive care, as well as higher average socioeconomic status.

However, the pattern is not purely rural versus urban. Some densely populated counties, such as Sacramento County (103.9), San Joaquin County (93.9), and San Bernardino County (88.1), also report elevated rates. This suggests that other factors, including income inequality, access to quality care, prevalence of chronic disease, and environmental or lifestyle factors, play an important role.

Counties in the Central Valley, such as Fresno (85.6), Madera (83.9), Merced (83.3), Stanislaus (90.7), and Tulare (87.0), tend to cluster in the moderate-to-higher range. This aligns with broader public health findings that this region experiences higher rates of conditions like hypertension, diabetes, and obesity—key risk factors for stroke.

Overall, this dataset reinforces an important concept in public health: health outcomes are shaped by place. Even within a single state, individuals living in different counties may experience very different levels of risk due to variations in healthcare access, economic conditions, education, environment, and health behaviors.

Stroke risk is not evenly distributed, even within the same state. Understanding local patterns helps public health professionals target prevention efforts, improve access to care, and reduce disparities in high-risk communities.

Table 11.6.1: Alphabetical listing of California stroke death rates by county, 2021-2023 for Adults Aged 35 Years and Older.

Alphabetical listing of California stroke death rates by county

County (Alphabetical)	Rate per 100,000 (age-standardized)
Alameda County	79.3086
Alpine County	65.7021
Amador County	77
Butte County	87.4126
Calaveras County	74.6416
Colusa County	73.7582
Contra Costa County	86.3913
Del Norte County	80.5516
El Dorado County	72.0249
Fresno County	85.5945
Glenn County	84.7065
Humboldt County	161.506
Imperial County	73.3166
Inyo County	75.0297
Kern County	82.855
Kings County	78.8865
Lake County	65.1594

County (Alphabetical)	Rate per 100,000 (age-standardized)
Lassen County	67.235
Los Angeles County	68.0484
Madera County	83.8816
Marin County	60.1342
Mariposa County	85.3082
Mendocino County	66.8647
Merced County	83.3239
Modoc County	85.6287
Mono County	76.1822
Monterey County	74.506
Napa County	66.8507
Nevada County	68.4968
Orange County	70.7207
Placer County	110.325
Plumas County	51.9185
Riverside County	80.4297
Sacramento County	103.895
San Benito County	83.0402
San Bernardino County	88.1286
San Diego County	84.1523
San Francisco County	68.916
San Joaquin County	93.9291
San Luis Obispo County	118.679
San Mateo County	66.8105
Santa Barbara County	86.8183
Santa Clara County	62.8255
Santa Cruz County	77.2614
Shasta County	75.7814
Sierra County	79.8218
Siskiyou County	84.8723
Solano County	109.84
Sonoma County	77.8358

County (Alphabetical)	Rate per 100,000 (age-standardized)
Stanislaus County	90.7028
Sutter County	109.057
Tehama County	78.5221
Trinity County	49.8361
Tulare County	87.0352
Tuolumne County	78.0565
Ventura County	66.8944
Yolo County	96.2335
Yuba County	143.491

Source: Centers for Disease Control and Prevention. Interactive Atlas of Heart Disease and Stroke. Accessed on [April 15, 2026].

Table 11.6.2: California stroke death rates by county, 2021-2023 for Adults Aged 35 Years and Older. Ordered From Lowest to Highest

California stroke death rates by county, 2021-2023

County (by rate, low to high)	Rate per 100,000 (age-standardized)
Trinity County	49.8361
Plumas County	51.9185
Marin County	60.1342
Santa Clara County	62.8255
Lake County	65.1594
Alpine County	65.7021
San Mateo County	66.8105
Napa County	66.8507
Mendocino County	66.8647
Ventura County	66.8944
Lassen County	67.235
Los Angeles County	68.0484
Nevada County	68.4968
San Francisco County	68.916
Orange County	70.7207
El Dorado County	72.0249
Imperial County	73.3166
Colusa County	73.7582
Monterey County	74.506
Calaveras County	74.6416

County (by rate, low to high)	Rate per 100,000 (age-standardized)
Inyo County	75.0297
Shasta County	75.7814
Mono County	76.1822
Amador County	77
Santa Cruz County	77.2614
Sonoma County	77.8358
Tuolumne County	78.0565
Tehama County	78.5221
Kings County	78.8865
Alameda County	79.3086
Sierra County	79.8218
Riverside County	80.4297
Del Norte County	80.5516
Kern County	82.855
San Benito County	83.0402
Merced County	83.3239
Madera County	83.8816
San Diego County	84.1523
Glenn County	84.7065
Siskiyou County	84.8723
Mariposa County	85.3082
Fresno County	85.5945
Modoc County	85.6287
Contra Costa County	86.3913
Santa Barbara County	86.8183
Tulare County	87.0352
Butte County	87.4126
San Bernardino County	88.1286
Stanislaus County	90.7028
San Joaquin County	93.9291
Yolo County	96.2335
Sacramento County	103.895
Sutter County	109.057
Solano County	109.84
Placer County	110.325
San Luis Obispo County	118.679
Yuba County	143.491

County (by rate, low to high)	Rate per 100,000 (age-standardized)
Humboldt County	161.506

Source: Centers for Disease Control and Prevention. Interactive Atlas of Heart Disease and Stroke. Accessed on [April 15, 2026].

Age and Stroke Risk

- Risk increases with age, but strokes can occur at any age.
- In 2014, 38% of stroke hospitalizations were among adults under age 65.

Warning Signs and the Importance of Early Action

Recognizing the signs of stroke and acting fast can save lives and improve outcomes. The Cincinnati Stroke Scale provides early warning signs of a stroke. It is a quick and simple tool used by both medical professionals and bystanders to identify potential stroke symptoms. It focuses on three key physical indicators that can be observed in a matter of seconds:

- **F = Face:** Facial droop. Does one side of the face droop down? Ask the person to smile?
- **A = Arm:** One arm drifts downward. Ask the person to raise both arms. Can the person raise both arms, or is one arm weak?
- **S = Speech:** Is speech slurred or confused?
- **T = Time:** If the person shows any of these signs, call 9-1-1 immediately! Time is critical!

Prompt treatment, especially within 3 hours of symptom onset, significantly improves the chances of recovery and reduces long-term disability.

Risk Factors for Stroke

Many strokes are preventable. Leading risk factors include:

- High blood pressure
- High cholesterol
- Smoking
- Obesity
- Diabetes

1 in 3 U.S. adults has at least one of these risk factors.

The Centers for Disease Control and its partners have national initiatives and programs to reduce rates of death and disability caused by stroke and to help people live longer, healthier lives. The CDC's Division for Heart Disease and Stroke Prevention (DHDSP) supports all 50 states by providing resources to combat heart disease and stroke, while also leading or collaborating on key national programs and initiatives.

The following are national stroke prevention initiatives:

- The WISEWOMAN program screens women aged 35 to 64 who have low incomes and little or no insurance for chronic disease risk factors and refers them to lifestyle programs in an effort to prevent heart disease and strokes.
- The Paul Coverdell National Acute Stroke Program funds states to measure, track, and improve the quality of care for stroke patients. The program works to reduce death and disability from stroke.
- The Million Hearts® initiative, which is co-led by CDC and the Centers for Medicare & Medicaid Services, works with other federal agencies and private-sector partners to raise awareness about heart disease and stroke and prevent heart attacks and strokes.

Question

- What happens to brain cells when blood flow to the brain is interrupted?
- What are the two main types of stroke?
  - How do they differ?
- What is a transient ischemic attack (TIA)?
  - Why should it not be ignored?
- What are the key signs in the Cincinnati Stroke Scale (FAST) that help identify a possible stroke?

Preventing Stroke

Many strokes can be prevented by making healthy lifestyle choices and working with a health care team to manage underlying health conditions. Prevention is especially important because once a stroke occurs, the damage can be permanent. By adopting healthier habits, scheduling regular checkups, and following medical advice, individuals can significantly reduce their risk of stroke. (Centers for Disease Control and Prevention, 2024) [9]
Two recent public health campaigns highlight the importance of prevention in ways that inspire and empower different communities:

"Start Small. Live Big." Encourages adults aged 55 and older to take small but consistent steps, such as attending medical appointments, becoming more physically active, and improving nutrition, to continue living healthy and fulfilling lives. (Centers for Disease Control and Prevention, 2024) [9]

"Live to the Beat." Designed to empower Black adults to adopt heart-healthy behaviors in ways that are personally meaningful and sustainable. The campaign emphasizes living healthfully "on your own terms" by finding strategies that fit individual lifestyles. (Centers for Disease Control and Prevention, 2024) [9]

Prevention Strategies

Individuals can take many positive steps to reduce their risk of stroke. Lifestyle modifications or medical treatments can help change certain risk factors for stroke, while others, such as hereditary factors, cannot be altered. Awareness of personal risk can support preventive action.

Because stroke is a form of cardiovascular disease affecting the heart and blood vessels, keeping the cardiovascular system as healthy as possible can help reduce the risk. The most important measures individuals can take to control their stroke risk include:

Work With Your Health Care Team

Prevention works best when it is a collaborative process. With regular checkups, a doctor can keep an eye on risk factors such as heart disease, high blood pressure, and high blood cholesterol. A doctor can also suggest ways to control or eliminate these problems with medical care, diet, and lifestyle modifications. For those who have already experienced a stroke or a transient ischemic attack (TIA), follow-up care, including medications, lifestyle changes, and possible surgical treatments, can greatly reduce the risk of future strokes (Centers for Disease Control and Prevention, 2024). [9]

Control Blood Pressure

High blood pressure (hypertension) is the single most important risk factor for stroke. Hypertension is often called the "silent killer" because it may not have any obvious symptoms. That's why it's important to check blood pressure regularly. Even mild hypertension can increase stroke risk. In general, blood pressure should be in the 120s/80s or lower.

To reduce the risk of stroke, individuals should control their blood pressure with:

- Low-sodium diet
- Medication, taken regularly according to a doctor's instructions

- Moderate or low alcohol consumption, if an individual drinks at all
- Regular exercise
- Stress management
- Weight control (Stanford Health Care, n.d.) [22]

Measuring blood pressure is a simple, painless procedure performed with an inflatable arm cuff. This test helps determine whether an individual has high blood pressure (hypertension) or prehypertension, both of which are risk factors for heart disease. Table 11.6.3 is a chart to help determine a BP rating.

Table 11.6.3: Blood Pressure Classification Chart

Blood pressure classifications

BP Classification	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Normal	<120	<80
Pre-hypertension	120-139	80-89
Stage 1 Hypertension	140-159	90-99
Stage 2 Hypertension	≥160	≥100
Stage 3 Hypertension	≥180	≥110

Table taken from What's Your Number?

Stop Smoking

Studies confirm that smokers have a higher risk of stroke, regardless of other factors such as age, high blood pressure, or heart disease. The risk declines dramatically within a few years of stopping smoking. Smoking greatly increases stroke risk by damaging blood vessels and raising blood pressure. Health care providers can recommend counseling, medications, or nicotine replacement therapies to support quitting.



Figure 11.6.5: UNDO, a program of the California Department of Public Health, is one of the nation's leading public health programs. Its tagline is "End Tobacco Damage Now," and it is fighting to end Big Tobacco's deadly epidemic in California. Smoking is the leading cause of death for a multitude of diseases and is a major risk factor for numerous health problems. (Public Domain via UNDO)

Treat Heart Disease

Individuals may be able to reduce stroke risk by treating heart conditions such as:

- Irregular heart rhythms (atrial fibrillation)
- Heart attack
- Heart valve disease

Eat a Healthy Diet

Foods high in fat, cholesterol, and salt increase the risk of stroke. An individual can improve their diet by taking these steps:

Avoid excess fat: Eating high amounts of cholesterol and fat, particularly saturated fat, may contribute to atherosclerosis, which can lead to stroke. Reduce dietary fat and cholesterol by:

- Limiting the amount of fat or oil added in cooking
- Trimming fat and skin from meats and poultry
- Using low-fat or nonfat dairy products
- Broiling and baking foods rather than frying (Stanford Health Care, n.d.) [22]

Nutrition plays a central role in preventing stroke. Eating a diet rich in fruits, vegetables, whole grains, and lean proteins helps support heart and brain health.

Avoid excess sodium: Excess sodium in the diet is linked to hypertension. To limit sodium:

- Eat fresh foods when possible.
- Avoid oversalting foods—try non-salt seasoning instead.
- Limit processed and canned foods containing "hidden" salts such as disodium phosphate, monosodium glutamate, or sodium nitrate (Stanford Health Care, n.d.). [22]

Limit alcohol intake: People who drink more than two alcoholic beverages per day have an increased risk of stroke. For heavy drinkers, the risk of stroke increases further. Even healthy young adults who drink heavily are at higher risk of stroke (Stanford Health Care, n.d.). [22]

Maintain a Healthy Weight

Being overweight strains the heart and blood vessels. Keeping your weight at a healthy level reduces stroke risk. Excess weight and obesity can increase your risk of high blood pressure, heart disease, and diabetes.

Exercise Regularly

Regular exercise minimizes the increase in body fat with age. Exercise can also reduce levels of atherosclerosis that can lead to stroke. Experts recommend at least 150 minutes of activity per week (20 to 30 minutes of aerobic exercise three to four times a week). Individuals should talk to their doctor before starting a new exercise program (Stanford Health Care, n.d.). [22]

Treat Diabetes

Diabetes can cause circulatory problems that raise stroke risk. Good control of diabetes appears to reduce the disease's cardiovascular complications.

Reduce Stress

Stress may increase blood pressure, which can indirectly raise stroke risk. A one-time stressful event rarely causes a stroke, but long-term unresolved stress can contribute to high blood pressure. Stress management techniques that can reduce blood pressure include:

- Relaxation techniques
- Biofeedback
- Exercise
- Psychological counseling (Stanford Health Care, n.d.) [22]

Reconsider Oral Contraceptives

Oral contraceptives (the pill) appear to increase the risk of blood clots, including clots that cause stroke. Individuals with stroke risk factors who are currently using oral contraceptives should consult their doctor about other methods of birth control. The risk is highest for:

- Pills with high estrogen content
- Women over age 30

- Women who smoke (Stanford Health Care, n.d.) [22]

Be Cautious With Postmenopausal Estrogen Use

Postmenopausal estrogen replacement (hormone replacement therapy, or HRT) can raise a woman's risk of stroke. The decision to use estrogen therapy should be individualized, considering factors like age, symptom severity, personal and family medical history, and potential risks and benefits (Stanford Health Care, n.d.). [22]

Control Medical Conditions

Working closely with health care professionals is vital for managing conditions that elevate stroke risk:
High cholesterol: Should be checked at least every 5 years; controlled through diet, exercise, or medications if needed.
High blood pressure: Should be monitored regularly at home, clinics, or pharmacies. Treatment may include medication and lifestyle changes.
Diabetes: Requires regular blood sugar checks and adherence to diet, exercise, and treatment plans to prevent complications.
Heart disease (including atrial fibrillation): May require medication or surgical interventions; effective treatment can lower stroke risk substantially.

Take Medications as Prescribed

Medications for high blood pressure, cholesterol, diabetes, or heart conditions are most effective when taken exactly as directed. Patients should not stop taking medication without consulting their doctor, and should ask questions if anything is unclear.

Stroke is a serious but often preventable condition and remains one of the leading causes of death and long-term disability in the United States. By making healthier lifestyle choices, such as improving diet, exercising regularly, managing stress, and avoiding tobacco, individuals can dramatically reduce their risk. Working closely with health care providers for regular checkups, screenings, and treatment plans adds another layer of protection. Prevention is powerful: small, consistent steps taken today can protect brain health, preserve independence, and ensure a higher quality of life in the years to come.

Questions

- How often do you drink alcohol, and how much do you typically consume at one time?
  - Is your intake within recommended limits to reduce your stroke risk?
- Think about your eating habits over the past week.
  - How often did you consume foods high in sodium, saturated fat, or cholesterol?
  - What's one realistic change you could make to reduce these in your diet?
- How do you usually manage stress in your life?
  - Do you use any strategies like exercise, deep breathing, or talking to someone?
  - Are there signs that stress may be affecting your health?

Key Points

- Stroke is the fifth leading cause of death in the U.S., resulting in more than 130,000 deaths annually, about 1 in every 20 deaths.
- A stroke ("brain attack") occurs when a blood clot blocks blood flow to the brain or when a blood vessel in the brain ruptures.
- In the U.S., someone has a stroke every 40 seconds, and someone dies from a stroke approximately every four minutes
- There are about 795,000 strokes per year, of which approximately 610,000 are first-time strokes, and 185,000 are recurrent strokes; nearly one-quarter are repeat events
- Stroke is a leading cause of long-term disability; over half of stroke survivors aged 65 and older experience reduced mobility
- The economic impact of stroke is substantial, $33 billion annually in the U.S., including medical costs, medication, and lost productivity
- Non-modifiable risk factors for stroke include age, sex, heredity, and ethnicity. Meanwhile, modifiable factors include high blood pressure, high cholesterol, heart disease, diabetes, obesity, prior TIA or stroke, smoking, excessive alcohol use, poor diet, and inactivity

- Many strokes are preventable through lifestyle changes: avoiding tobacco, limiting alcohol, consuming a balanced diet, regular doctors' visits, and maintaining regular physical activity.

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11.7: Diabetes



Figure 11.7.1: Terms associated with diabetes include "exercise treatment," "cardiovascular improvement," "self-management," "gestational," and more. (created by Cheryl Owiesny)

Introduction

Diabetes mellitus is a chronic metabolic disease characterized by abnormally high levels of blood glucose (**hyperglycemia**). Left untreated or poorly managed, diabetes can lead to serious complications, including cardiovascular disease, kidney failure, nerve damage, and vision impairment (Stanford Health Care, 2025). [22] In the United States alone, approximately 38 million people, about 1 in every 10, are living with diabetes, and an estimated 1 in 5 of them do not know it. In addition, more than 98 million American adults have prediabetes, a condition that significantly increases the risk of developing type 2 diabetes, yet over 80% of these individuals are unaware of their condition. These statistics highlight both the public health burden of diabetes and the urgent need for prevention, early detection, and effective management strategies.

Physiology of Glucose Regulation

The foods we consume are broken down primarily into glucose, a sugar that serves as the main energy source for cells. For glucose to enter cells and be metabolized for energy, the body relies on the hormone insulin, produced by the pancreas. In healthy individuals, insulin allows glucose to move from the bloodstream into tissues where it is used or stored.

In diabetes, however, this finely balanced system becomes disrupted. Either the body produces little or no insulin (insulin deficiency), or the cells become resistant to insulin's effects (insulin resistance). This results in elevated blood glucose levels, which, over time, cause damage to organs and tissues throughout the body.

Symptoms of Diabetes

The manifestation of diabetes varies by type. Type 1 diabetes often develops rapidly, within days or weeks, and can present with severe symptoms. Type 2 diabetes, by contrast, frequently develops more gradually and may go unnoticed for years. Common symptoms include:

- Excessive thirst
- Frequent urination
- Increased hunger

- Unintended weight loss
- Blurred vision
- Fatigue
- Slow-healing infections
- Bedwetting in children who previously remained dry at night
- Have numb or tingling hands or feet
- Have very dry skin
- Have more infections than usual (Centers for Disease Control and Prevention, 2024) [10]

Unrecognized and untreated symptoms may progress to dangerous complications such as diabetic ketoacidosis in type 1 diabetes, or long-term vascular and neurologic damage in type 2.

Types of Diabetes

Although the overarching feature of all diabetes is elevated blood glucose, different types of diabetes vary in their causes, onset, and treatment requirements.

- **Type 1 Diabetes**: An autoimmune condition in which the body destroys its own insulin-producing pancreatic cells. It often develops in youth but can occur at any age. It accounts for 5–10% of all diagnosed cases. Patients are insulin-dependent for life.
- **Type 2 Diabetes**: The most common form, representing 90–95% of cases. It develops gradually, with insulin resistance as the central feature. Risk factors include obesity, inactivity, family history, and being age 40 or older. Importantly, type 2 diabetes can often be prevented or delayed through lifestyle modification.
- **Prediabetes**: A reversible intermediate stage in which blood glucose levels are elevated but not yet high enough for a diabetes diagnosis. Without intervention, many individuals with prediabetes will develop type 2 diabetes within 5–10 years.
- **Gestational Diabetes**: A condition that arises during pregnancy due to hormonal changes and insulin resistance. It does not usually have symptoms. During pregnancy, testing for gestational diabetes should be done between 24 and 28 weeks. A baby is at higher risk for health problems and obesity. Being active and eating healthy can help protect the mother's and the babies' health. It places both mother and child at a higher future risk of type 2 diabetes.
- **Other Forms**: These include post-transplant diabetes (caused by immunosuppressive drugs) and cystic fibrosis-related diabetes, where pancreatic scarring interferes with insulin production.

Question

- How does insulin normally regulate blood glucose levels, and what goes wrong in people with type 2 diabetes?
- Compare and contrast type 1 and type 2 diabetes in terms of causes, typical age of onset, and treatment needs.

Causes and Risk Factors

The **etiology** of diabetes depends on the type, but in general, both genetic, autoimmune, and environmental/lifestyle factors contribute.

- **Type 1 Diabetes**: Triggered by autoimmune destruction of pancreatic cells, with genetic susceptibility and possible environmental triggers (such as viral infections).
- **Type 2 Diabetes**: More strongly linked to obesity, sedentary lifestyle, high blood pressure, poor diet, and advancing age. However, not all individuals with type 2 diabetes are overweight.
- **Gestational Diabetes**: Related to hormonal changes that cause insulin resistance during pregnancy.
- **General Risk Factors Across Types**:
  - Overweight or obesity (BMI ≥ 26)
  - Central adiposity (waist circumference > 35 inches in women, > 40 in men)
  - Family history of diabetes
  - Sedentary lifestyle/inactivity
  - Race/ethnicity (higher prevalence among African Americans, Hispanics, Native Americans, Pacific Islanders, and Asian Americans)
  - Hypertension (≥140/90 mm Hg)

- Previous abnormal glucose tolerance tests
- History of gestational diabetes (Stanford Health Care, 2025) [21]

Diagnostic Tests

Accurate diagnosis is critical for treatment and risk management. Common diagnostic methods include:

- **Hemoglobin A1C test**: Reflects average glucose levels over the past two to three months. A result below 5.7% is normal; 5.7–6.4% indicates prediabetes; and ≥6.5% confirms diabetes.
- **Fasting Plasma Glucose test**: Measures glucose after at least 8 hours of fasting.
- **Oral Glucose Tolerance test (OGTT)**: Measures the body's response to glucose after ingestion.
- **Albuminuria testing**: Screens for kidney damage due to diabetes.
- **Home blood glucose monitoring**: Provides daily glucose patterns and trends for patient self-management (Stanford Health Care, 2025). [21]

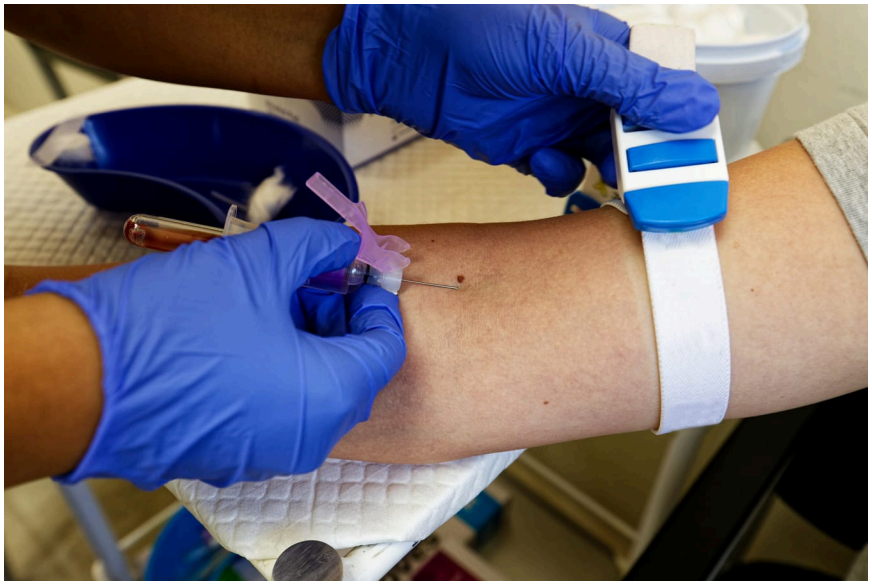


Figure 11.7.2: (Blood draw; Jacques Hugo via AdobeStock)

Complications From Diabetes

Diabetes is a leading cause of morbidity and mortality worldwide. Chronic hyperglycemia can damage blood vessels, nerves, and organs, leading to:

- Cardiovascular disease (heart attack, stroke)
- Kidney failure
- Retinopathy and blindness
- Neuropathy and foot ulcers, occasionally leading to amputation
- Increased susceptibility to infection

In the U.S., diabetes accounts for $413 billion annually in medical costs and lost productivity. On average, health care costs for a person with diabetes are more than twice as high as for someone without the disease.

Prevention

While type 1 diabetes cannot currently be prevented, type 2 diabetes and prediabetes can often be delayed, or even reversed, with lifestyle interventions.
Key management and prevention strategies include:

- A healthy diet rich in fiber, lean proteins, and limited refined sugars
- Regular physical activity (≥150 minutes per week of moderate exercise)
- Weight loss when overweight or obese
- Smoking cessation and moderation of alcohol
- Regular glucose monitoring and adherence to prescribed medications
- Building a diabetes care team, including endocrinologists, dietitians, and diabetes educators
- For those already diagnosed, treatment may include insulin therapy (essential for type 1), oral or injectable medications for type 2, and ongoing monitoring to prevent complications.

Question

- Why might some people who are not overweight still develop type 2 diabetes?
- What are two lifestyle interventions that can delay or prevent the progression from prediabetes to type 2 diabetes?

Management of Diabetes

Although diabetes has no cure, it can be effectively managed with lifestyle changes, consistent monitoring, and appropriate medical treatment. Successful management does not simply improve day-to-day health and quality of life; it also delays or prevents long-term complications such as cardiovascular disease, kidney damage, and nerve injury. The National Institutes of Health (NIH) outlines four primary pillars of diabetes management: nutrition, physical activity, medication adherence, and glucose monitoring.

Nutrition and Meal Planning

A central aspect of diabetes management is dietary modification. A balanced diabetes meal plan emphasizes nutrient-dense foods that support steady glucose levels, cardiovascular health, and healthy weight management. Recommendations include:

- Choosing fruits and vegetables, beans, whole grains, lean meats (such as poultry and fish), and low-fat dairy products.
- Avoiding sugar-sweetened beverages, opting instead for water as the primary fluid source.
- Reducing calories, saturated fat, trans fat, sugar, and salt.
- Practicing portion control, often through techniques such as the "plate method," where half the plate is vegetables, one-quarter lean protein, and one-quarter whole grains. Figure 11.7.3 is a visual of the "plate method".

Because carbohydrates (carbs) have the greatest effect on blood glucose, patients are encouraged to monitor the type and quantity of carbs consumed. Carbohydrate counting is a widely used tool to match food intake with insulin or medication action. The appropriate carbohydrate allowance varies based on age, weight, activity level, and treatment goals, making personalized diet planning with a healthcare professional essential.

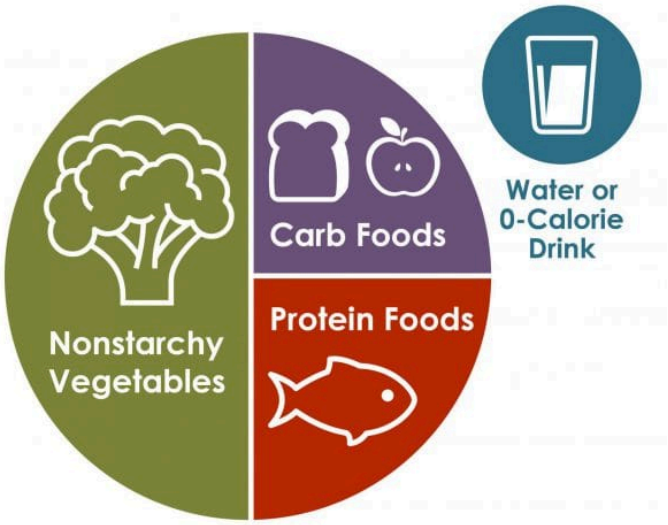


Figure 11.7.3: Use the plate method to balance portions of vegetables, protein, and carbohydrate foods. As show in this graphic, non-startchy vegetables should be half of your meals, with one-quarter of the meal being carbohydrate foods, and the remainder protein foods. Meals should be accompanied by water or a zero-calorie drink. (Public Domain via Center for Disease Control)

Physical Activity

Engaging in regular physical activity is another cornerstone of diabetes control. Physical activity helps lower blood glucose by increasing the body's sensitivity to insulin, reduces cardiovascular risk factors, and aids in weight management. NIH recommends aiming for at least 30 minutes of moderate activity (e.g., brisk walking, swimming, cycling) on most days of the week. Notably, individuals with type 2 diabetes often experience measurable improvements in glucose control and insulin sensitivity after incorporating exercise into their routine.

Question

- Why are carbohydrates considered the most important nutrient to monitor in diabetes management?
- How does regular exercise improve blood glucose control at the physiological level?

Medication

For many individuals, diet and exercise alone may not adequately control blood glucose levels. Medications, including oral drugs, injectables, and insulin, play a vital role in achieving target glucose, blood pressure, and cholesterol levels. Adherence to prescribed treatments is critical, even during periods of good health or stable measurements, because diabetes remains a chronic condition requiring continuous management.

Blood Glucose Monitoring

Monitoring glucose levels provides real-time feedback on the effectiveness of management strategies and informs decisions about food, exercise, and medications. Patients may use either:

- **Blood glucose meters (glucometers)**: Handheld devices that measure glucose from a small blood sample, usually taken from a fingertip. See Figure 11.7.4
- **Continuous glucose monitors (CGMs)**: Devices with sensors placed under the skin that measure glucose every few minutes. See Figure 11.7.5

Even with a CGM, periodic fingertip checks with a glucometer are required to verify accuracy.

When to Check Blood Glucose

Testing frequency depends on the type of diabetes, treatment regimen, and physician recommendations. Common testing times include:

- Upon waking (fasting)
- Before meals
- Two hours after meals
- At bedtime

Patients on insulin therapy (particularly type 1 diabetes) may need additional checks, including before and after exercise.

Blood Glucose Targets

Typical recommended ranges include:

- Before meals: 80–130 mg/dL
- Two hours after eating: <180 mg/dL

Targets are individualized, taking into account age, co-existing health conditions, and overall treatment goals.



Figure 11.7.4: A blood glucose monitor for diabetes. (Glucose monitor; sweet life via unsplash)

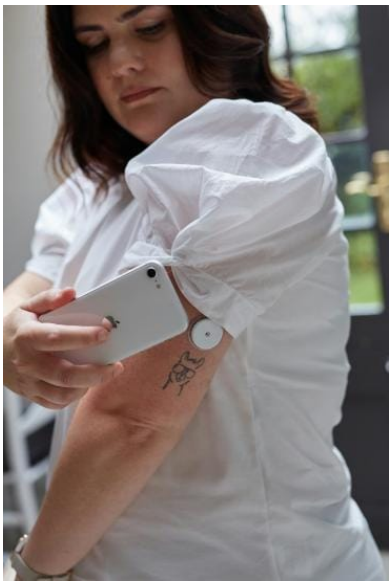


Figure 11.7.5: Continuous glucose monitor. (Continuous Glucose monitor; sweet life via unsplash)

Methods for Taking Insulin

Managing diabetes often requires taking insulin to help control blood glucose levels. Insulin regimens are highly individualized; what works best for one person may not be right for another, and plans often change over time in response to variations in health, daily routines, and personal treatment goals. Some individuals use just one type of insulin, while others may take several types at different times to match their body's needs throughout the day. Each method of insulin delivery comes with its own set of benefits and challenges, so it's important to work closely with your healthcare team to determine the option best suited for you.

Insulin Therapy

Maintaining optimal blood glucose levels is essential for people with diabetes, as both excessively low and high values can pose serious health risks.

Hypoglycemia (Low Blood Sugar): Blood glucose below 70 mg/dL is considered low and may result from missing a meal, excessive insulin use, certain oral medications, unplanned exercise, or alcohol consumption. Symptoms often include sweating, shakiness, confusion, or irritability. Severe hypoglycemia can lead to seizures or unconsciousness. Prevention involves regular meals, adjusting medicine for activity, and moderating alcohol intake.

Hyperglycemia (High Blood Sugar): High blood sugar may develop from illness, stress, overeating, or inadequate insulin/medicine use. Persistent hyperglycemia (≥240 mg/dL) should be evaluated for ketones, as high ketone levels may signal the onset of diabetic ketoacidosis (DKA), a life-threatening emergency.

Before exploring insulin delivery and types, understanding these common terms is essential:

- **Bolus insulin**: Short- or rapid-acting insulin taken at or before meals to control blood sugar levels.
- **Basal insulin**: Intermediate- or long-acting insulin taken to keep blood sugar levels steady between meals and overnight.
- **Basal-bolus regimen**: Rapid-acting insulin taken at mealtimes and long-acting insulin taken once or twice a day
- **Onset**: How quickly insulin begins to lower blood sugar after it's taken.
- **Peak time**: When insulin is at maximum strength.
- **Duration**: How long insulin works to lower your blood sugar (Centers for Disease Control and Prevention, 2024) [11]

Methods for Insulin Administration

There are four methods of insulin administration, each with unique advantages and drawbacks:

Syringe

Traditional syringes deliver insulin via needle injection and allow for dose customization. Smaller syringes permit finer dose adjustment, while larger ones suit those with higher needs. A doctor will guide an individual on how much insulin to take per dose.
Pros:

- Requires less training than a pump
- Often less expensive than pumps

Cons:

- Less discreet than insulin pens and insulin pumps
- Less portable and may be less comfortable (Centers for Disease Control and Prevention, 2024) [11]

Insulin Pens

Insulin pens are available as pre-filled devices or reusable cartridges. The dose is dialed and injected through a fine needle, making administration more comfortable and convenient—especially for on-the-go use.
Pros:

- Pens are more portable and easier to use than syringes
- Pen needles are smaller and more comfortable than syringe needles

Cons:

- More expensive; may not be covered by insurance
- Not all types of insulin can be used with a pen (Centers for Disease Control and Prevention, 2024) [11]

Insulin Pump

An insulin pump is a computerized device that delivers rapid-acting insulin through a thin tube placed under the skin in the fatty layer, offering precise and flexible dosing. The user calculates the dose, and the pump delivers the bolus. Figure 11.7.6 is an image of a young diabetic woman who is wearing a continuous glucose monitor and an insulin pump.

Pros:

- Can improve glucose control (A1c)
- Deliver insulin more accurately
- Deliver bolus insulin more easily
- Eliminate unpredictable effects of intermediate- or long-acting insulin.
- Greater flexibility with meals, exercise, and daily schedule.
- Can improve physical and psychological well-being.

Cons:

- Potential for weight gain and infection
- Expensive, requires training
- May cause diabetic ketoacidosis if it is stopped or stops working correctly.
- Visible reminder of diabetes (Centers for Disease Control and Prevention, 2024) [11]

The insulin pump may integrate with your continuous glucose monitor (CGM) to help understand how your blood glucose is being affected and change the amount of insulin in some cases. Pumps can help some people reach their blood glucose targets, and many people prefer this continuous system of insulin delivery over injections.

Insulin Inhaler

Inhalers deliver ultra-rapid-acting insulin through the lungs at mealtime. They are always combined with a long-acting injectable insulin.

Pros:

- Is not an injection
- Acts very fast; is as effective as injectable rapid-acting insulins.
- Can be taken at the beginning of meals.
- Could lower the risk of low blood sugar.
- Could cause less weight gain
- The inhaler device is smaller

Cons:

- Might cause mild or severe coughing.
- Still requires basal insulin injection or pump
- Less precise dosing
- Higher cost
- Types of Insulin (Centers for Disease Control and Prevention, 2024) [11]

Insulin Types

Table 11.7.1 presents the major types of insulin, illustrating their onset, peak time, and duration, along with common methods of administration and typical usage scenarios in diabetes management.

Table 11.7.1 Types of Insulin: Onset, Peak, Duration, and Usage (Centers for Disease Control and Prevention, 2024) [10]

Insulin Type	Onset	Peak Time	Duration	Common Use & Method
Rapid acting	15 min	1 hour	2–4 hours	Usually taken right before
Rapid-acting inhaled	10–15 min	30 min	3 hours	Usually taken right before a meal. Often used with injectable long-acting insulin.
Regular/short-acting	30 min	2–3 hours	3–6 hours	Usually taken 30–60 min before a meal.
Intermediate acting	2–4 hours	4–12 hours	12–18 hours	Covers insulin needs for half a day or overnight. Often used with rapid- or short-acting insulin.
Long acting	2 hours	Does not Peak	Up to 24 hours	Basal needs; often with other insulins if needed
Ultra-long acting	6 hours	Does not Peak	36+ hours	Provides steady insulin for long periods.
Premixed	5–60 min	Peaks vary	10–16 hours	Combines intermediate- and short-acting insulin. Usually taken 10 to 30 minutes before breakfast and dinner.

Your doctor will prescribe the specific insulin or combination suited to your lifestyle, diet, activity level, age, and how your body absorbs and utilizes the medication. Different insulin brands vary in their onset, peak, and duration, even within the same type, so always check dosing instructions and follow your provider's guidance.

Lifestyle Practices for Long-Term Success

Aside from the primary management strategies above, effective self-care requires consistency and awareness. Evidence-based lifestyle tips include:

- Eating meals at regular times to prevent glucose spikes and dips.
- Make water the beverage of choice while limiting alcohol intake (no more than 1 drink per day for women, 2 for men).

- Choosing fruit as a healthier sweet option.
- Tracking food intake, activity, and glucose readings to identify patterns and triggers.
- Working with a diabetes care team for continuous education, support, and adjustment of management plans.



Figure 11.7.6: For many diabetics, using today's available technology is key to living life to the fullest. (Diabetic women; Halfpoint via Adobe stock)

Diabetes management requires a comprehensive, individualized approach that balances daily lifestyle decisions with medical treatment and consistent monitoring. While there is no cure, taking active steps in diet, physical activity, medication use, and glucose monitoring allows individuals with diabetes to lead healthy, productive lives and reduce the risk of serious complications.

Question

- What is the advantage of pairing a continuous glucose monitor (CGM) with traditional blood glucose meter checks?
- Why might illness or stress contribute to hyperglycemia even when diet and activity levels remain unchanged?
- What daily strategies can help individuals recognize patterns in their blood glucose fluctuations?

Public Health Outlook

With millions of Americans living with diabetes, and millions more at risk, the disease represents both a clinical and public health challenge. Addressing diabetes requires a dual approach: educating individuals on modifiable risk factors while strengthening health care systems to support early detection, treatment, and long-term management.

Education initiatives and support organizations play a critical role in empowering individuals and families affected by diabetes to manage the condition and improve quality of life. Diabetes Self-Management Education and Support (DSMES) programs, promoted by the Centers for Disease Control and Prevention (CDC), provide practical skills in areas such as healthy eating, physical activity, medication adherence, glucose monitoring, risk reduction, emotional coping, and problem solving. DSMES services, typically delivered by certified diabetes care and education specialists, are widely offered in hospitals, clinics, community centers, schools, and even virtually, making essential guidance accessible throughout a patient's journey, including at diagnosis, when complications develop, and during major life changes.

Support for Diabetes

Numerous organizations offer resources, peer support, advocacy, and education. Examples include:

- **American Diabetes Association (ADA)**: Provides recognized diabetes education programs, advocacy, and up-to-date information for patients and healthcare professionals.

- **Association of Diabetes Care & Education Specialists (ADCES)**: Offers practitioner resources, family and caregiver education, and accredited self-management programs.
- **Breakthrough T1D (formerly JDRF)**: Focuses on supporting and advancing research and education for type 1 diabetes, with community-building initiatives for families and youth. This organization is improving lives today and tomorrow by accelerating life-changing breakthroughs to cure, prevent, and treat type 1 diabetes and its complications.
- **Children's Diabetes Foundation** and **Children with Diabetes**: Provide family-focused education, support, and events for children living with type 1 diabetes.
- **DiabetesSisters**: Serves women with diabetes through peer support, education, and wellness resources.
- **Beyond Type 1 & Beyond Type 2**: Deliver education, global community engagement, advocacy, and resources tailored to both type 1 and type 2 diabetes.
- **diaTribe Foundation**: Offers free online publications and resources to improve understanding of diabetes management and technology.
- **Defeat Diabetes Foundation**: Focuses on preventing and managing Type 2 diabetes through education, awareness, and community programs.
- **The Diabetes Link**: Focuses on empowering young adults with both Type 1 and Type 2 diabetes by providing peer support, resources, and connections.

Community-based organizations, faith groups, schools, and local health departments may also offer diabetes education workshops, support groups, and culturally appropriate materials. Technology-driven approaches, such as online education videos, apps, and remote counseling, continue to expand outreach, making education more accessible and diverse in format.

Collectively, these initiatives and organizations foster knowledge, confidence, and practical skills, helping individuals and families navigate diabetes management and cope with challenges across all life stages.

Key Points

- Diabetes is a chronic metabolic disorder marked by high blood glucose, resulting from insufficient insulin production, insulin resistance, or both.
- Type 2 diabetes is the most common form (90–95% of cases), often associated with lifestyle factors, while type 1 diabetes (5–10% of cases) is autoimmune in origin and requires lifelong insulin therapy.
- Prediabetes is a reversible condition of elevated blood glucose that increases the risk of developing type 2 diabetes and cardiovascular disease.
- Major complications of uncontrolled diabetes include heart disease, kidney failure, blindness, nerve damage, and limb amputation.
- Diagnosis relies on blood tests such as Hemoglobin A1C, fasting glucose, and glucose tolerance testing, along with screenings for diabetes-related complications.
- Although diabetes has no cure, long-term health can be maintained through a comprehensive management plan involving healthy nutrition, regular physical activity, blood glucose monitoring, and medication when needed.
- Lifestyle modifications, including balanced meal planning, portion control, and at least 30 minutes of moderate physical activity most days, support glycemic control, weight management, and reduced cardiovascular risk.
- Blood glucose monitoring and medication adherence help achieve and maintain target levels and reduce the risk of acute events like hypoglycemia and diabetic ketoacidosis.
- Self-care strategies such as consistent meal timing, adequate hydration, tracking food and activity, and regular consultation with a diabetes care team are key to long-term success and minimizing complications.
- Diabetes imposes a significant public health burden in the United States, with annual costs exceeding $400 billion in medical expenses and lost productivity.

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11.8: About Cancer



Figure 11.8.1: Ongoing efforts in cancer research are helping society come closer to eradicating this disease. (Microscope; National Cancer Institute via unsplash)

Introduction

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, are now 90 percent or better, and the 5-year survival rate for all cancers combined is currently about 67 percent.

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. Figure 11.8.2
- Invade into nearby areas and spread to other areas of the body. Figure 11.8.3
- Tell blood vessels to grow toward tumors.
- Hide from or trick the immune system. The immune system normally eliminates damaged or abnormal cells. Cancer 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.

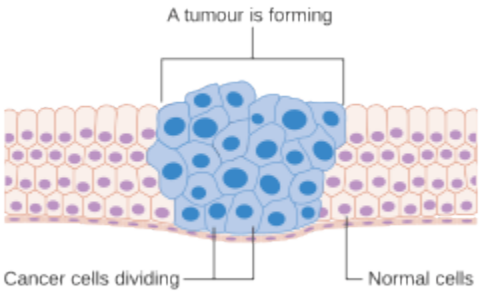


Figure 11.8.2: In this diagram, cancer cells form among normal cells, growing in size and dividing until a tumor begins to form. (Cancer cells, Cancer Research UK via CC BY-SA (Attribution ShareAlike))

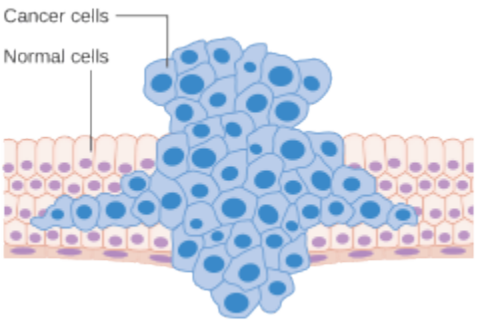


Figure 11.8.3: As cancerous cells continue to grow and divide, the tumor forces its way through normal cells, forming an irregular mass. (Cancer cell tumor; Cancer Research UK via CC BY-SA (Attribution ShareAlike) license)

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. Figure 11.8.4 shows a benign tumor and a malignant tumor. 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 are life-threatening, such as benign tumors in the brain. Cancerous (malignant) tumors spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumors.

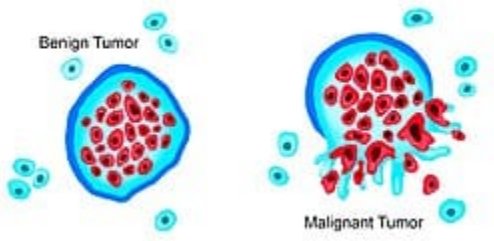


Figure 11.8.4: Benign tumors are fully encapsulated by normal cells. Malignant tumors are not encapsulated, and they spread among normal cells. (Tumor types; Wikimedia Commons)

Benign tumors:

- Usually grows 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 the surrounding tissues and cause damage
- It 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: How Cancer Spreads

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.

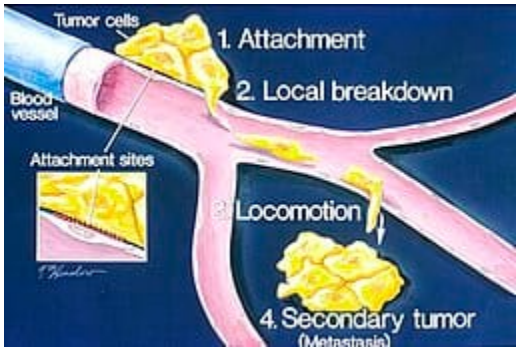


Figure 11.8.5: How cancer metastasis occurs, discussed below. (Metastasis; via Wikimedia Commons) Alternative Text Description

Cancer cells spread through the body in a series of steps. Figure 11.8.5 illustrates how metastasis occurs. This schematic drawing highlights four key stages: (1) attachment, (2) local breakdown, (3) locomotion, and (4) formation of a secondary tumor.

At the most basic level, metastasis begins when cancer cells grow into, or invade, nearby normal tissue. From there, they move through the walls of nearby lymph nodes or blood vessels, gaining access to the body's transportation systems. Once inside, the cells travel through the lymphatic system or bloodstream to other parts of the body. Eventually, they stop in small blood vessels at a distant location, where they invade the vessel wall and move into surrounding tissue. In this new environment, the cells begin to grow and form a small tumor. As the tumor develops, it can stimulate the growth of new blood vessels (angiogenesis), creating 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.

Table 11.8.1 *Main Sites of Metastasis Based on Common Types 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, and other lung
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

Cancer staging is a way of describing how advanced a cancer is at the time of diagnosis. Staging considers factors such as the size of the primary tumor, whether cancer has spread to nearby lymph nodes, and whether it has metastasized to other parts of the body. Understanding the stage of cancer is essential because it helps doctors assess how serious the disease is, plan the most effective treatment, and evaluate eligibility for clinical trials. Although cancer may progress or spread over time, it is always referred to by the stage assigned at diagnosis, with new information added to describe changes. To determine the stage, doctors may use imaging tests (such as x-rays or scans), laboratory results, and other diagnostic procedures. Most cancers are classified using formal staging systems, with the TNM system being the most widely used. In TNM staging, T describes the size and extent of the main tumor, N indicates whether nearby lymph nodes are involved, and M shows whether the cancer has metastasized. This system, along with other cancer-specific staging methods, provides a common language for patients, doctors, and researchers to discuss and compare cancer diagnosis and treatment.

Question

- What is the difference between normal cell growth and cancer cell growth?
- How do benign tumors differ from malignant tumors in terms of growth and spread?
- What does the term metastasis mean, and why is it a key factor in cancer staging?

Table 11.8.2 *Stages of Cancer*

Stage	What it means
Stage 0	Early, non-invasive; abnormal cells are present but have not spread to nearby tissue. Also called carcinoma in s
Stage I	Cancer is present. Small localized tumor; limited growth; no lymph node involvement or minimally so; hasn't sp
Stage II	Larger tumor or more growth into nearby tissue; may have spread to nearby lymph nodes but not to distant pa

Stage	What it means
Stage III	More advanced local and regional spread; usually involves more extensive growth, possibly involvement of mul
Stage IV	Metastatic Cancer: The cancer has spread to distant organs or distant lymph nodes. Usually more difficult to t

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 a 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 a 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 over the body.
- **Melanoma**
  - Melanoma is a 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 cancerous) or malignant (cancerous).

Compare Types of Cancer

The National Cancer Institute provides in-depth information on the types of cancers. One of the ways they provide information 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, prevention, treatment, and screening options.

Visit the National Cancer Institute's "Cancers by Location/System"

Cancer Rates

Cancer is the second leading cause of death. Based on data from 2018-2021 (excluding 2020 due to pandemic disruptions), it is estimated that about 38.9% 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 the incidence rate and death rate can

help understand the survival rate of various types of cancer. For example, estimations for 2022 show breast cancer incidents 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 11.8.3 2025 Deaths by Cancer Type Data Set (American Cancer Society, n.d.) [1]

Cancer Type	2025 Estimated Cancer Deaths
Breast (Male & female breast cancers combined for the whole U.S.)	42,680
Prostate	35,770
Lung and bronchus	124,730
Colorectum	52,900
Skin (excluding basal & squamous)	14,110
Melanoma of the skin	8,430
Lymphoma	20,540
Urinary Bladder (includes in situ cases)	17,420
Kidney and renal pelvis	14,510
Non-Hodgkin lymphoma	19,390
Uterine corpus	13,860
Pancreas	51,980
Leukemia	23,540
Oral cavity and pharynx	12,770
Thyroid	2,290
Liver and intrahepatic bile duct	30,090
Myeloma	12,030
Stomach	10,780
Brain and other nervous system	18,300
Esophagus	16,250
Ovary	12,730
Soft tissue (including heart)	5,410
Cervix	4,320
Larynx	3,910
Gallbladder and other biliary	4400
Anus, anal canal, and anorectum	2,030
Testis	600
Hodgkin lymphoma	1,150
Vagina and other female genital	1,950
Vulva	1,770
Ureter and other urinary organs	1,210
Bones and joints	2,190
Eye and orbit	490

Penis and other male genitals	510

Table 11.8.3 has been created from the American Cancer Society; Cancer Statistics Center

Cancer begins when a normal cell undergoes changes that lead to uncontrolled growth and often the ability to spread, or metastasize, to other parts of the body. While cancer remains the second leading cause of death in the United States and worldwide, advances in early detection and treatment have steadily improved survival rates over recent decades. Understanding the basic biology of cancer cells, the differences between benign and malignant tumors, and how cancer spreads empowers individuals and communities to recognize the importance of prevention, screening, and prompt medical care.

Key Points

- Cancer starts when cells grow out of control instead of following normal signals.
- Tumors can be either benign (not cancerous) or malignant (cancerous and able to spread).
- Malignant tumors can invade nearby tissues and organs or travel to distant areas via blood or lymph (metastasis).
- Leukemia is a cancer of the blood and does not form solid tumors.
- Cancer is the second leading cause of death in the U.S. and globally.
- Survival rates for some cancers, like breast and prostate, now exceed 90% for five years after diagnosis.
- There are more than 100 types of cancer, often named by the organ or cell type where they begin.
- Early detection, regular screenings, and understanding risk factors are key to improving outcomes.

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11.9: Cancer Screening and Symptoms



Figure 11.9.1: (No Cancer; National Cancer Institute via unsplash)

Introduction

Regular cancer screening and awareness of symptoms are crucial in the fight against cancer. In many cases, cancer does not cause symptoms in its early stages and can remain unnoticed until it becomes more serious. Because of this, annual medical checkups and recommended screenings, such as Pap tests, mammograms, and colonoscopies, are essential for detecting cancer before symptoms appear. Early detection through screening can lead to better treatment outcomes and improved survival rates. In addition to screenings, it is important to be familiar with general warning signs. The acronym CAUTION summarizes several symptoms that could signal cancer and should prompt a visit to a healthcare provider. Since symptoms often vary by the type and location of cancer, the following lists highlight common signs for some major cancers to help raise awareness and promote timely action.

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 to 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.

Change in bowel or bladder habits

A sore that does not heal

Unusual bleeding or discharge

Thickening or lump in the breast or elsewhere

Indigestion or difficulty in swallowing

Obvious change in wart or mole

Nagging cough or hoarseness

Question

- The acronym CAUTION is a tool for recognizing potential warning signs of cancer.
  - Which of these warning signs do you think people are most likely to ignore, and why?
- Early detection greatly improves survival rates.
  - What barriers (social, cultural, financial, or personal) might prevent people from accessing cancer screenings?
  - How could those barriers be reduced?

Symptoms Related to the Type of Cancer

The symptoms of cancer vary depending on the type and location of the disease. Some cancers may cause noticeable signs early on, while others may remain silent until they are more advanced. The following lists highlight some of the more common symptoms associated with different types of cancer. These lists are not exhaustive, but they provide an overview of warning signs that may warrant medical evaluation. Recognizing these symptoms and seeking timely medical attention can be critical for early detection and successful treatment.

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 shape of the breast
- Pain in any area of the breast



Figure 11.9.2: Regular mammographies can detect early-stage breast cancer. (Women getting mammogram; National Cancer Institute via unsplash)

Prostate

- Difficulty starting urination
- Weak or interrupted flow of urine
- Frequent urination, especially at night
- Difficulty emptying the bladder
- 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 having 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 neck, armpits, or groin
- Fever
- Night sweats
- Feeling tired
- Weight loss

Uterine

- Vaginal bleeding, or discharge from the vagina that is not normal
- Pain or pressure in the pelvic area

Brain and the Nervous System

- Brain tumor symptoms:
  - 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:
  - 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

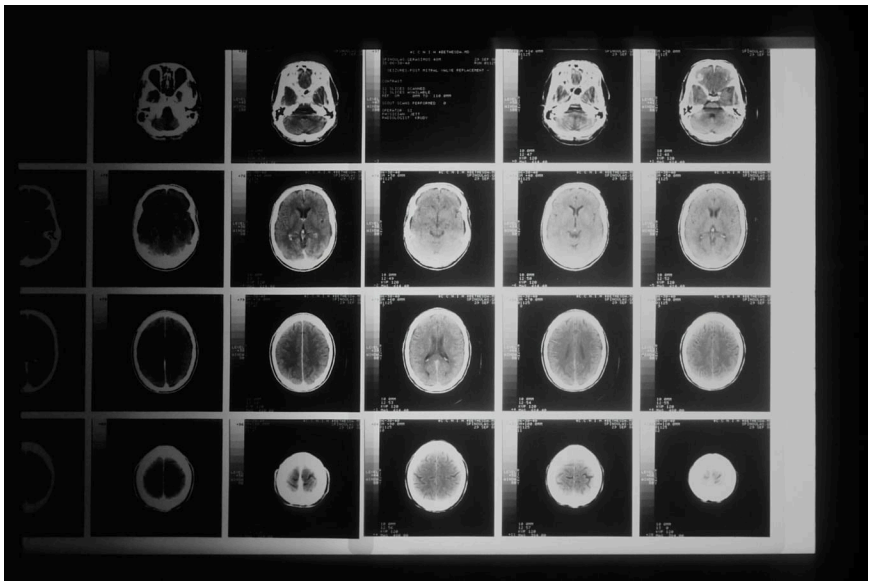


Figure 11.9.3: Computer-assisted tomography is a diagnostic technique that uses computers to organize thousands of X-rays, taken by a rotating machine around the patient. When first applied in the 1970's, CAT scans revolutionized the detection of brain tumors. (Cat scan of brain; National Cancer Institute via unsplash)

Urinary Bladder

- Blood in the urine (most common)
- 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
- A fever that keeps coming back
- Not feeling like eating
- Losing weight for no reason
- Something is blocking the 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 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 the vagina that is not normal

Melanoma of the Skin

- A-B-C-D-Es of melanoma. Figure 11.9.1 provides a visual comparison of abnormal (left side) and normal melanomas (right side).
  - **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?

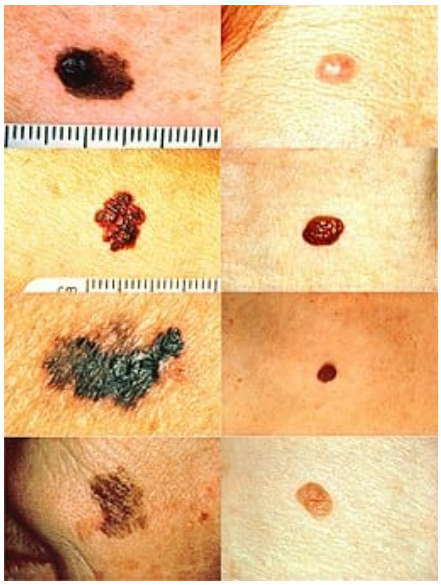


Figure 11.9.4: The ABCD'S of skin cancer detection. On the left side from top to bottom: melanomas showing (A) Asymmetry, (B) a border that is uneven, ragged, or notched, (C) coloring of different shades of brown, black, or tan, and (D) a diameter that has changed in size. The normal moles on the right side do not have abnormal characteristics (no asymmetry, even border, even color, no change in diameter). (Melanoma vs Normal mole; via Public domain)

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

Understanding cancer symptoms and the value of regular screening is an essential part of disease prevention and early detection. While many cancers may not show symptoms in their early stages, awareness of potential warning signs empowers individuals to seek care promptly. Routine screenings, combined with knowledge of both general and cancer-specific symptoms, can greatly improve the chances of identifying cancer at an earlier and more treatable stage.

Question

- Why is cancer screening important even when no symptoms are present?
- How might this change how you think about your own health care routine?

- The A-B-C-D-Es of melanoma provide a simple way to remember warning signs of skin cancer.
  - Which of these signs—Asymmetry, Border, Color, Diameter, or Evolving—do you think people are most likely to overlook?
  - Why might that increase the risk of a late diagnosis?

Key Points

- Many cancers are asymptomatic: Some cancers produce no early warning signs, which makes screening and routine medical checkups essential.
- Importance of screenings: Women: Pap tests annually; mammograms starting at age 40 (earlier with a family history of breast cancer).
- Men & Women: Colonoscopy every 10 years beginning at age 45.
- Early detection saves lives: The earlier cancer is found, the more effective treatment is likely to be.
- The CAUTION acronym helps identify seven warning signs of cancer.
- Cancer symptoms vary by type: While CAUTION highlights general warning signs, specific cancers have characteristic symptoms (e.g., coughing up blood in lung cancer, jaundice in pancreatic or liver cancer, or lumps in breast or testicular cancer).
- Patient awareness is critical: Knowing possible symptoms and risk factors, combined with regular checkups, improves chances of early diagnosis and treatment success.

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11.10: Cancer Risk and Prevention



Figure 11.10.1: Regular use of a sunscreen with a high sun protection factor (such as SPF 50) can help prevent skin cancer. (Sunsceen bottle; Onela Ymeri via unsplash)

Introduction

Cancer prevention is actions you can take to lower the chance of getting cancer. In 2025, about 2 million people in the United States are expected to be diagnosed with cancer. Beyond the physical challenges of the disease, cancer can bring emotional distress and create significant financial burdens for patients, families, and society. By focusing on prevention, we can reduce the number of new cases, decrease cancer-related deaths, and ease the overall impact of cancer on individuals and communities.
Cancer is not a single disease but rather a group of related conditions. A combination of factors, including genetics, lifestyle choices, and environmental exposures, can influence an individual's risk. Scientists continue to explore strategies for prevention, which include avoiding known carcinogens, making healthy lifestyle changes, detecting precancerous conditions early, using medications (chemoprevention), and, in some cases, considering risk-reducing surgeries.

Carcinogenesis: How Cancer Develops

Carcinogenesis is the process by which normal cells transform into cancer cells. This transformation involves changes, or mutations, in genes that normally regulate cell growth, repair, and death. When these genetic controls break down, cells may divide uncontrollably or fail to die when they should. This uncontrolled growth can lead to tumors. While benign tumors remain localized, malignant tumors can invade nearby tissues and spread to other parts of the body.

Risk Factors

Cancer risk factors are conditions or exposures that increase the likelihood of developing cancer. They can be divided into known and potential factors:

- Known risk factors include cigarette smoking and tobacco use, certain infections, radiation exposure, and the use of immunosuppressive medicines after an organ transplant.
- Factors that may affect risk include diet, alcohol consumption, physical inactivity, obesity, diabetes, and environmental exposures.

It is important to recognize that some risk factors are modifiable, meaning individuals can take steps to change them (such as quitting smoking, maintaining a healthy weight, or limiting alcohol), while others, such as inherited genetic mutations, cannot be

controlled.

On the other hand, protective factors are behaviors or conditions that reduce cancer risk, such as regular physical activity, a nutrient-rich diet, and participation in recommended screenings. By focusing on reducing modifiable risk factors and promoting protective factors, individuals can play an active role in lowering their chances of developing 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 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. The Dietary Guidelines for Americans recommends that adults of legal drinking age (21 years or older) choose not to drink alcohol or to drink alcohol in moderation (2 drinks or fewer in a day for men, 1 drink or fewer in a day for women) (Centers for Disease Control and Prevention, 2025). [4]
- **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; 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 may reduce the risk 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. People of all ages and skin tones should limit the amount of time they spend in the sun, especially between mid-morning and late afternoon. UV radiation is reflected by sand, water, snow, and ice and can go through windshields and windows. Even though skin cancer is more common among people with light skin tone, people of all skin tones can develop skin cancer.
- **Tobacco**
  - Tobacco use is a leading cause of cancer and 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 physically active people 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.

Tobacco

Tobacco use is a leading cause of cancer and 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 (National Cancer Institute, n.d.). [18]

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. 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 (National Cancer Institute, n.d.). [18]

Scientists believe that cigarette smoking causes about 30% of all cancer deaths in the United States.

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.

Question

- Which cancer risk factors are within your personal control, and which are not?
  - How does this influence your view of prevention?
- Screening is considered a form of prevention because it can detect precancerous conditions.
  - What challenges might people face in accessing regular screenings?
  - How could these be addressed?

Key Points

- Cancer prevention lowers the chance of developing cancer and reduces the overall burden of disease.
- Carcinogenesis is the process by which normal cells transform into cancer cells due to genetic mutations that disrupt normal

growth and death cycles.
- Some tumors are benign (noncancerous), while others are malignant (cancerous and able to spread).
- Known risk factors include tobacco use, infections, radiation, and immunosuppressive medicines.
- Modifiable lifestyle factors such as diet, alcohol intake, physical activity, obesity, and diabetes can increase or reduce cancer risk.
- Protective factors include healthy eating, regular exercise, avoiding tobacco and excessive alcohol, and participating in screening programs.
- Some prevention strategies include avoiding carcinogens, early detection of precancerous conditions, chemoprevention, and risk-reducing surgery.

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11.11: Comprehension Check

Summary

Chronic diseases and infections such as cardiovascular disease (CVD), diabetes, and sexually transmitted infections (STIs/STDs) present significant public health challenges in the United States and worldwide. These conditions vary in cause and impact—from clogged arteries and disrupted blood glucose regulation to viral and bacterial infections—but they share a common thread: many are preventable, manageable, or treatable through informed choices and proactive health care. Preventive strategies such as routine screening, vaccination (for HPV and hepatitis B), blood pressure and glucose monitoring, and safe sexual practices play a crucial role in reducing disease burden. Additionally, recognizing early warning signs—such as chest pain, fatigue, vision changes, or unusual discharge—can lead to timely interventions and better outcomes.

Lifestyle behaviors are often the first line of defense. Eating a balanced diet, engaging in regular physical activity, avoiding tobacco and excess alcohol, maintaining a healthy weight, and managing stress all contribute to reduced risk for heart disease and type 2 diabetes, and can help boost immune function to resist infections. Education also empowers individuals to take charge of their health, understanding how conditions develop, the importance of treatment adherence, and the availability of community resources fosters both individual and collective health resilience. Whether addressing chronic diseases or communicable infections, an integrated approach that emphasizes prevention, early detection, and sustainable behavior change is essential to long-term health and well-being.

Test Your Understanding

- When was the last time you had your blood pressure checked? Do you know what your typical reading is, and if it's within the healthy range?
- Are you currently getting at least 150 minutes of moderate exercise per week? If not, what barriers are preventing you from being more active, and how could you start “small” like the “Start Small. Live Big.” campaign suggests?
- How often do you go for regular check-ups or health screenings? What might be holding you back from seeing a doctor more regularly?
- What are some of the most common types of heart disease affecting women, and how might their symptoms differ from those in men?
- List at least five major risk factors for heart disease that affect both women and men. How can these risks be reduced or managed through healthy lifestyle choices?
- What are the main types of diabetes, and which one is most common in the United States?
- Name at least five risk factors that can increase a person's likelihood of developing Type 2 diabetes.
- How can prediabetes be reversed or prevented from progressing to Type 2 diabetes? List two lifestyle changes that are supported by evidence.
- What does each letter in the CAUTION acronym stand for in relation to cancer warning signs?
- How do normal cells differ from cancer cells in their growth and behavior?
- How is cancer staged, and what does stage IV indicate?
- Describe one common symptom for breast cancer and one for colorectal cancer.
- What term is used for cancer cells spreading to distant parts of the body, and why is this process significant?

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Chapter 11 Glossary

- **Angiogram:** A coronary angiogram is a test that uses X-rays to look at the heart's blood vessels, called the coronary arteries.
- **Angina:** Also known as angina pectoris, is chest pain or discomfort that occurs when part of your heart muscle does not get enough oxygen-rich blood.
- **Arrhythmia:** An arrhythmia is a heart rhythm that isn't normal. Your heart may be beating too fast when you're at rest or just not beating in a regular pattern.
- **Arteriosclerosis:** Hardening of the arteries.
- **Atherosclerosis:** Is a common disease that develops when plaque builds up in your arteries.
- **Benign tumor**: A benign tumor is a non-cancerous growth of cells that does not spread to other parts of the body.
- **Blood Pressure**: The force exerted by blood on the walls of the blood vessels, created by the pumping action of the heart.
- **Cerebral Embolism**: A blockage in a brain artery caused by a clot or debris that formed elsewhere in the body and traveled to the brain, cutting off blood flow.
- **Cerebral Thrombosis**: A blood clot that forms directly within a brain artery, gradually blocking blood flow and potentially causing a stroke.
- **Cholesterol:** A waxy, fat-like substance that is both produced by the liver and obtained from certain foods.
- **Coronary Artery Disease**: A disease in which there is a narrowing or blockage of the coronary arteries (blood vessels that carry blood and oxygen to the heart). Coronary artery disease is usually caused by atherosclerosis (a buildup of fatty material and plaque inside the coronary arteries).
- **Carditis:** Inflammation of the heart.
- **Diastole**: The period of the heart’s relaxation.
- **Etiology**: The cause or origin of a disease or condition.
- **Hemorrhagic**: Relating to or involving bleeding; in the stroke context, it refers to a stroke caused by a ruptured blood vessel leaking blood into or around the brain.
- **High-Density Lipoproteins (HDL)**: It is sometimes called the "good" cholesterol because it carries cholesterol from other parts of your body back to your liver. Your liver then removes the cholesterol from your body.
- **Hyperglycemia**: A term for high blood glucose (blood sugar).
- **Hypoglycemia**: Abnormally low blood sugar levels, which can cause symptoms resembling a stroke (confusion, weakness, dizziness) but are reversible with glucose restoration.
- **Intracerebral Hemorrhage**: Bleeding that occurs directly within the brain tissue itself, typically from a ruptured blood vessel, causing rapid pressure buildup and brain damage.
- **Ischemic**: Relating to insufficient blood supply to tissue; an ischemic stroke occurs when a blockage prevents adequate blood flow to part of the brain.
- **Lipoproteins:** They are complex particles composed of lipids (fats) and proteins that transport lipids throughout the bloodstream. They play a crucial role in the metabolism and distribution of fats in the body.
- **Low-Density Lipoproteins (LDL):** A type of cholesterol that is often referred to as "bad" cholesterol. It is a lipoprotein, which means it is a combination of fat (cholesterol) and protein
- **Malignant tumor:** A malignant tumor, also known as cancer, is an abnormal growth of cells that can invade and spread to other parts of the body.
- **Metastasis:** The spread of cancer cells from their original (primary) site to other parts of the body.
- **Myocardial infarction (MI):** A myocardial infarction (MI), commonly known as a heart attack, occurs when blood flow to the heart muscle decreases or stops in one of the coronary arteries, causing tissue death (infarction).
- **Stroke:** When blood flow to the brain is blocked, or there is sudden bleeding in the brain.
- **Subarachnoid Hemorrhage**: Bleeding into the space between the brain and the surrounding membrane (subarachnoid space), most often caused by a ruptured aneurysm.
- **Systole**: The period of the heart’s contraction.
- **Transient Ischemic Attack (TIA)**: A brief, temporary episode of stroke-like symptoms caused by a short-lived blockage in blood flow to the brain, with no lasting damage; often called a "mini-stroke" and a warning sign of future stroke risk.

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11.14: Detailed Accessible Description

Figure 11.1.2: Thoracic Anatomy of Heart and Lungs

This image shows the chest (thoracic cavity) from the front. The heart sits in the center, between the right and left lungs. The heart is enclosed in a protective sac called the pericardium. The four main chambers are labeled: right atrium, right ventricle, left atrium, and left ventricle. Major blood vessels are also labeled. The superior vena cava brings blood into the right atrium from above. The pulmonary trunk carries blood from the heart to the lungs. The aortic arch carries blood from the heart to the body.

The mediastinum is the central space in the chest that contains the heart and major vessels. Below the heart and lungs is the diaphragm, a muscle that separates the chest from the abdomen and helps with breathing. Other labeled structures include the ribs (cut to show internal organs), the pleura (lining around the lungs), and the pericardium (lining around the heart). A smaller side-view (sagittal) inset shows how the heart sits in relation to the trachea (airway), esophagus (food tube), thymus, and major vessels. The apex (tip) of the heart points down and slightly to the left. This image shows how the heart, lungs, and blood vessels are arranged in the chest and how they work together to move oxygen through the body.

Figure 11.1.3: Arteries, Capillaries, and Veins

This image shows how blood flows through three types of blood vessels, moving from left to right. On the left, a large **red artery** carries blood away from the heart. Arrows indicate the direction of flow moving outward from the artery into smaller branches. In the center, the artery divides into many small vessels called **capillaries**. These form a thin, web-like network that spreads through tissues. This is where oxygen and nutrients move from the blood into the body.

On the right, the capillaries merge into a larger **blue vein**. Arrows show blood flowing into the vein and back toward the heart. The **color change from red to blue** represents a change in oxygen levels. Red indicates oxygen-rich blood in the artery. Blue indicates oxygen-poor blood in the vein after oxygen has been delivered to tissues.

Labels and arrows identify the artery, capillaries, and vein, and help show the path and direction of blood flow. This image explains how blood delivers oxygen and nutrients through capillaries and then returns to the heart through veins.

Figure 11.1.4: Blood Flow Through the Body

This diagram shows how blood circulates through the body **via two pathways: the pulmonary circulation (top) and the systemic circulation** (bottom). Blood flow circulates continuously.

Color meaning:

- Red vessels carry oxygen-rich blood
- Blue vessels carry oxygen-poor blood
- Purple networks show capillaries where gas exchange occurs

Pulmonary circulation (top section):
Blood leaves the heart through the pulmonary artery (blue) and travels to the lungs. In the lungs, blood moves through purple capillary networks where it gains oxygen. Oxygen-rich blood then returns to the heart through the pulmonary vein (red).

Systemic circulation (bottom section):
Oxygen-rich blood leaves the heart through the aorta (red) and travels to the body.

- In the upper body, blood flows through capillaries (purple), delivering oxygen, and returns through veins (blue) to the vena cava.
- In the liver, blood arrives through the hepatic artery (red) and also through the hepatic portal vein, which carries blood from the stomach and intestines. Blood leaves the liver through the hepatic vein (blue).
- In the kidneys, blood enters through the renal artery (red), passes through capillaries, and exits through the renal vein (blue).
- Blood also circulates through the lower body, where capillaries exchange gases before returning to the heart.

All blue (deoxygenated) blood returns to the heart through the **vena cava**, completing the cycle. Arrows on the vessels show the direction of blood flow throughout the system.

Figure 11.1.5: Circulation of Blood Through the Heart

The image illustrates the flow of blood through the human heart and is divided into two main sections. On the left, there is a flowchart detailing the sequence of blood circulation, with blue and red arrows indicating direction. Blue arrows signify deoxygenated blood moving from the body tissues to the lungs, and red arrows indicate oxygenated blood moving from the lungs to the body tissues. The sequence is as follows: deoxygenated blood flows from the body tissues to the vena cava, then to the right atrium, crosses through the tricuspid AV valve into the right ventricle, and proceeds through the pulmonary semilunar valve to the pulmonary arteries, reaching the lungs. Oxygenated blood is moved from the lungs to the pulmonary veins, entering the left atrium, crossing the bicuspid AV valve into the left ventricle, passing through the aortic semilunar valve, and entering the aorta to be distributed to the body tissues.

On the right, a labeled diagram of the heart is shown. The heart is depicted in cross-section, highlighting the chambers, valves, and major vessels. The right atrium and ventricle are shown in blue, indicating deoxygenated blood pathways, while the left atrium and ventricle are shown in red, indicating oxygenated blood pathways. Labels include: Aorta, Left Atrium, Left Ventricle, Right Atrium, Right Ventricle, Superior Vena Cava, Inferior Vena Cava, Pulmonary Artery, Pulmonary Vein, Pulmonary Valve, Tricuspid Valve, Mitral Valve, and Aortic Valve.

Figure 11.1.6: Conduction System of the Heart

The image is a detailed anatomical illustration of the human heart, highlighting its internal structures with a focus on the electrical conduction system. This frontal view shows various parts of the heart labeled with fine lines pointing to specific components. The heart is depicted in shades of red, while major arteries and veins like the aorta are shown in blue. The image includes labels for the Sinoatrial (SA) node, Atrioventricular (AV) node, anterior, middle, and posterior internodal pathways, and more. Yellow pathways indicate the conductive fibers that include Bachman's bundle, the Atrioventricular (AV) bundle (bundle of His), right and left bundle branches, and Purkinje fibers. The left and right atria, as well as the ventricles, are also labeled.

Frontal plane through heart

This is the small inset diagram in the upper left, showing a whole heart with a transparent plane slicing through it front-to-back. It's a locator image — it tells the viewer exactly what "slice" of the heart the large main image represents, since the heart is normally a solid 3D organ.

Sinoatrial (SA) node

Located high in the wall of the right atrium, near where the vena cava enters. This is the heart's natural pacemaker — the point where the electrical signal that triggers each heartbeat begins.

Anterior internodal (pathway)

One of three yellow conduction pathways leading away from the SA node through the right atrium, carrying the signal down toward the AV node.

Atrioventricular (AV) node

Positioned lower in the right atrium, at the border between the atria and ventricles. It receives the signal from all three internodal pathways and briefly delays it, giving the atria time to finish contracting before the ventricles are activated.

Middle internodal (pathway)

A second yellow pathway running from the SA node to the AV node, alongside the anterior and posterior pathways.

Posterior internodal (pathway)

The third of the three pathways connecting the SA node to the AV node.

Right atrium

The upper-left chamber (viewer's left) that receives blood from the body. It houses both the SA node and the AV node.

Right ventricle

The lower-left chamber, which pumps blood to the lungs. Purkinje fibers and the right bundle branch spread through its walls.

Arch of aorta

The large blue vessel at the top of the image, carrying oxygen-rich blood away from the heart to the rest of the body. It's shown for orientation, not part of the electrical system.

Bachman's bundle

Shown as dashed white lines arcing across the top of both atria. It branches off the anterior internodal pathway and carries the electrical signal specifically to the left atrium, so both atria contract in sync.

Left atrium

The upper-right chamber (viewer's right), which receives oxygenated blood from the lungs. It's activated via Bachman's bundle.

Atrioventricular (AV) bundle

Continues downward from the AV node through the fibrous tissue separating the atria from the ventricles. It's the sole normal electrical bridge between the upper and lower chambers.

Left ventricle

The lower-right, thick-walled chamber that pumps blood out to the body via the aorta. It's supplied by the left bundle branch and Purkinje fibers.

Right and left bundle branches

The point where the bundle of His splits into two paths — one running down the right side of the septum toward the right ventricle, the other down the left side toward the left ventricle.

Figure 11.2.4 Ischemic Stroke

The image shows a medical illustration of the side profile of a human head and neck, focusing on the brain's blood supply. The main part of the image displays a brain highlighted in beige and brown tones. Arteries appear in red, indicating the direction of blood flow from the neck to the brain. A label points to a blocked section of an artery in the brain caused by an embolus, signifying a blood clot. This blockage leads to restricted blood flow, shown with arrows, which can result in brain tissue death. An inset circle to the right magnifies the blocked artery section, with the embolus prominently visible, illustrating its impact on blood flow. This inset emphasizes how the blockage can cause tissue death adjacent to the clot. Text labels identify areas of interest, including the "Cerebral arteries within brain" and the "Location of brain tissue death."

Figure 11.2.5 Hemorrhagic Stroke

The image depicts a side view illustration of a human head focused on the brain, showing a cerebral aneurysm. The upper part of the image reveals a detailed cutaway of the brain. The aneurysm appears in red, indicating a rupture in the cerebral artery with blood spreading around the brain tissue. Brain tissue surrounding the aneurysm is highlighted, indicating potential tissue death. A circular inset on the right provides an enlarged view of the ruptured artery. The inset shows a detailed illustration of blood flow and damage to brain tissue. Arrows indicate blood flow direction, emphasizing the pressure from the aneurysm.

Figure 11.4.2 Balloon Angioplasty

Overall layout

The image has three connected visual components illustrating angioplasty: a whole-body view on the left showing the catheter's full path into the body, a close-up heart view in the middle showing where the catheter reaches its target, and a magnified cross-section on the right showing what happens at the blockage itself.

Whole-body view (left)

A semi-transparent human male torso shows the path of a catheter as a dark line running from the groin up through the body to the heart. It enters at the catheter entrance, labeled at the upper thigh — this represents the femoral artery, the standard access point where doctors insert catheters for heart procedures. From there, the line travels upward through the abdomen and chest, following the aorta, until it reaches the heart at the top. Small black arrows are placed along this path pointing upward and toward the heart; these arrows represent the normal direction of blood flow through the aorta toward and through the heart — showing that the catheter is threaded against this flow, moving from the distant femoral artery toward the heart, which sits at the source of that arterial flow.

Close-up heart view (center)

This zoomed-in illustration shows the heart itself with its surface network of coronary arteries (the yellow-tan and red branching vessels on the heart's outer surface, which supply the heart muscle with its own blood). Three labels clarify the anatomy here:

• Aorta – the large vessel arching over the top of the heart, the main trunk that carries oxygenated blood out to the whole body, and the route the catheter travels through to reach the heart.

• Right coronary artery – one of the heart's own surface blood vessels, branching off the base of the aorta; this is the specific artery being treated in this illustration (i.e., where the blockage is located).

• Catheter – shown as a thin line running up through the aorta and curving into the opening of the right coronary artery, showing exactly where the catheter tip is guided to perform the procedure. A small square outlined on the artery marks the exact site being magnified in the inset on the right.

Magnified inset (top right)

This cross-section cuts through the wall of the right coronary artery at the site of blockage, revealing the procedure in progress:

• Flattened plaque – the yellowish, fatty buildup along the inner artery wall that has narrowed the vessel; the label points to the plaque after it has been pressed flat against the artery wall by the balloon, rather than bulging inward and restricting blood flow as it did before treatment.

• Inflated balloon – the label points to the balloon portion of the catheter tip, shown expanded to fill the artery's diameter. It's this inflation that physically compresses the flattened plaque against the artery wall, widening the channel through which blood can flow. The catheter shaft is visible extending out of the vessel toward the lower right, showing how it's fed in from outside the body.

Title

“Balloon-tipped Catheter” identifies the device and procedure shown across all three panels: a catheter equipped with an inflatable balloon at its tip, used to treat arterial blockages from the inside.

How the pieces relate

The whole-body view shows the catheter’s journey from entry point to heart; the heart close-up shows the specific artery it reaches and the path it takes to get there; and the magnified inset shows the actual therapeutic action — the balloon inflating to flatten plaque and restore blood flow at the blockage site.

Figure 11.4.3 Coronary Artery Bypass Graft (CABG)

The image illustrates four stages of a Coronary Artery Bypass Graft (CABG) procedure, each labeled as "Single," "Double," "Triple," and "Quadruple." Each section shows a human heart with bypass grafts highlighted. The hearts are shown in rows from left to right. In each case, a graft is added to bypass blocked arteries.

- "Single": One graft appears on the heart.
- "Double": Two grafts are visible.
- "Triple": Three grafts are shown.
- "Quadruple": Four grafts are visible.

The hearts are depicted using a red hue for muscle and arteries, while the grafts are lighter for contrast. Blue elements signify veins and oxygen-depleted blood.

Text labels are placed above each heart illustration, and the full title "Coronary Artery Bypass Graft (CABG)" is positioned below.

Figure 11.5.8 Cancer Metastasis

The image visually represents this process within a branching blood vessel. Cancer cells are shown attaching to the vessel wall, breaking through the tissue, moving along the blood flow pathway, and forming a new tumor in a different location. Arrows and numbered steps guide the viewer from the original tumor site to the formation of a secondary tumor, reinforcing the sequence of events.

Cancer cells spread by attaching, breaking tissue, moving through vessels, and forming new tumors elsewhere.
This figure shows how cancer spreads (metastasis), helping students understand how disease can impact the body’s systems and physical function. This figure is a simplified drawing of how cancer cells spread through the body, a process called metastasis. A large blood vessel is shown as a wide, tube-like structure that branches into smaller vessels from left to right. The vessel represents a pathway for blood flow.

Clusters of cancer cells appear as irregular shapes that are visually distinct from the vessel. These clusters are shown at multiple points to represent different stages of spread. The contrast in appearance helps distinguish cancer cells from normal tissue.

On the left side of the figure, cancer cells are shown attached to the inner wall of the blood vessel. Labels identify “tumor cells” and “attachment sites,” indicating where the cells stick to the vessel wall. This corresponds to the first step, attachment.

In the next stage, labeled “local breakdown,” the cancer cells begin to disrupt and break through the vessel wall. This represents invasion into nearby tissue.

In the center of the figure, labeled “locomotion,” individual cancer cells move through the blood vessel. Arrows indicate the direction of movement, showing cells traveling from the original site through the branching vessel.

On the right side, a new cluster of cancer cells appears outside the vessel wall. This is labeled “secondary tumor (metastasis).” These cells have exited the bloodstream and begun growing in a new location.

The overall flow of the image moves from left to right: attachment, invasion, movement, and new tumor formation. Arrows and numbered steps reinforce this sequence, helping the viewer understand the progression even without relying on color.

Figure 11.6.2 Stroke

The image illustrates two types of strokes: ischemic and hemorrhagic. The top section has a title and introductory sentence in black text on a yellow background: "Stroke: A stroke, sometimes called a brain attack, happens in one of two ways." The left section depicts a blocked artery. A circular diagram shows a narrowed artery with a red and yellow clot labeled "Blood Clot." Below is a brain with a shaded area indicating "Death of Brain Tissue." The right section illustrates a ruptured artery. Another circular diagram displays a damaged blood vessel featuring a burst, labeled "Broken Vessel." Below is a brain labeled "Hemorrhage," showing an affected area. Each section includes numbered headings in maroon: "1 Blocked Artery" and "2 Ruptured Artery," with a brief explanation beneath each.

Transcribed Text:

Stroke: A stroke, sometimes called a brain attack, happens in one of two ways: 1 Blocked Artery: An ischemic stroke occurs when a blood clot blocks the blood flow in an artery within the brain. Blood Clot. Death of Brain Tissue. 2 Ruptured Artery: A hemorrhagic stroke occurs when a blood vessel bursts within the brain. Broken Vessel. Hemorrhage.

Figure 11.6.3 Map of U.S. Stroke Death Rates by County

Title and scope

“Stroke Death Rates, 2018-2020, Adults, Ages 35+, by County” — a U.S. map from the CDC showing county-level stroke mortality rates, adjusted for age, so differences reflect actual risk rather than just older populations in some areas.

Legend (Age-Adjusted Prevalence, %)

Six categories, shaded from lightest to darkest purple, plus gray for missing data:

- Lightest purple/lavender: 3.6–61.4%
- Light purple: 61.5–70.6%
- Medium purple: 70.7–78.4%
- Dark purple: 78.5–89.3%
- Darkest purple (near-black): 89.4–177.5%
- Gray: Insufficient data

Geographic distribution on the continental map

The clearest pattern is a band of high stroke death rates running through the Southeast — Mississippi, Alabama, Georgia, Louisiana, Arkansas, Tennessee, and the Carolinas are dominated by dark and darkest purple counties, forming a dense, largely continuous region often referred to as the “Stroke Belt.” This is the single largest concentration of high-mortality counties on the map.

Beyond the Southeast, darker purple counties also appear more sporadically through Appalachia, parts of the lower Midwest (Missouri, Kentucky, Oklahoma), and scattered rural counties in the Great Plains and West (including patches in Washington, Oregon, Idaho, and Nevada).

In contrast, the lightest shades cluster heavily in the Upper Midwest and Northern Plains — Minnesota, Wisconsin, the Dakotas, Nebraska, and Colorado show large areas of pale lavender, indicating comparatively low stroke death rates. New England and the Mid-Atlantic (Massachusetts, New Hampshire, Vermont, New York, Pennsylvania) also show mostly lighter shades, though with some pockets of darker purple mixed in.

The rest of the country — the Southwest, much of the West Coast, and the upper Great Lakes — shows a mixed patchwork of light

and medium purple, without one shade clearly dominating.

Inset maps (territories and non-contiguous states)

- Alaska: mostly light-to-medium purple, with a small darker patch in the south-central area.
- Hawaii: shown mostly in light purple.
- Guam: shaded in the darkest purple category, indicating it falls in the highest stroke-mortality range (89.4–177.5%).
- Northern Mariana Islands: also shaded in the darkest purple category, matching Guam's high rate.
- American Samoa: shown in the lightest shade category.
- Puerto Rico: mostly light purple, with one small darker area visible.
- U.S. Virgin Islands: insufficient data available

Insufficient data source and methodology were found on the Centers for Disease Control and Prevention Website.

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12: RELATIONSHIPS, IMMUNITY, AND DISEASE PREVENTION



Figure 12.1: Listen, learn, and love in your relationships. (Brown wooden blocks on white surface; Brett Jordan via Unsplash)

Introduction

Human health is influenced not only by biology but also by the quality of our relationships and daily choices. This chapter explores the connections between emotional intimacy, sexual health, and the body's immune defenses. Students will learn how healthy relationships and responsible sexual decision-making contribute to overall wellness and how the immune system protects the body from harmful pathogens. The chapter also examines sexually transmitted infections (STIs), methods of prevention, and the importance of informed, evidence-based health behaviors in reducing disease risk. By understanding the links between relationships, immunity, and disease prevention, readers can make informed decisions that support lifelong health and well-being.

Learning Objectives

- Compare signs of healthy and unhealthy relationships
- Define the many types of loving relationships.
- Employ effective communication techniques.
- Describe the difference between sex, gender, and sexuality
- Identify the major maternal and newborn complications associated with untreated sexually transmitted infections (STIs) and recommend appropriate prevention and treatment strategies for managing STIs during pregnancy.
- Describe how infectious diseases spread through the chain of infection and analyze how public health measures and vaccinations help break this chain and promote long-term immunity.
- Choose the best type of contraceptive method based on effectiveness against unintended pregnancy and STD transmission.

12.1: Relationships

12.2: Pregnancy, Contraception and Abortion

12.3: Sex, Gender, and Sexuality

12.4: The Immune System

12.5: Sexually Transmitted Infections (STIs) and Diseases (STDs)
12.6: What is the Incidence, Prevalence, and Cost of STIs?
12.7: Pregnancy and STIs
12.8: Common Types of STIs
12.9: Comprehension Check
12.10: Glossary
12.11: References
12.12: Detailed Accessible Description

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12.1: Relationships

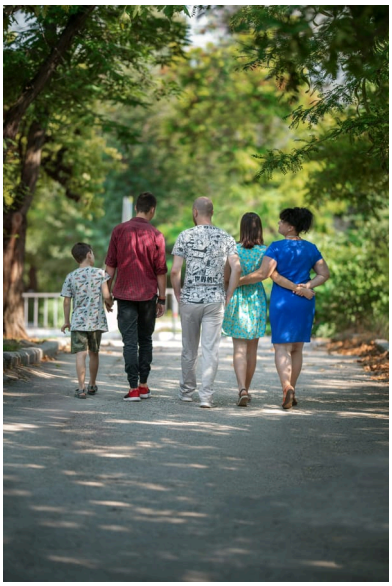


Figure 12.1.1: (Group walking together; Some Tale via unsplash)

Introduction

Human relationships are fundamental to our health, happiness, and sense of purpose. From the friendships we cultivate to the romantic partnerships we build, the connections we form with others shape who we are and how we experience the world. This section explores the nature of relationships and love, drawing on psychological research to help us better understand what makes relationships thrive or struggle. It also examines the communication skills that are essential to building and maintaining healthy connections. Whether you are navigating a new relationship, strengthening an existing one, or reflecting on patterns from your past, the concepts covered here offer practical tools for fostering deeper, more meaningful bonds with the people in your life.

Relationships That Support Health

This section explores the interconnected topics of relationships, sexuality, and contraception, highlighting how they shape overall health and life satisfaction. It begins with social wellness, emphasizing the value of strong relationships, community engagement, and mutual care in promoting longevity and well-being. The discussion then addresses the distinction between sex and gender, explaining how biological traits and social identities shape personal experiences and health outcomes. Finally, the chapter covers pregnancy, contraception, and abortion, highlighting the importance of reproductive choices, access to care, and the role these issues play in both individual and public health.

Social wellness is just one of the dimensions of wellness that impact our overall health and well-being. Maintaining healthy relationships, enjoying being with others, developing friendships and intimate relations, caring about others, letting others care about you, and contributing to your community are all important aspects of developing your social wellness. A meta-analysis of 148 studies indicated that people with adequate social relationships had a reduction in risk of mortality comparable to quitting smoking (Holt-Lunstad et al, 2010) [11], and social relationships have also been shown to prevent and even cure some diseases (Howick et al, 2019). [12] It is well documented that strong social relationships extend life and improve health.

Types of Relationships and Love

It is challenging to define what love is and the varying types of love and relationships we have throughout our lives. A Psychologist named Robert Sternberg has spent his career researching love and developing theories that help increase our understanding of love and relationships.

Triangular Theory of Love

In the 1980's, Sternberg developed the Triangular Theory of Love (Sternberg, n.d.) [18], which describes different types of love and relationships based on a combination of three components (ingredients): passion, intimacy, and commitment. Years later, Sternberg developed the Theory of Love as a Story, which focuses on how a person's beliefs and conceptions about relationships impact the type and success of their relationships. Most recently, Sternberg has blended the two theories into one theory now known as Sternberg's Love-Match Theory.

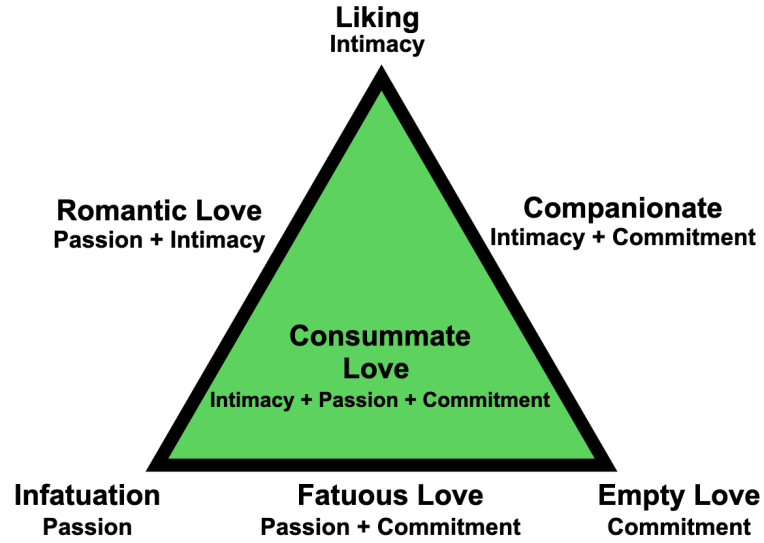


Figure 12.1.2: This diagram is a visual representation of the *Triangular Theory of Love*, which is explained below. Table 12.1.1 lists all of the information shown here. (Public Domain by wikimedia commons)

Sternberg uses intimacy, passion, and commitment to describe different types of love, with each type of love including varying degrees of intimacy, passion, and commitment. The goal for a long-term happy relationship is to have a high level of all three components.

- **Intimacy** refers to feelings of closeness, connectedness, and bondedness. It includes warmth, being comfortable, being open and honest, feeling valued and safe, and feeling that you can count on the person.
- **Passion** typically refers to the drives that lead to romance, physical attraction, or sexual fulfillment. However, passion can also refer to intense feelings of care, such as not being able to live without the person, which could be a passionate need to ensure someone is safe and healthy, like a child or family member.
- **Commitment** is not a feeling, but rather a decision you choose to make throughout your relationship. It is the decision to love a certain person, and in the long term, to one's commitment to maintain that love.

Table 12.1.1*: Types of Love and Relationships Based on Levels of Intimacy, Passion, and Commitment (Sternberg, n.d.)* [18]

Type of Love	Intimacy	Passion	Commitment
Non-Love	No	No	No
Friendship	Yes	No	No
Infatuation	No	Yes	No
Empty Love	No	No	Yes
Romantic Love	Yes	Yes	No
Companionate Love	Yes	No	Yes
Fatuous Love	No	Yes	Yes
Consummate Love	Yes	Yes	Yes

The Triangular Theory of Love can be helpful for evaluating relationships by understanding how love changes based on varying levels of intimacy, passion, and commitment. Couples can better understand their love and avoid challenges in their relationship by working on the areas that need improvement. For example, a married couple who once had high levels of intimacy, passion, and commitment might find that their level of passion has lowered over the years and may choose to focus on bringing passion back to their relationship to support their love. Or, a couple who have romantic love with high levels of intimacy and passion may make the decision to be committed to one another and reach full consummated love.

Reflection: Types of love in your life

- Review the types of love in Table 10.1. Identify people in your life or in your past who you would associate with each type of love. Think about a relationship you've been in...
  - How has the type of love changed over time?
  - How might you use the varying levels of passion, intimacy, and commitment to identify areas of a relationship that may need work?



Figure 12.1.3: (Hands holding paper heart; Kelly Sikkema via unsplash)

Theory of Love as a Story

Although the Triangular Theory of Love provides a helpful structure for understanding varying types of love, it does not account for a person's belief in what love is or should be. Sternberg's Theory of Love as a Story focuses on recognizing and understanding a person's "love story" and how that story impacts their relationships. By understanding our story and the story of potential partners, we can better understand the expectations for the relationship.

A person's love story is unconsciously developed throughout their life by the relationships they see in real life as well as through the media. Your love story helps to explain what you are seeking in loving relationships and how that relationship fulfills your needs and wants. Although there are infinite story possibilities, based on years of research, Sternberg identified 26 types of love stories, including the garden story, business story, sewing story, horror story, sacrifice story, art story, and game story (Sternberg, 2022). [19]

Each type of story describes the relationship dynamics that are commonly at play. For example, those with a Business Story of relationships view the relationship as a business proposition or transaction and are looking for a business partner who will keep life organized and focused on important things like the economy, money, and social status. However, persons with a Garden Story of relationships view the relationship as something that will be successful as long as you take care of it and nurture it to grow strong, so for these persons, it is important to take care of each other and take care of their relationship (Sternberg et al, 2001). [20]

Research indicates that similar or complementary love stories lead to more successful relationships. Similar love stories mean each person brings similar expectations to the relationship. With this understanding, it may be helpful to more fully understand your own love story and also to recognize and understand the love story of your partner. Once we recognize and understand our own love story, we can begin to ask ourselves if we like the story, if the story has been working for us, or if we would like to change our story.

Challenge: Love stories and movies

Sternberg describes 26 types of love stories and explains that we see these love stories in various media throughout our lives.

Review the 26 types of love stories and try to associate a type of love story with a relationship as depicted in a movie you've watched or a book you've read (Sternberg, 2022). [19]

- In what ways were you able to identify the type of love story each person brought to the relationship?
- Did both people in the relationship bring a similar love story to the relationship?
- Were you able to identify relationships where two people brought different love stories or expectations to the relationship?
  - Did it cause a conflict?

Healthy vs. Unhealthy Relationships

We know relationships are important to our health and well-being; however, not all relationships are good for us. It is important to understand the signs and characteristics of healthy and unhealthy relationships.

In a healthy relationship, the couple believes in non-violent conflict resolution, where they can talk honestly, agree to disagree, and make decisions and compromises together. They communicate effectively, ensuring they are listening to each other without judgment, and communicate respectfully, showing each person is valued and loved. They recognize that each person is a unique individual and respect their right to autonomy to be able to enjoy time apart with friends and activities they enjoy. Their relationship is based on trust, which allows them to feel comfortable being themselves and feel unconditionally supported. Lastly, they have fun together and have more good times than bad.

Unhealthy relationships might focus on only one person while disregarding the other. One or both of the people in the relationship might drop friends and family or activities they enjoy. They might feel pressured or controlled in the relationship, or often feel sad, scared, or lonely when together. When a relationship has more bad times than good times, this can be a sign that the relationship is unhealthy.

Table 12.1.2: Characteristics of Healthy and Unhealthy Relationships (Youth.gov, n.d.) [27]

Healthy Relationships	Unhealthy Relationships
• **Mutual respect.** Respect means that each person values who the other is and understands the other person's boundaries. • **Trust**. Partners should place trust in each other and give each other the benefit of the doubt. • **Honesty.** Honesty builds trust and strengthens the relationship. • **Compromise.** In a dating relationship, each partner does not always get his or her way. Each should acknowledge different points of view and be willing to give and take. • **Individuality**. Neither partner should have to compromise who he/she is, and his/her identity should not be based on a partner's. Each should continue seeing his or her friends and doing the things he/she loves. Each should be supportive of his/her partner wanting to pursue new hobbies or make new friends. • **Good communication.** Each partner should speak honestly and openly to avoid miscommunication. If one person needs to sort out his or her feelings first, the other partner should respect those wishes and wait until he or she is ready to talk. • **Anger control.** We all get angry, but how we express it can affect our relationships with others. Anger can be handled in healthy ways, such as taking a deep breath, counting to ten, or talking it out. • **Fighting fair.** Everyone argues at some point, but those who are fair, stick to the subject, and avoid insults are more likely to come up with a possible solution. Partners should take a short break away from each other if the discussion gets too heated. • **Problem solving**. Dating partners can learn to solve problems and identify new solutions by breaking a problem into small parts or by talking through the situation. • **Understanding.** Each partner should take time to understand what the other might be feeling. • **Self-confidence.** When dating partners have confidence in themselves, it can help their relationships with others. It shows that they are calm and comfortable enough to allow others to express their opinions without forcing their own opinions on them. • **Being a role model.** By embodying what respect means, partners can inspire each other, friends, and family to also behave in a respectful way. • **Healthy sexual relationship.** Dating partners engage in a sexual relationship that both are comfortable with, and neither partner feels pressured or forced to engage in sexual activity that is outside his or her comfort zone or without consent.	• **Control.** One dating partner makes all the decisions and tells the other what to do, what to wear, or who to spend time with. He or she is unreasonably jealous and/or tries to isolate the other partner from his or her friends and family. • **Hostility.** One dating partner picks a fight with or antagonizes the other dating partner. This may lead to one dating partner changing his or her behavior in order to avoid upsetting the other. • **Dishonesty.** One dating partner lies to or keeps information from the other. One dating partner steals from the other. • **Disrespect.** One dating partner makes fun of the opinions and interests of the other partner or destroys something that belongs to the partner. • **Dependence**. One dating partner feels that he or she "cannot live without" the other. He or she may threaten to do something drastic if the relationship ends. • **Intimidation.** One dating partner tries to control aspects of the other's life by making the other partner fearful or timid. One dating partner may attempt to keep his or her partner from friends and family or threaten violence or a break-up. • **Physical violence.** One partner uses force to get his or her way (such as hitting, slapping, grabbing, or shoving). • **Sexual violence**. One dating partner pressures or forces the other into sexual activity against his or her will or without consent.

Communication

Being able to effectively communicate is an important skill for successful relationships.

Three keys to effective communication are:

1. **Be an active listener**
   - Actively listening means listening without judging and with an openness to want to understand what you are hearing.
2. **Communicate clearly**
   - When developing either written or verbal communication, it is important to take into consideration your audience, their cultures, and their experiences. Communication takes many skills; it is not just about listening and speaking, but also takes into consideration your thoughts and feelings throughout the exchange and how the setting or type of communication impacts the message. When communicating verbally or through written text, it is important to ensure your communication is clear and not too complex or lengthy.

3. **Understand body language**
   - Non-verbal clues play a large role in the communication process. Non-verbal feedback may be positive, such as nodding the head, maintaining eye contact, and leaning in. Non-verbal feedback can also seem to show you are uninterested, such as looking away, turning your body away, or rolling your eyes.



Figure 12.1.4: Sometimes it's not what you say, it's how you say it. (Wall with a phrase ; Andrew Valdivia via unsplash)

"I" Statements vs. "You" Statements

"I" statements can help you focus on and be clear about your own thoughts and feelings, and what it is that you want or need. They may also involve an acknowledgement of the thoughts/feelings/goals of the other person.

The real focus in "I" statements is on the "I feel," "I want," or "I think" part of the statement. Identifying your thoughts, feelings, needs, and wants related to a situation will help you to avoid blaming someone else or getting caught up in the emotion of the moment.

"You" statements, on the other hand, tend to place blame or criticize the other person. This typically puts the other person on the defensive and does not encourage open communication.

For example, saying "I feel worried when you are running late to meet me for dinner and don't call to let me know" (I statement) vs. "You are always running late, and never bother to let me know" (You statement) will likely result in two very different reactions and conversations! The first statement simply expresses how the person is feeling, whereas the second statement sets a critical and accusatory tone.

Be Assertive

Assertiveness is an honest and appropriate expression of your feelings, thoughts, wants, and needs. Acting in an assertive way helps you to stand up for your rights in a respectful manner. It is a way to communicate what you believe, what you want and need, and what is important to you. Assertiveness can sometimes be compared to, or confused with, being aggressive; however, aggressive behavior often means standing up for yourself in ways that violate the rights of others and can be demanding, hostile, and blaming.

People often associate the concept of assertiveness with standing up for their rights when they feel that someone has taken advantage of them in a negative way. However, it is also important to recognize that being more assertive can help you to communicate in a positive way in your relationships, which helps to promote mutual respect. Non-Assertive behavior is often submissive, inhibited, passive, and self-denying.

Assertiveness can help you:

- Speak up when you have a question or concern,
- Say “no” when you don’t want to do something, and
- Express thoughts or feelings

Communicating assertively does not guarantee that you will get what you want or need. However, you will have the satisfaction of expressing yourself in a positive, self-advocating way. You will probably feel better about yourself and your communication with others. And, you will increase the probability of getting what you need or want, while also respecting the wants or needs of others.

What keeps people from speaking up assertively?

- Not being clear about what they want and need
- Fear of displeasing others and of not being liked
- Not believing they have the right to be assertive
- Lacking the skills to effectively express themselves

To become more skilled in communicating assertively, it is important to practice. You won’t learn how to become a more assertive person just by reading one book or attending one workshop. You can practice with your friends and family. Let them know what you are doing first! Ask for help/feedback on how you’re doing.

- Start Gradually
  - In the beginning, don’t try changing your behavior in the most complex or difficult situations. Practice first in the least risky ones.
  - Some examples of starting gradually include:
    - Returning a purchased item (that you are not satisfied with) to a store for a refund
    - Asking your partner/roommate/kids to help empty the dishwasher or take out the garbage
    - Suggesting a movie that you would like to watch for an upcoming movie night
  - If you start small to enhance your chances of success, you will experience how it feels to express yourself assertively, and it will be easier to move on to more challenging situations.
- Keep in mind that no one can read your mind– focus on expressing and communicating what is important to you.

Key Points

- Social wellness is essential—strong relationships improve overall health and longevity, similar in effect to quitting smoking.
- Sternberg’s Triangular Theory of Love identifies intimacy, passion, and commitment as the three core components of love.
- Types of love vary depending on which components are present, from friendship to consummate love.
- Love as a Story theory highlights how personal and cultural narratives shape relationship expectations.
- Healthy relationships are built on respect, trust, honesty, communication, and individuality.
- Unhealthy relationships often involve control, hostility, dishonesty, disrespect, or violence.
- Effective communication requires active listening, clear expression, and awareness of nonverbal cues.
- “I” statements reduce defensiveness and foster openness, while “You” statements often sound accusatory.
- Assertiveness means expressing needs and boundaries respectfully, without aggression or passivity.
- Practicing communication skills—such as role-play or gradual assertiveness—builds confidence and strengthens relationships.

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12.2: Pregnancy, Contraception and Abortion



Figure 12.2.1: A baby announcement photo featuring the mother's sonogram images. (Sonogram announcement; Brooke Balentine via Upsplash)

Introduction

Pregnancy begins when a sperm fertilizes an egg, but even with many forms of contraception available, unintended pregnancies still happen. In these cases, abortion has long been part of reproductive healthcare. For nearly 50 years, abortion was protected under Roe v. Wade (1973), but in 2022, the Supreme Court overturned that decision, leaving each state to set its own laws. Today, access to abortion varies widely across the U.S., shaping health outcomes and creating new challenges, especially for people with fewer healthcare resources.

Pregnancy

Pregnancy is the term used to describe the period in which a fetus develops inside a womb or uterus. Pregnancy usually lasts about 40 weeks, or just over 9 months, as measured from the last menstrual period. Health care providers refer to three segments of pregnancy, called trimesters.

Pregnancy begins when a male's sperm fertilizes a female's egg. When fertilization occurs, it is called conception. On average, females release one egg each month, which is called ovulation. Thus, for pregnancy to occur, sperm only have a few days each month where it can meet the egg and attempt to fertilize it. It is important to understand a female's menstrual cycle to understand the days when pregnancy is most likely to occur.

It is very important to note that many women have irregular cycle lengths, might ovulate more than once in a month, and might ovulate more than one egg at a time. The fertility cycle is not an exact science.

The following description of the fertility cycle is for an average cycle of 28 days.

- Day 1: The first day of menstruation, or period. Periods typically last between 2 and 7 days.
- Days 1-7: Menstruation
- Sperm can remain alive and viable in the female's body up to 5 days after sexual intercourse. So, it’s possible to have intercourse up to 5 days before ovulation and get pregnant as a result.
- Days 12-16: The egg is typically released, called Ovulation, around day 14 of the cycle. It is best to estimate the release between days 12 and 16.

- Days 12-17: Once an egg is released from the ovaries, its life span is very short. Conception can only occur if the egg is fertilized 12 to 24 hours after the time of actual ovulation.

These biological realities mean the actual period of viable fertility can last anywhere from 5 to 8 days. In general, you're most fertile during the following times:

- The 5 days before ovulation
- The day of ovulation
- Within 12 to 24 hours after ovulation

Question

- Why is the fertile window typically considered to last 5–8 days during a woman's menstrual cycle, and how do sperm survival and egg lifespan contribute to this window?
- How might irregular menstrual cycles affect a person's ability to predict ovulation and their chances of conception?

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 (STDs); although all contraceptive methods are intended to reduce unwanted pregnancy, not all of them also protect against STDs. 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 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

Sexual partners need to discuss contraceptive options, asking questions such as:

- Does either partner have allergies, such as a latex allergy?
- Are the partners concerned about transmission of sexually transmitted diseases?
- Can females 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 STDs need to choose contraceptive options that reduce the transmission of STDs, which means choosing to use either a male condom or a 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 STDs. Couples who are in a long-term committed relationship and are not concerned about STDs 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, and fertility awareness methods.

Surgical Method (Permanent Option)

Permanent methods of birth control 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 releases 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 trick the woman's body into thinking she is pregnant, thus the egg is not released each month.

Barrier Method (Reversible)

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)

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.



Figure 12.2.2: There are many methods available to avoid unwanted pregnancy. (Anti-pregnancy pills and condoms; Reproductive Health Supplies Coalition via Upsplash)

Table 12.2.1: Type, Effectiveness, Risk, and Use of Common Contraceptive Methods

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
Abstinence (no sexual contact)	Natural- reversible	Unknown (0 for perfect use)	Yes	No medical side
Female sterilization (tubal ligation, “getting your tubes tied”)	Surgical- permanent	Less than 1%	No	Pain, bleeding, r
Male sterilization (vasectomy)	Surgical- permanent	Less than 1%	No	Pain, bleeding, r

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
Implantable rod (Implanon®, Nexplanon®)	Hormonal- reversible	Less than 1%	No	Headache, irregu include difficulty
Copper intrauterine device (IUD) (ParaGard®)	Nonhormonal- reversible	Less than 1%	No	Cramps for a few and heavier peri disease and the the uterus.
Hormonal intrauterine devices (IUDs) (Liletta, Mirena®, and Skyla®)	Hormonal- reversible	Less than 1%	No	Irregular periods serious risks inc from the uterus
Shot/injection (Depo-Provera®)	Hormonal- reversible	4-6%	No	Bleeding betwee Weight gain Changes in moo Sore breasts Headaches Bone loss with lo this type of birth

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
Oral contraceptives, combination hormones (“the pill” or “mini-pill))	Hormonal- reversible	7-9%	No	Headache, nause weight gain, and blood clots, strol older than 35
Skin patch (Xulane®)	Hormonal- reversible	7-9% May be less effective in women weighing 198 pounds or more	No	Skin irritation, h in mood, weight include blood cl women older tha
Vaginal ring (NuvaRing®)	Hormonal- reversible	7-9%	No	Vaginal irritation period, changes serious risks inc smokers and wo

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
Diaphragm with spermicide (Koromex®, Ortho-Diaphragm®)	Barrier- reversible	12%	No	Irritation, allergi Rarely, toxic sho Using a spermic
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, allergi Rarely, toxic sho Using a spermic
Cervical cap with spermicide (FemCap®)	Barrier- reversible	17-29%	No	Irritation, allergi Rarely, toxic sho Using a spermic

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
Male condom	Barrier- reversible	13-18%	Yes	A condom may t condoms
Female condom (“internal condom”)	Barrier- reversible	21	Yes	A condom may t

Name(s)	Type	Percentage of unwanted pregnancy within the first year of typical use	Protect against STDs?	Side effects an *These are not or nurse for mo
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 re pregnancy.
Fertility Awareness Method: Calendar, temperature, or rhythm method	Natural- reversible	24	No	Can be hard to k having sex or us
Spermicide alone	Barrier- reversible	28 Works best if used along with a barrier method, such as a diaphragm	No	Irritation, allergi Using a spermic

Question

- Which contraceptive methods both prevent pregnancy and reduce the risk of sexually transmitted diseases?
- Why is this distinction important?

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," and thus voted to reverse its 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 before 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 occurred before 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 was very likely dramatically different. The rate of complications 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 (Kortsmit et al, 2021). [14] 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 a 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 (Upadhyay et al, 2015). [21] 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 (White et al, 2015). [22]

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.

Key Points

- Pregnancy lasts about 40 weeks, measured from the last menstrual period, and is divided into three trimesters.
- Fertility and conception depend on ovulation and a short fertile window (about 5–8 days each cycle), influenced by sperm survival and egg viability.
- Contraceptive methods are diverse and include surgical (permanent), hormonal (reversible), barrier (reversible), and fertility awareness methods.
- The effectiveness of contraception differs between "perfect use" and "typical use," and only abstinence is 100% effective.
- STD protection is not provided by most contraceptives—condoms (male and female) are the primary methods that reduce disease transmission.
- Abortion is a medical option to end a pregnancy; it is safe and common when legally accessible. The U.S. legal landscape has shifted dramatically since Roe v. Wade was overturned in 2022, leaving abortion rights up to individual states.

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12.3: Sex, Gender, and Sexuality



Figure 12.3.1: These pride buttons feature symbols and flag designs that represent diverse gender identities (male, female, nonbinary, transgender, genderqueer, and more), celebrating inclusivity and LGBTQ+ pride. (Gender buttons; Marek Studzinski via Unsplash)

Introduction

Understanding sex and gender is an important step toward greater self-awareness and empathy for others. While these terms are often used interchangeably in everyday conversation, they refer to distinct aspects of human identity, one rooted in biology, the other shaped by culture and society. Similarly, human sexuality is far more complex than simple categories suggest, encompassing a wide range of attractions, experiences, and identities.

Symbols and Colors

It is important to recognize that colors and symbols do not have a single universal meaning. Instead, they are shaped by community use, historical context, and evolving cultural understanding. Many Pride flags are created by individuals or grassroots communities rather than official organizations, which means that symbolism continues to grow and adapt alongside changing language and identity categories (Wikipedia contributers, 2026). [23] This fluidity reflects a key concept in the study of sex, gender, and sexuality: identity is not static, and the ways we represent identity must remain flexible and inclusive.

For students and practitioners in health and kinesiology, understanding these symbols goes beyond cultural awareness; it connects directly to creating inclusive environments. Recognizing and respecting identity markers can help foster psychological safety, improve communication, and support overall well-being. When individuals feel seen and represented, they are more likely to engage in health-promoting behaviors and participate fully in physical activity settings.

For many people, especially those in the LGBTQ+ community, navigating a world that does not always affirm their identities comes with unique health challenges and social burdens. This section explores these concepts with the goal of building a more complete and compassionate understanding of the diverse ways people experience sex, gender, and sexuality and why that understanding matters for individual and public health alike. Figure 12.3.1 shows a a sampling of pride buttons that feature symbols and flag designs that represent diverse gender identities.

Students who want to explore these ideas further are encouraged to visit resources such as the UC Davis LGBTQIA Resource Center and the University of Colorado Boulder Center for Cultural Connections & Community, both of which provide clear explanations of LGBTQ+ identities, symbols, and pride flag meanings.

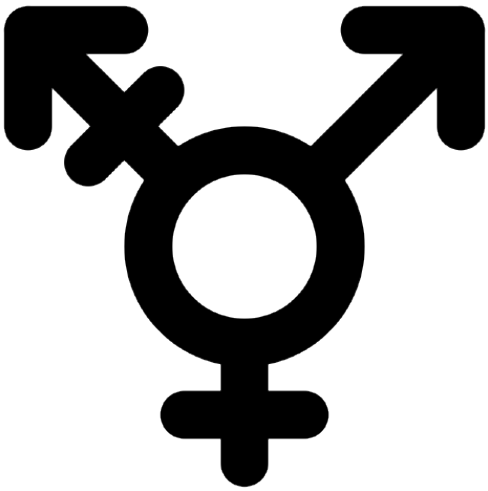
Symbols

Visual symbols and colors play a powerful role in how identity is expressed, recognized, and understood. Within the LGBTQ+ community, these elements are not random or purely decorative; they are intentionally designed to communicate meaning, history, and belonging. Pride flags, in particular, function as visual language systems, allowing individuals to represent aspects of their identity in ways that are immediate, visible, and widely understood.

Table 12.3.1: presents several commonly recognized gender-related identities and representations used in health, education, scientific, and inclusive community settings. While meanings and interpretations may vary slightly across cultures and communities, these representations help support communication, identity recognition, and inclusivity. Understanding their use can help promote greater awareness, respect, and cultural competence in health and wellness environments.

Table 12.3.1: Symbols of LGBTQ+

Symbol	Name	Meaning	Contex/Use
 Figure 12.3.2: (Public Domain via Wikimedia Commons)	Male symbol	Represents male gender identity	Commonly used in health, science, and demographic contexts to represent male identity
 Figure 12.3.3: (Public Domain via Wikimedia Commons)	Female symbol	Represents female gender identity	Commonly used in health, science, and demographic contexts to represent female identity

Symbol	Name	Meaning	Contex/Use
 Figure 12.3.4: (Public Domain via Wikimedia commons)	Transgender symbol	Represents gender diversity beyond male and female	Used in inclusive health, education, and LGBTQ+ contexts to represent transgender and gender-diverse identities

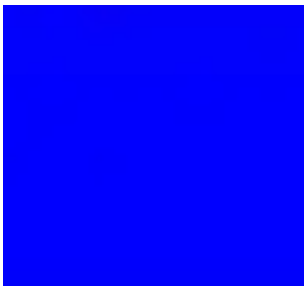
Symbol	Name	Meaning	Contex/Use
 Figure 12.3.5: Nonbinary (Creative Commons via Wikimedia Commons)  Figure 12.3.6: Intersex (Creative Commons via Wikimedia Commons)	Nonbinary / Intersex variations	Represents identities outside the male–female binary	Used in inclusive and educational contexts to represent nonbinary, intersex, and diverse gender identities

Pride Color Meanings

Table 12.3.2: highlights common colors used in Pride flags and the meanings often associated with them. While meanings may vary slightly across different flags and communities, many colors reflect themes such as life, healing, love, resilience, diversity, and inclusion. Learning about these meanings can help build greater understanding, respect, and awareness of human diversity.

Table 12.3.2: Colors of LGBTQ+

Color	Meaning	Context/Use
	Life	Represents vitality and the foundation of human experience
	Healing	Reflects recovery, resilience, and well-being
	Sunlight	Symbolizes positivity, energy, and hope

Color	Meaning	Context/Use
	Nature	Represents growth, connection, and natural diversity
	Harmony/Serenity	Reflects peace, balance, and stability
	Spirit	Represents inner strength, identity, and community

Color	Meaning	Context/Use
	Sex, sexuality, desire	Symbolized sexuality as a natural and affirming part of human identity, not something to be hidden or stigmatized.
	Black symbolizes remembrance, resilience, and strength Brown represents LGBTQ+ people of color who have been underrepresented	Represent People of Color and the HIV/AIDS community

Common Pride Flags and Their Meanings

The most widely recognized example is the rainbow Pride flag, first created in 1979 by artist and activist Gilbert Baker. Each color was originally chosen to reflect a specific aspect of human experience: life, healing, sunlight, nature, serenity, and spirit, among others (Human Rights Campaign, n.d.). [13] Over time, the flag evolved into a simplified six-color version that remains globally recognized today. More importantly, the rainbow itself symbolizes diversity, representing the wide spectrum of human identities, experiences, and expressions within the LGBTQ+ community (Wikimedia contributers, 2026). [25]



Figure 12.3.7: Original 8-Stripe Rainbow Pride Flag/Gilbert Baker Pride Flag. (Public Domain via Wikimedia Commons)

Original 8-Stripe Rainbow Pride Flag/Gilbert Baker Pride Flag

Designed by San Francisco artist and activist Gilbert Baker in 1978 at the request of Harvey Milk for the San Francisco Gay Freedom Day Parade, with the first flags hand-dyed and stitched by Baker and volunteers. Created as a unifying symbol of pride and liberation for gay and lesbian communities, meant to replace the pink triangle (a Nazi persecution symbol) with an affirmative, hopeful emblem. Figure 12.3.7 is a flag composed of horizontal stripes in colors arranged from top to bottom: hot pink, red, orange, yellow, green, light blue, indigo, and violet. Each stripe is of equal width, and the colors are vividly displayed, creating a bold and bright pattern.

- Hot pink- sex/sexuality.
- Red– life.
- Orange– healing.
- Yellow– sunlight.
- Green– nature.
- Turquoise– magic/art.
- Indigo– serenity/harmony.
- Violet– spirit.

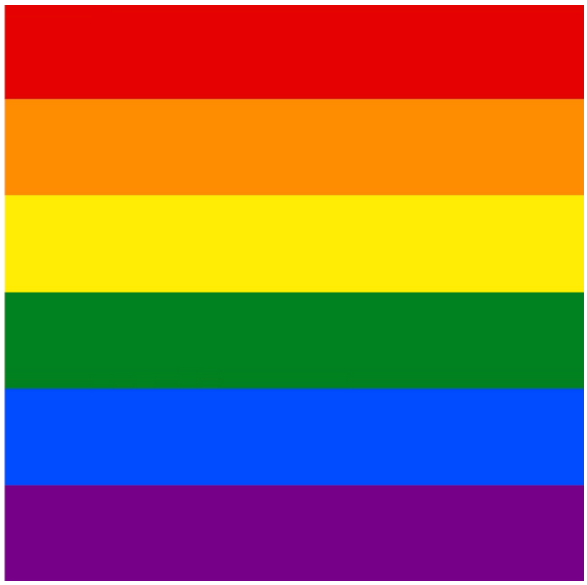


Figure 12.3.8: Rainbow Pride Flag. Public Domain; Guanaco via Wikimedia Commons)

Rainbow Pride Flag

Evolved from Baker's 1978 design; by 1979–1980 the flag was simplified for mass production, dropping hot pink due to fabric availability and merging or replacing turquoise/indigo with a single blue stripe, resulting in the now-standard six-color version. Serves as the broad symbol for the LGBTQ+ community, emphasizing diversity and unity across sexual orientations and gender identities. Figure 12.3.8 depicts the Rainbow Pride Flag, consisting of six horizontal stripes. From top to bottom, the colors are red, orange, yellow, green, blue, and purple. Each stripe is of equal width, creating a uniform and symmetrical appearance. The flag is often associated with LGBTQ+ pride and diversity.

- Red– life.
- Orange– healing.
- Yellow– sunlight.
- Green– nature.
- Blue– harmony/peace.
- Violet– spirit.



Figure 12.3.9: Philadelphia Pride Flag. (Public Domain via Wikimedia Commons)

Philadelphia Pride Flag

Introduced in 2017 as part of the “More Color More Pride” campaign created by the agency Tierney in partnership with Philadelphia’s Office of LGBT Affairs; first raised at Philadelphia City Hall to highlight racism within local LGBTQ+ spaces and to affirm queer and trans people of color. Introduced in 2017 as part of the “More Color More Pride” campaign created by the agency Tierney in partnership with Philadelphia’s Office of LGBT Affairs; first raised at Philadelphia City Hall to highlight racism within local LGBTQ+ spaces and to affirm queer and trans people of color. Keeps the six-stripe rainbow as a base while explicitly centering racial inclusion and the experiences of Black and Brown LGBTQ+ people, using the flag as a conversation starter about racism and intersectionality in the community. Figure 12.3.9 is a version of the LGBTQ+ pride flag featuring eight horizontal stripes. From top to bottom, the colors are black, brown, red, orange, yellow, green, blue, and purple. Each stripe is of equal width, stretching across the entire image, representing diversity and inclusivity within the community.

- Black– Black LGBTQ+ communities; also broadly associated with confronting racism.
- Brown– Brown LGBTQ+ communities and other people of color.
- Red– life.
- Orange– healing.
- Yellow– sunlight.
- Green– nature.
- Blue– harmony.
- Purple/violet– spirit.

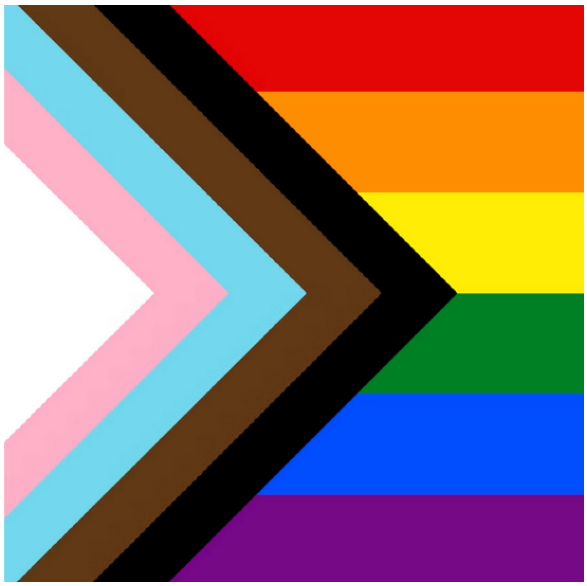


Figure 12.3.10: Progress Pride Flag. (Public Domain via Wikimedia)

Progress Pride Flag

Designed in 2018 by graphic designer Daniel Quasar as a redesign of the rainbow flag that incorporates elements of the Philadelphia flag and the transgender flag; Quasar arranged the additional stripes in a chevron pointing right to symbolize forward movement and the need for ongoing progress. Emphasizes inclusion and progress by visually prioritizing marginalized groups—transgender people, people of color, and those affected by HIV/AIDS—within the broader LGBTQ+ community. Figure 12.3.10 is a representation of the Progress Pride Flag. On the right half of the image are six horizontal stripes in the colors red, orange, yellow, green, blue, and purple, starting from the top (Wikimedia contributers, 2026). [24]

- On the left side, a chevron pattern points right, comprising five stripes in different colors. From the outside to the inside, the colors are white, pink, light blue, brown, and black. The chevron overlays the left side of the horizontal stripes.
- Traditional rainbow section (background): red, orange, yellow, green, blue, violet retain their meanings of life, healing, sunlight, nature, harmony/peace, and spirit.
- Light blue, pink, white- transgender and non-binary people, drawing directly from the transgender pride flag.

- Brown– people of color and racial justice.
- Black– marginalized communities of color, people living with HIV/AIDS, and remembrance of those lost to the epidemic and related stigma.
- Arrow/chevron shape – points forward to show movement toward greater inclusivity while overlapping the rainbow to acknowledge work still to be done.



Figure 12.3.11: Transgender Pride Flag. (Public Domain via Wikimedia Commons)

Transgender Pride Flag

Created by trans activist Monica Helms in 1999; first flown at a Pride parade in Phoenix, Arizona, in 2000, and later donated in its original form to the Smithsonian's National Museum of American History. Represents transgender people and the diversity of gender identities under the trans umbrella, serving as a symbol for rights, visibility, and community. Figure 12.3.11 is a flag consisting of five horizontal stripes. From top to bottom, the colors are light blue, pink, white, pink, and light blue. The stripes are of equal width and run parallel across the flag.

- Light blue – traditional color associated with baby boys.
- Pink – traditional color associated with baby girls.
- White (center stripe) – people who are intersex, transitioning, non-binary, or whose gender is neutral or undefined.
- The pattern is symmetrical so that the flag appears "correct" no matter which way it is flown, symbolizing that there is no wrong way to be or become your gender.

More to Explore

The following websites are provided as starting points for students to explore additional information related to sex, gender, and sexuality, including LGBTQ+ symbols, Pride flags, and color meanings. These resources encourage students to deepen their understanding of identity, inclusion, and the diverse ways people express and experience themselves and their communities.

University of Colorado Boulder Center for Cultural Connections and Community

The Human Rights Campaign

Pride

Rainbow Flag (LGBTQ)

BU Today/Boston University

The Ongoing Evolution of LGBTQ+ Representation

As understanding of identity has expanded, so too have the symbols used to represent it. Newer Pride flag designs build upon the original rainbow to highlight inclusion and visibility for groups that have historically been underrepresented. For example, the Progress Pride flag incorporates black and brown stripes to recognize LGBTQ+ people of color and those affected by HIV/AIDS, along with light blue, pink, and white stripes representing transgender and gender-diverse individuals (Women's College Hospital, 2023). [26] The forward-pointing arrow design emphasizes that progress toward equality and inclusion is ongoing. Figure 12.3.1 , at the beginning of the chapter, is a small representation of the use of symbols, colors, and flags to represent diverse gender identities.

In addition to flags, specific symbols also carry meaning. The transgender symbol (⚧) combines traditional male and female symbols with additional elements to represent gender diversity. The lambda (λ), adopted in the 1970s, has been used as a symbol of unity and liberation. The pink triangle, once used to mark individuals persecuted during the Holocaust, has been reclaimed as a symbol of resilience, remembrance, and resistance. Each of these symbols reflects how communities can transform meaning over time—turning markers of oppression into sources of strength and identity.

This is only a sampling of the many colors, symbols, and flags that exist across the LGBTQ+ spectrum, offered here to introduce this important content and give students an entry point into a much larger conversation. These pride flags show that our symbols are not fixed; they grow and change as our communities do. Each new stripe, color, or design, whether it is the added black and brown stripes on the Philadelphia Pride Flag, the trans colors in the Progress Pride Flag, or the original meanings in Gilbert Baker's rainbow, reflects an evolving effort to recognize more people and more experiences. As conversations about race, gender identity, and inclusion deepen, the flags adapt, reminding us that LGBTQ+ history is still being written and that our visual language of pride will continue to expand with it.

Exploring Sex and Gender

When filling out official documents, you are often asked to provide your name, birthdate, 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.

Sex

"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 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.

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: Cisgender versus Transgender

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 prefix "trans-" comes from Latin, meaning "across from" or "on the other side of". In contrast, the prefix "cis-" means "on this side of".

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.

Question

- Think of an example from your own life or media where sex and gender did not align.
  - How did culture or society respond?
- Compare how gender roles (such as clothing, work, or family expectations) differ across two cultures you are familiar with.

Sexuality

Human sexuality refers to a person's sexual interest in and attraction to others, as well as their capacity to have erotic experiences and responses. A person's sexual orientation is their emotional and sexual attraction to particular sexes or genders, which often shapes their sexuality. Sexuality may be experienced and expressed in a variety of ways, including thoughts, fantasies, desires, beliefs, attitudes, values, behaviors, practices, roles, and relationships. These may manifest themselves in biological, physical, emotional, social, or spiritual aspects. The biological and physical aspects of sexuality largely concern the human reproductive functions, including the human sexual-response cycle and the basic biological drive that exists in all species. Emotional aspects of sexuality include bonds between individuals that are expressed through profound feelings or physical manifestations of love, trust, and care. Social aspects deal with the effects of human society on one's sexuality, while spirituality concerns an individual's spiritual connection with others through sexuality.

LGBTQ+ Health

People who are lesbian, gay, bisexual, transgender, queer, and/or questioning (LGBTQ+) 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 United States and the world. The perspectives and needs of LGBTQ+ 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 LGBTQ+ 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 LGBTQ+ community are at increased risk for several 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 LGBTQ+ populations still experience.

LGBTQ+ sexual health and well-being are 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. The incidence of hate crimes and discrimination promulgated through the denial of equal rights contributes to the perpetuation of homophobia as a structural norm.

As a result of cultural and societal discrimination, many LGBTQ+ people suffer an added burden of stress and experience health disparities, such as:

Whether you are gay or straight, you can help reduce homophobia, stigma, and discrimination in your community and decrease the associated negative health effects. Even small things can make a difference, such as accepting and supporting a family member, friend, or co-worker.

Explore More

The following websites are provided as starting points for students to explore additional information, deepen their understanding, and continue learning about LGBTQ+ flags, colors, and representations independently. This is not a comprehensive list, but rather an introduction to a broader and continually evolving area of study and representation.

Center for Cultural Connections and Community

The Human Rights Campaign

Gender Symbols

Pride

Rainbow Flag (LGBTQ)

BU Today/Boston University

Key Points

- Potential difficulties in getting or keeping health insurance, and possible employment instability.
- Limited access to high-quality health care that is responsive to LGBTQ+ health issues.
- Mental health problems and unhealthy coping skills, such as substance abuse, risky sexual behaviors, and suicide attempts.
- Challenges or difficulties with being open about one's sexual orientation can increase stress, limit social support, and negatively affect overall health.
- The effects of homophobia, stigma, and discrimination can be especially hard on adolescents and young adults. In addition to an increased risk of being bullied at school, they are also at risk of being rejected by their families and, as a result, are at increased risk of homelessness.
- Sex and gender are distinct: sex refers to biological traits, while gender refers to social and cultural roles.
- Biological sex exists on a spectrum: about 1–1.7% of people are born intersex, showing that sex is not strictly binary.
- Gender is a social construct shaped by cultural norms and can vary widely across societies.
- Gender identity may align with or differ from sex assigned at birth (cisgender vs. transgender, with many possible identities).
- Sexuality encompasses attraction, desires, behaviors, and relationships, influenced by biological, emotional, social, and spiritual factors.
- LGBTQ+ health disparities are linked not only to behavior but also to stigma, discrimination, and lack of culturally competent health care.

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- 10.2: Sex, Gender, and Sexuality by Kelly Falcone is licensed CC BY-SA 4.0. Original source: https://pressbooks.pub/introtohealth.

12.4: The Immune System



Figure 12.4.1: Washing hands with soap and water is one of the simplest and most effective ways to break the chain of infection. By removing pathogens that may be present on the skin, handwashing reduces the risk of transmitting infectious diseases, including those that can weaken the immune system or be spread through close contact, such as sexually transmitted infections (STIs). Regular hand hygiene is a key public health strategy to support the body's natural defenses and protect both individual and community health. (Hand washing; Kristine Wook via Upsplash)

Introduction-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 (Balloux & van Dorp, 2017). [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, viruses, 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. We are constantly exposed to pathogens. Thankfully, our immune system is in a constant battle working to identify the foreign invader (pathogen) and destroy it. 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).

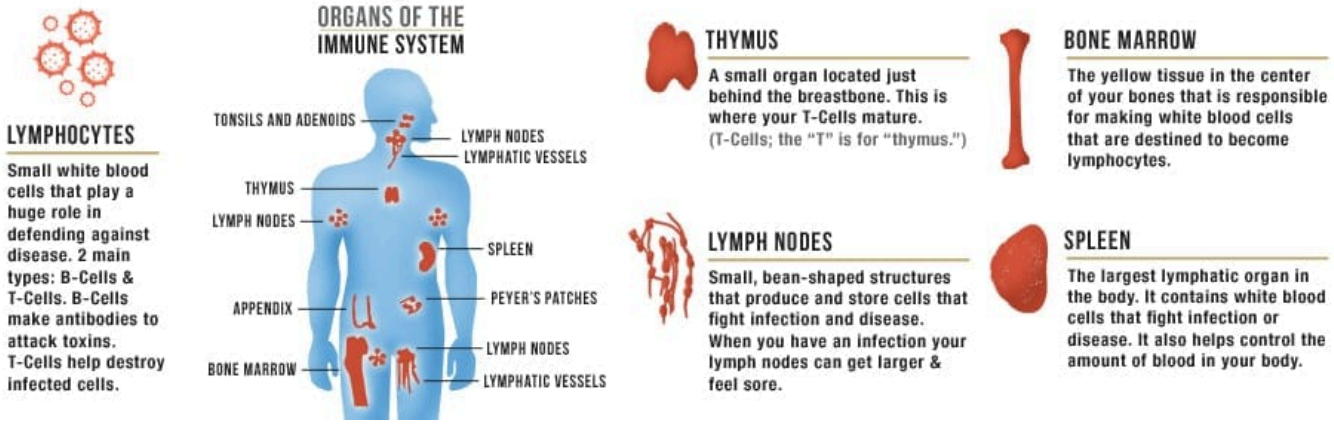


Figure 12.4.2*:* Organs of the Immune System (Public Domain via Wikimedia Commons) Alternative Text Description

Figure 12.4.2 illustrates the major organs and structures of the human immune system and their roles in defending the body against infection and disease. The immune system is composed of specialized cells, tissues, and organs that work together to detect, attack, and eliminate harmful pathogens such as bacteria, viruses, and toxins. The organs of the immune system include tonsils and adenoids, lymph nodes (multiple), lymphatic vessels, spleen, Peyer's Patches, bone marrow, appendix, and the thymus.

Lymphocytes: Small white blood cells that play a huge role in defending against disease. 2 main type" B-Cells & T-Cells. B-Cells make antibodies to attack toxins. T-Cells help destroy infected cells.

Thymus: A small organ located just behind the breastbone. This is where your T-cells mature. (T-Cells; the "T" is for "thymus".)

Lymph Nodes: Small bean-shaped structures that produce and store cells that fight infection and disease. When you have an infection, your lymph nodes can get larger and feel sore.

Bone Marrow: The yellow tissue in the center of your bones that is responsible for making white blood cells that are destined to become lymphocytes.

Spleen: The largest lymphatic organ in the body. It contains white blood cells that fight infection or disease. It also helps control the amount of blood in your body.

Together, these organs form an interconnected defense network. They not only respond to infections but also provide immune memory, allowing the body to respond more rapidly and effectively to pathogens it has encountered before.

Question

- What are pathogens, and which five categories do they fall into?
- How does the immune system distinguish between helpful, harmful, and neutral microorganisms?

Pathogens and Infectious Diseases

The number of viruses and bacteria on Earth is staggering, and they occupy essentially every environment (Piret & Boivin, 2021).[16] 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 as parasites.

Table 12.4.1: 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 their ability to continue to infect hosts. In order to continue to infect humans, the virus has to overcome the human immune system. 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 unexpected 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 12.4.2 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	Wild Rodents' associated fleas	30-50 million
Black Death	1347-1351	Central Asia	Yersinia pestis	Wild 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)	Avian (birds)	50 million
Asian Flu	1957-1958	China	Influenza A (H2N2)	Avian (birds)	>1 million
Hong Kong Flu	1968-1970	China	Influenza A (H3N2)	Avian (birds)	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)	Pigs	148000-249000
Middle East Respiratory Syndrome (MERS)	2015	Middle East	MERS-CoV	Bat, dromedary camels	947
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 variants include the Omicron variant and the Delta variant, with new variants of the virus expected to occur. The COVID-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 (Sampath et al, 2021). [17]

Pandemics: The Chain of Infection

The way in which people become infected with a pathogen is referred to as the Chain of Infection.

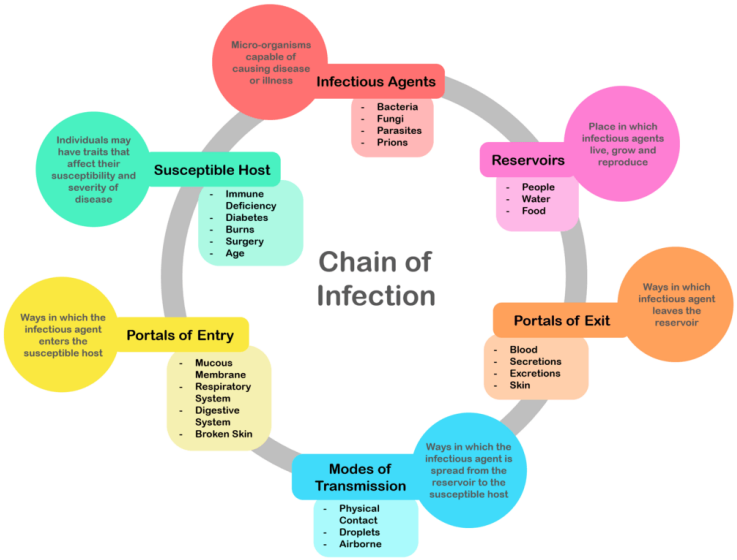


Figure 12.4.3: This chart shows how infections spread from germs to people. The cycle includes the germ (infectious agent), where it lives (reservoir), how it leaves (portal of exit), how it spreads (mode of transmission), how it enters the next person (portal of entry), and who gets sick (susceptible host). Stopping the chain at any step helps prevent disease. (CC BY 4.0; Genieieiop via Wikimedia Commons) Alternative text description.

The chain of infection, Figure 12.4.3, 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, viruses, 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 an inapparent infection who is capable of transmitting the pathogen to others. Asymptomatic, 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, such as 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, flea, or tick.

The infectious agent then needs to find a **"Portal of Entry**" into the new susceptible 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 the 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 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 disinfecting 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.

Question

- What is the difference between an epidemic and a pandemic?
- Where in the “chain of infection” can public health measures be most effective?

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 over time 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 body's physical and chemical barriers, along with white blood cells that are always present in the blood and tissues, ready to destroy 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 both a barrier to 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 defense 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 respond.

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 pathogen. 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 Pattern (PAMPs), the other markers are specific, called an Antigen. Many

pathogens share the same PAMPs; however, they 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.

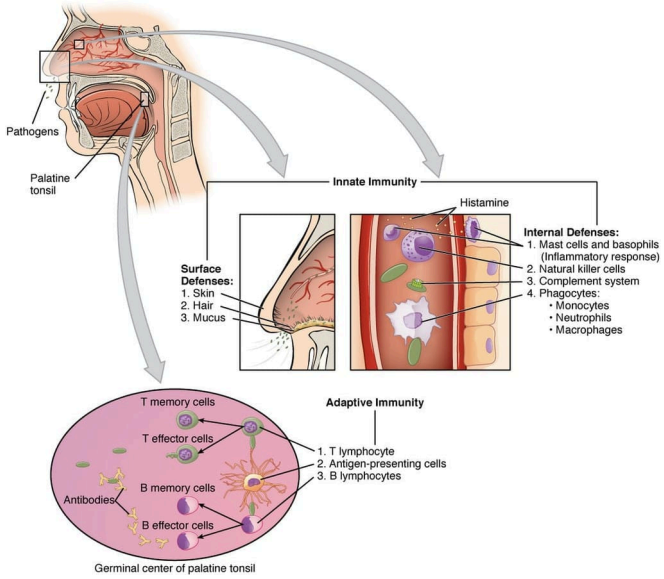


Figure 12.4.4*: Diagram of the Innate and Adaptive Immune System* (Cooperation Between Innate and Immune_Responses; OpenStax College by CC BY 4.0) Detailed Accessible Description

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 12.4.4). 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 matures).

Table 12.4.3*: Types of Immune Cells: Characteristics, Locations, and Images*

Cell type	Characteristics	Location
Mast cell	Dilates blood vessels and induces inflammation through the 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 tissue

Cell type	Characteristics	Location
Macrophage	Phagocytic cell that consumes foreign pathogens and cancer cells. Stimulates the response of other immune cells.	Migrates from blo
Natural killer cell	Kills tumor cells and virus-infected cells.	Circulates in the tissues.
Dendritic cell	Presents antigens on its surface, thereby triggering adaptive immunity.	Present in epithe lung, and tissues Migrates to lymp
Monocyte	Differentiates into macrophages and dendritic cells in response to inflammation.	Stored in the spl vessels to infecte

Cell type	Characteristics	Location
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 blo
Basophil	Responsible for defense against parasites. Releases histamines that cause inflammation and may be responsible for allergic reactions.	Circulates in the tissues.
Eosinophil	Releases toxins that kill bacteria and parasites, but also causes tissue damage.	Circulates in the tissues.

Steps to the Immune System Battle

The steps to the immune system battle are shown in Figure 12.4.5 and are described in detail below.

- The cellular immune response begins when a pathogen gets through the body's physical and chemical barriers.
- If a pathogen gets past the host's 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 illness symptoms.
- 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 helper 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, helping activate the adaptive immune system by presenting their antigen. They also recruit more immune cells.

    - Mast Cells: launch an 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 the inflammatory response.
    - Eosinophils: Kill bacteria and parasites.
- Innate immune cells alert the whole body to a problem by activating the inflammatory response and initiating the adaptive immune system.
- The inflammatory response causes swelling, pain, and a 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 on 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 break down 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 more quickly.
- When the adaptive cells are “trained” 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, making 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 the flu, strep throat, or COVID multiple times.

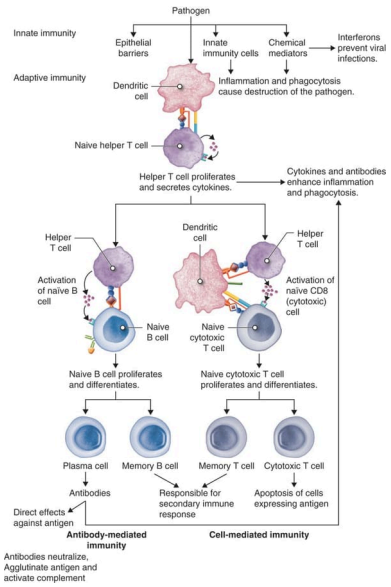


Figure 12.4.5 : Overview of Innate and Adaptive Immunity (Lymph_42 © Open Learning Initiative by CC BY)

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 result is the same: to develop memory cells to acquire immunity against the pathogen.

If the immune system could not 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 12.4.3: Vaccine Types, Characteristics, and Protections from Disease

Vaccine Type	Characteristics
Inactivated vaccines	• Inactivated vaccines use the killed version of the germ that causes a disea • Inactivated vaccines usually don't provide immunity (protection) that's as s you may need several doses over time (booster shots) in order to get ongoi diseases.
Live-attenuated vaccines	• Live vaccines use a weakened (or attenuated) form of the germ that causes • Because these vaccines are so similar to the natural infection that they hel strong and long-lasting immune response. Just 1 or 2 doses of most live va 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 health care provider before receiving them, such as people with weake 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 c with limited access to refrigerators.
Messenger RNA (mRNA) vaccines	• Researchers have been studying and working with mRNA vaccines for deca 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, manufacturing times and, because they do not contain a live virus, no risk c person getting vaccinated.

Vaccine Type	Characteristics
Subunit, recombinant, polysaccharide, and conjugate vaccines	• Subunit, recombinant, polysaccharide, and conjugate vaccines use specific its protein, sugar, or capsid (a casing around the germ). • Because these vaccines use only specific pieces of the germ, they give a ve response that's targeted to key parts of the germ. They can also be used or needs them, including people with weakened immune systems and long-ter • One limitation of these vaccines is that you may need booster shots to get against diseases.
Toxoid vaccines	• Toxoid vaccines use a toxin (harmful product) made by the germ that cause immunity to the parts of the germ that cause a disease instead of the germ immune response is targeted to the toxin instead of the whole germ. Like s vaccines, you may need booster shots to get ongoing protection
Viral vector vaccines	• For decades, scientists have studied viral vector vaccines. Some vaccines r outbreaks have used viral vector technology, and a number of studies have vaccines against other infectious diseases such as Zika, flu, and HIV. Scien technology to make COVID-19 vaccines. • Viral vector vaccines use a modified version of a different virus to deliver pa viruses have been used as vectors, including influenza, vesicular stomatitis and adenovirus, which causes the common cold. Adenovirus is one of the v COVID-19 vaccines being studied in clinical trials.
DNA vaccines	• In development. • Easy and inexpensive to make—and they produce strong, long-term immun
Recombinant vector vaccines (platform-based vaccines)	• In development • They act like natural infections, so they're especially good at teaching the i fight germs.

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 a child, as antibodies move across the placenta before birth. Passive immunity is not long-lasting because the individual does not produce memory cells.

Exercise 12.4.1

- What are two major differences between the innate and adaptive immune systems?
- How do vaccines create long-term immunity?
- What is the difference between active immunity (natural or artificial) and passive immunity?

Key Points

- The immune system protects the body from pathogens (bacteria, viruses, fungi, protozoa, worms) and harmful substances.
- It is made up of cells, tissues, and organs such as the thymus, spleen, lymph nodes, bone marrow, and white blood cells.
- The innate immune system provides rapid, non-specific defense, while the adaptive immune system provides specific, long-term protection through memory cells. Pathogens are found everywhere—in the air, food, water, soil, and living organisms.
- Infectious diseases spread through the chain of infection: infectious agent → reservoir → portal of exit → mode of transmission → portal of entry → susceptible host.
- The immune system fights pathogens through physical barriers (skin, mucus, tears) and immune cells like neutrophils, macrophages, dendritic cells, B-cells, and T-cells.
- Vaccines train the adaptive immune system by creating memory cells, leading to faster, stronger responses upon re-exposure. Pandemics occur when an epidemic spreads globally, such as the 1918 Spanish flu and COVID-19.
- Viruses mutate over time (antigenic drift/shift), making it possible to get sick multiple times from diseases like influenza or COVID.
- Breaking the chain of infection—through hygiene, vaccines, and public health practices—is critical for disease prevention.

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12.5: Sexually Transmitted Infections (STIs) and Diseases (STDs)



Figure 12.5.1: Condom use is a crucial step in reducing the risk of sexually transmitted infections. (Two unopened condoms; Reproductive Health Supplies Coalition via Unsplash)

Introduction

Sexually transmitted infections are one of the most common health concerns facing people today, yet they remain widely misunderstood and, for many, difficult to talk about openly. Because STIs often cause no noticeable symptoms, millions of people carry and unknowingly transmit infections every year. The good news is that most STIs are preventable, many are curable, and all are manageable with the right information and care. This section covers the essential facts about STIs, how they spread, how they are diagnosed, and how they can be prevented and treated, along with an encouraging look at recent trends suggesting that prevention efforts are beginning to make a meaningful difference. Understanding this information is a critical step toward making informed decisions that protect both your own health and the health of your partners.

The Changing Landscape of STIs

For the first time in nearly two decades, U.S. public health officials are reporting some positive news about sexually transmitted infections (STIs). According to recent surveillance data from the Centers for Disease Control and Prevention (CDC), the total number of reported STIs declined by 1.8% between 2022 and 2023, a potential sign that the rapid rise in infections since 2011 may finally be leveling off (Centers for Disease Control and Prevention, 2024). [2]

This modest progress is largely attributed to a 7% decrease in gonorrhea cases, with rates falling among both men and women, especially among women, who saw a 14% reduction. Chlamydia rates remained relatively stable, while syphilis cases increased only slightly, by 1%, after years of double-digit growth. Importantly, cases of primary and secondary syphilis, the most infectious stages of the disease, dropped by 10%, marking the first meaningful decline in over 20 years.

Despite these encouraging signs, the overall burden of STIs remains unacceptably high. In 2023, more than 2.4 million cases of gonorrhea (601,319), syphilis (209,253), and chlamydia (1,648,568) were reported nationwide. Alarmingly, congenital syphilis, the transmission of syphilis from mother to infant, reached its highest level since 1992, with nearly 3,900 cases, including 279 stillbirths and infant deaths.

STIs continue to disproportionately impact certain groups. Almost half (48%) of all reported infections occurred among

adolescents and young adults aged 15–24, while nearly one-third (32%) were among Black persons. Gay and bisexual men also remain at elevated risk, underscoring persistent health disparities that demand targeted prevention and care strategies.

Sexually transmitted infections (STIs), sometimes referred to as sexually transmitted diseases (STDs), are among the most common health concerns worldwide. They are caused by bacteria, viruses, or parasites and are spread primarily through sexual contact involving the vagina, penis, anus, or mouth.
Many infections cause few or no symptoms, meaning individuals may transmit infections without knowing it. However, STIs can have serious and long-lasting consequences, including infertility, pelvic inflammatory disease, pregnancy complications, and increased risk of acquiring HIV. Understanding how these infections spread, their health effects, and how they can be prevented or treated is essential for lifelong health (Centers for Disease Control and Prevention, 2024). [4]

STI or STD: What's the Difference?

- **STI (Sexually Transmitted Infection)**: Refers to the presence of a virus, bacterium, parasite, or fungus in the body. A person can have an STI without symptoms.
- **STD (Sexually Transmitted Disease)**: Refers to the condition that develops when an STI causes noticeable symptoms or complications.

Public health agencies such as the CDC now prefer the term STI because it emphasizes prevention and early treatment, even before disease develops. (Centers for Disease Control and Prevention, 2024). [4]

Causes of STIs

STIs are caused by three main types of organisms:

- Bacteria – Examples: Chlamydia, Gonorrhea, Syphilis
- Viruses – Examples: HIV, Herpes simplex virus, Human papillomavirus (HPV), Hepatitis B, Cytomegalovirus (CMV), Zika
- Parasites – Examples: Trichomonas vaginalis, crab lice, scabies mites

In addition to sexual contact, certain infections can spread through contaminated needles, tattooing or piercing equipment, blood transfusions, or, in some cases, nonsexual close contact (National Institute of Child Health and Human Development, 2025). [15]

How STIs Spread

- Vaginal, anal, or oral sex
- Intimate physical contact (less common)
- Sharing contaminated needles or equipment
- From mother to infant during pregnancy, delivery, or breastfeeding (for some infections like HIV and syphilis) (Centers for Disease Control and Prevention, 2024). [4]

Ejaculation does not need to occur for transmission. Even individuals without symptoms can spread infections.

Signs and Symptoms of STDs/STIs

Not all STIs produce noticeable symptoms. A person may feel ill and notice some of the following signs and symptoms:

- Unusual discharge from the penis or vagina
- Sores or warts on the genital area
- Painful or frequent urination
- Itching and redness in the genital area
- Blisters or sores in or around the mouth
- Abnormal vaginal odor
- Anal itching, soreness, or bleeding
- Abdominal pain

- Fever

Because many infections are asymptomatic, regular testing is essential for anyone sexually active.

Preventing Sexually Transmitted Infections (STIs)

Sexually transmitted infections (STIs) are among the most common health concerns worldwide, yet they are also largely preventable. Safer sex practices, regular testing, and timely treatment are the most effective ways to stop the spread of these infections. Because many STIs cause no noticeable symptoms, individuals may be infected without knowing it, making prevention and testing especially important.

Risk Factors for STIs

Certain behaviors increase the likelihood of contracting or spreading an STI:

- Having anal, vaginal, or oral sex without a condom
- Having multiple sex partners
- Having anonymous sex partners
- Engaging in sex while under the influence of alcohol or drugs, which can reduce judgment and lead to riskier behaviors

Understanding these risk factors helps individuals make more informed decisions about their sexual health.

Prevention Strategies

There are several steps people can take to reduce their risk of infection:

- **Abstinence** - Not having vaginal, anal, or oral sex is the only way to completely avoid STIs.
- **Vaccination** - Vaccines are available for hepatitis B and human papillomavirus (HPV), both of which can cause serious long-term health problems if untreated.
- **Limit Number of Partners -** Reducing your number of sexual partners lowers the overall risk of exposure.
- **Mutually Monogamous Relationships -** Being in a long-term, faithful relationship with a partner who has tested negative for STIs provides significant protection.
- **Condom Use -** Using condoms correctly every time you have vaginal, anal, or oral sex greatly reduces the risk of infection.
- **Routine Testing -** You and your partner should be tested regularly and share results openly. This ensures early detection and treatment, even when no symptoms are present.

Preventing STIs requires a combination of responsible choices, safer sex practices, regular testing, and medical treatment when needed. These steps not only protect individual health but also help stop the wider spread of infections in the community (Centers for Disease Control and Prevention, 2024). [3]

How Do Health Care Providers Diagnose STIs?

Diagnosing sexually transmitted infections (STIs) can be challenging because many infections produce no symptoms, or symptoms may be so mild that people do not realize they are infected. For this reason, health professionals emphasize the importance of regular testing for anyone sexually active. Early diagnosis allows for timely treatment, reduces the chance of long-term complications, and helps prevent transmission to others.

Importance of Communication and Screening

A key step in diagnosis is honest communication with a health care provider. Patients should discuss their sexual history, risk factors, and any symptoms (even if minor) with their provider. Because individuals can carry and spread an infection without knowing it, routine screening is often recommended even in the absence of symptoms.

Diagnostic Methods

- Health care providers use several tools to detect STIs:
- Physical exam: Visible sores, rashes, warts, or unusual discharge may provide immediate clues.
- Microscopic examination and cultures: Samples of fluid or discharge from the vagina, penis, anus, or sores can be collected and examined under a microscope or cultured in a lab to identify bacteria, yeast, or parasites.
- Pap smear and cervical screening: For women, a Pap test can reveal abnormal cell changes linked to human papillomavirus (HPV), which can cause genital warts and cervical cancer.
- Blood tests: Infections such as HIV, syphilis, and hepatitis A, B, or C are often diagnosed using blood samples that detect antibodies or the presence of the virus.

Because no single test covers all STIs, providers often use a combination of these methods depending on the individual's history, symptoms, and risk factors. (Centers for Disease Control and Prevention, 2024). [3]

Partner Notification and Public Health

Since STIs are spread from person to person, health departments may notify individuals if they have been exposed to certain reportable infections. Not every STI is reportable, but for those that are (such as syphilis, gonorrhea, HIV, and chlamydia), public health follow-up helps ensure exposed individuals are tested and treated quickly. This process reduces ongoing transmission in the community.

Because so many STIs are asymptomatic, diagnosis relies heavily on screening and testing rather than symptoms alone. Regular checkups, open communication with healthcare providers, and timely treatment are essential for breaking the cycle of transmission and protecting both individual and public health.

Partner Communication and Safer Sex Conversations

Open, honest communication with sexual partner(s) is one of the most effective ways to reduce the risk of sexually transmitted infections (STIs). While these conversations can feel uncomfortable at first, they are a critical part of making informed, respectful, and healthy decisions. Developing strong communication skills not only protects physical health but also builds trust and mutual understanding within relationships.

Start the Conversation Early
Do not wait until the moment of sexual activity to bring up sexual health. Talking before engaging in sexual behavior allows both partners to think clearly, ask questions, and make informed choices without pressure. Planning creates space for thoughtful decision-making rather than reactive choices.

Be Open and Honest
Honesty is essential. Be clear about your sexual history, including the number of partners you have had and any potential risks. While this may feel vulnerable, transparency helps both partners accurately assess risk and decide on protective measures such as condom use or testing.

Create a Respectful Space
Approach the conversation with understanding and without judgment. A respectful tone encourages openness and reduces defensiveness. Remember that your partner may also feel nervous or unsure. Listening actively and responding with empathy helps build a foundation for ongoing communication, not just a one-time discussion.

Share Important Health Information
If you have a sexually transmitted infection, it is important to inform your partner—even if you are currently receiving treatment or managing the condition. Many STIs can still be transmitted or may require precautions. Sharing this information allows both partners to take appropriate steps to protect their health.

Ask About Testing
A simple but important question is: "When were you last tested for STIs?" This helps clarify potential risk and encourages accountability. In many cases, couples may choose to get tested together, which can reduce anxiety and promote shared responsibility for sexual health (Centers for Disease Control and Prevention, 2024). [9]

Question

- Which two vaccines are recommended to help prevent certain STIs?
- Why is regular STI testing important, even for people who do not have symptoms?

Treatment and Management

- Antibiotics cure bacterial and some parasitic infections.
- Antiviral drugs help control viral STIs by reducing symptoms and lowering transmission risk.
- Partner treatment is essential to prevent reinfection.
- Complete treatment course even if symptoms improve.
- Follow medical advice on when it is safe to resume sexual activity.

For lifelong infections such as HIV, ongoing treatment is necessary to protect both individual and public health.

The CDC credits several recent advances with helping to slow infection rates:

- **Doxycycline post-exposure prophylaxis (doxy PEP):** Taking the antibiotic doxycycline within 72 hours of unprotected sex has been shown to significantly reduce chlamydia, gonorrhea, and syphilis in high-risk groups such as men who have sex with men and transgender women.
- **At-home testing:** Newly authorized self-tests for chlamydia, gonorrhea, and syphilis improve accessibility and early detection.
- **Coordinated national response:** Expanded outreach and prevention programs have begun to address the ongoing syphilis epidemic.

Key Points

- STIs are common and can cause serious health complications if untreated.
- Many infections are asymptomatic—testing and screening are critical.
- Bacterial and parasitic STIs are curable; viral STIs can be managed but not cured.
- Early diagnosis and treatment protect both personal and community health.
- Most STIs do not cause symptoms, so regular testing and open communication with partners are essential for early detection and prevention.
- Practicing safer sex, including correct condom use, vaccination, and limiting partners, greatly reduces the risk of infection, but abstinence is the only way to completely avoid STIs.

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12.6: What is the Incidence, Prevalence, and Cost of STIs?



Figure 12.6.1: (People working in a lab; National Institute of Allergy and Infectious Diseases via Unsplash)

Introduction

Sexually transmitted infections are not just a personal health concern; they represent a significant and costly public health challenge affecting millions of Americans. While individual cases may go unnoticed due to a lack of symptoms, the collective impact of STIs on the healthcare system, the economy, and communities across the country is staggering. Data from the CDC paints a striking picture: roughly one in five Americans had an STI on any given day in 2018, and the financial burden of new infections alone reached nearly $16 billion in direct medical costs. This section takes a closer look at the true scope of STIs in the United States, who is most affected, which infections drive the largest share of cases, and why improving prevention efforts and data collection is essential to turning the tide on one of the nation's most persistent public health challenges.

Understanding the Impact of STIs

A recent CDC analysis provides one of the most comprehensive pictures to date of the impact of sexually transmitted infections (STIs) in the United States. The findings highlight both the widespread nature of these infections and the enormous economic burden they place on the healthcare system.

In 2018, the CDC estimated that about 20% of the U.S. population—approximately one in five people—had an STI on any given day. This means millions of Americans were living with infections such as chlamydia, gonorrhea, syphilis, herpes, human papillomavirus (HPV), hepatitis B, and HIV, many of which were undiagnosed. The data underscore how common STIs are, even among people who may not consider themselves at risk.

The CDC also reported that STIs acquired in 2018 alone are expected to cost the U.S. healthcare system nearly $16 billion in direct medical expenses. These costs include doctor visits, diagnostic testing, medication, and long-term treatment for chronic infections such as HIV. They do not account for indirect costs, such as lost productivity, missed workdays, or the social and emotional toll that STIs can have on individuals and families. Figure 12.6.1 is a visual representation of these statistics (Centers for Disease Control and Prevention, 2024). [2]

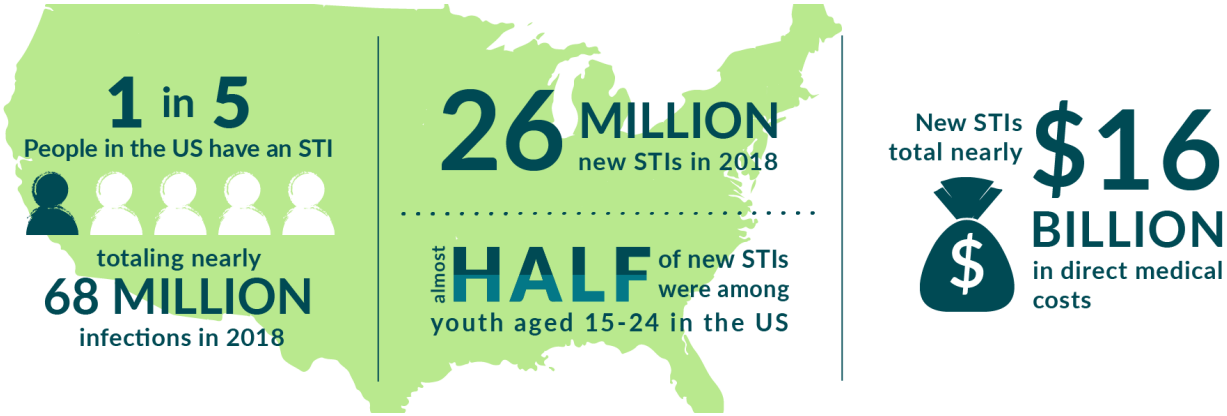


Figure 12.6.2: STIs remain common and costly to the nation's health. (Public Domain; CDC) Alternative text description.

The Scope of STIs in the United States

A 2018 CDC analysis provides a detailed look at the burden of sexually transmitted infections (STIs) in the United States. The study examined eight of the most common infections: chlamydia, gonorrhea, hepatitis B virus (HBV), herpes simplex virus type 2 (HSV-2), human immunodeficiency virus (HIV), human papillomavirus (HPV), syphilis, and trichomoniasis.

Prevalence and Incidence

The analysis revealed that chlamydia, trichomoniasis, genital herpes, and HPV accounted for 98% of all existing (prevalent) infections and 93% of all new (incident) infections in 2018. This concentration shows that a small number of STIs are responsible for the vast majority of the overall burden.

- Prevalence refers to how many people are living with an infection at a given time.
- Incidence refers to the number of new infections occurring within a specific time period.

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) (Centers for Disease Control and Prevention, 2024). [2]

Table 12.6.1: STI Prevalence and Incidence in the United States. (Public Domain; CDC)

STI	Prevalence (current infections)	Incidence (new infections)
HPV	42.5 million	13 million
HSV-2	18.6 million	572,000
Trichomoniasis	2.6 million	6.9 million
Chlamydia	2.4 million	4 million
HIV (ages 13 and older)	984,000	32,600
Gonorrhea	209,000	1.6 million
Syphilis (ages 14 and older)	156,000	146,000
HBV (ages unavailable)	103,000	8,300

Health and Reporting Challenges

The findings emphasize the serious health consequences of untreated STIs, including infertility, cancer, chronic pain, and increased vulnerability to other infections such as HIV. Because many STIs are asymptomatic or go undetected, they are frequently underreported to the CDC. This means actual infection rates are likely even higher than surveillance data suggest.

Economic Burden

STIs also carry a heavy financial toll. In 2018, new infections alone generated nearly $16 billion in direct lifetime medical costs in the United States. These estimates include testing, treatment, and ongoing care, but do not account for indirect costs such as:

- Lost productivity
- Emotional and social consequences
- Prevention programs and public health resources

The CDC notes that there are important data gaps:

- Many infections go undetected or unreported.
- Limited or missing data on natural clearance (how the body may clear infections without treatment), on rates of asymptomatic infection, etc.
- Needs for better population-based screening data.

Improving data quality would allow more precise estimates, better targeting, and more effective public health interventions (Centers for Disease Control and Prevention, 2024). [2]

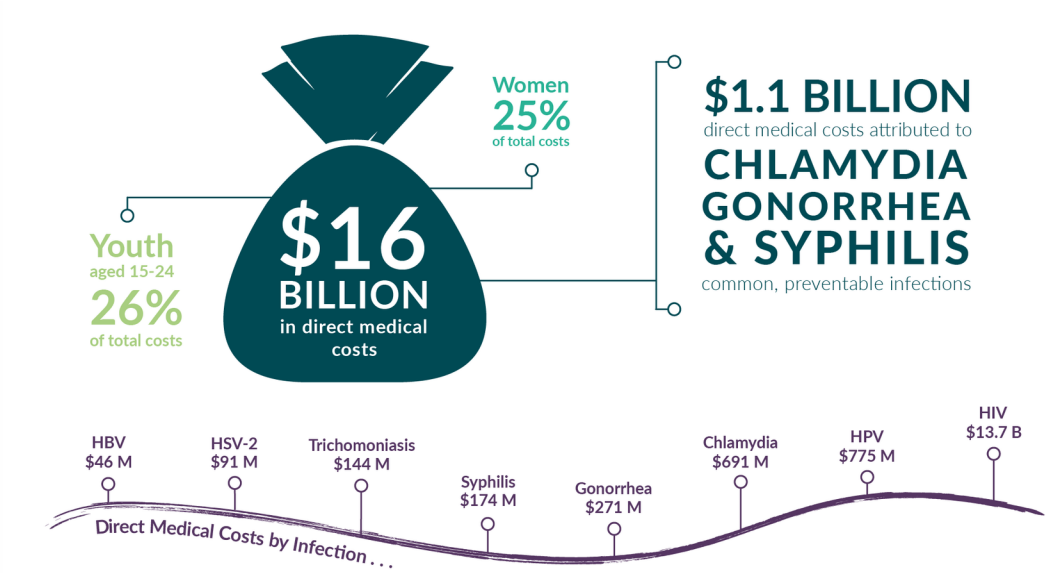


Figure 12.6.3: STIs cost the U.S. Healthcare system Billions each year. (Public Domain; CDC) Alternative text description.

Key Points

- STIs are widespread, with millions of cases often undiagnosed or asymptomatic.
- A few infections account for most cases: Chlamydia, trichomoniasis, herpes, and HPV represented the vast majority of both existing and new infections, showing how concentrated the burden is.
- The economic cost is enormous: New STIs acquired in 2018 alone are projected to cost nearly $16 billion in direct medical expenses, not including lost productivity or emotional and social impacts.
- Prevention and better data are essential: Because STIs are preventable, focused prevention strategies—especially for high-risk groups—and improved surveillance can reduce health consequences, healthcare costs, and disparities.

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12.7: Pregnancy and STIs

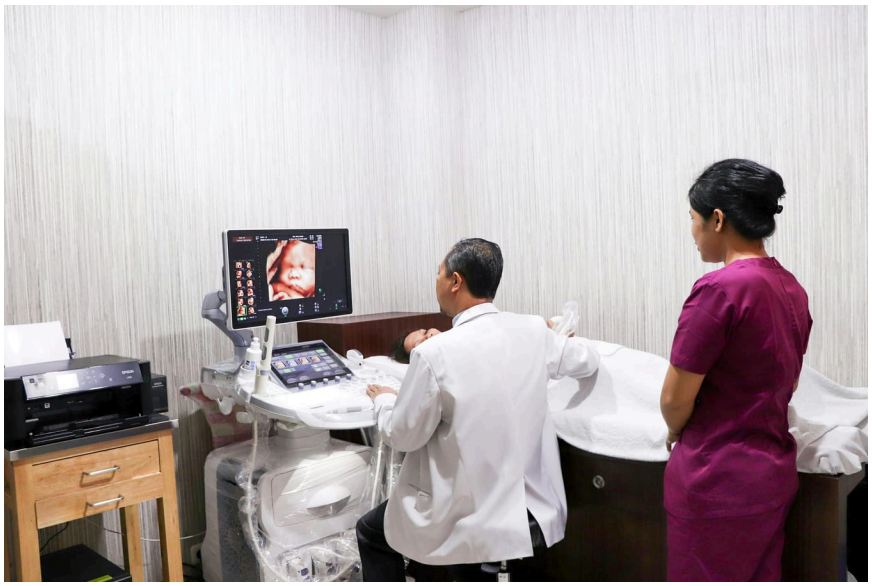


Figure 12.7.1: A pregnant woman is having a 4-Dimensional fetomaternal ultrasound examination done by her doctor with a nurse watching over to check the baby's growth. (Doctors office; Bagoes Ilhamy via Upsplash)

Why Are STIs of Particular Concern During Pregnancy?

Sexually transmitted infections (STIs) are a major concern during pregnancy because many of them can be passed from the mother to the fetus during pregnancy, to the infant during childbirth, or even after birth through breastfeeding. Infections such as HIV, syphilis, gonorrhea, chlamydia, and Zika pose especially high risks, leading to both immediate and long-term health complications for the baby. Some infections also increase the risk of pregnancy complications that affect the health of both mother and child.

The good news is that with timely testing, early treatment, and careful prenatal care, many of these risks can be reduced or completely prevented. For this reason, STI screening is a standard and essential part of prenatal care. Identifying infections early allows healthcare providers to treat curable conditions (such as gonorrhea and chlamydia) and to manage incurable infections (such as HIV or herpes) in ways that protect both mother and baby (Centers for Disease Control and Prevention, 2024). [6]

How Transmission Can Be Prevented or Reduced

- **HIV**: HIV can pass from mother to infant during pregnancy, delivery, or breastfeeding. However, treatment with antiretroviral medications throughout pregnancy and near delivery can dramatically reduce transmission. Current research also shows that if an HIV-positive mother is healthy and on treatment, breastfeeding carries almost no risk of passing on the virus. If the mother's immune system is not well-controlled, formula feeding may be recommended when safe alternatives are available.
- **Herpes**: If a woman has active herpes lesions or untreated HIV at the time of delivery, doctors may recommend a cesarean section (C-section) to protect the infant.
- **Gonorrhea and Chlamydia**: Both infections can be treated with antibiotics during pregnancy. Infants can also receive treatment immediately after birth. As an added safeguard, hospitals routinely apply an antibiotic ointment to newborns' eyes to prevent blindness caused by undetected infections.
- **Zika Virus**: Zika is a virus primarily transmitted through the bite of infected Aedes mosquitoes. It gained global attention due to its link to severe birth defects, including microcephaly (an abnormally small head size) and other neurological complications in infants born to infected mothers. What makes Zika unique compared to many other mosquito-borne illnesses is that it can also be transmitted through sexual contact. The virus can persist in bodily fluids, particularly semen, for weeks to months after infection. This means an individual who was infected through a mosquito bite can later pass the virus to a sexual partner, even if they no longer have symptoms. As a result, Zika bridges two modes of transmission: vector-borne

(mosquito) and sexually transmitted. Because of these dual transmission pathways, pregnant women are advised not only to avoid travel to regions where Zika is active, but also to take precautions against both mosquito exposure and unprotected sexual contact with partners who may have been exposed. These precautions are critical in reducing the risk of infection during pregnancy and protecting fetal development (Centers for Disease Control and Prevention, 2024). [5]

Potential Complications of STIs in Pregnancy

If not detected and treated, STIs can lead to serious outcomes, including:

- Miscarriage (loss of pregnancy before 20 weeks)
- Ectopic pregnancy (when the embryo implants outside the uterus)
- Preterm labor and premature delivery (before 37 weeks)
- Low birth weight
- Congenital conditions such as blindness, deafness, bone deformities, microcephaly, and intellectual disabilities
- Stillbirth (fetal loss at or after 20 weeks)
- Serious illness in the newborn during the first month of life
- Newborn death
- Health complications for the mother, such as pelvic infections or worsened disease progression (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2021). [10]

Because the effects of STIs during pregnancy can be devastating but are often preventable, routine prenatal STI testing and treatment are essential. This protects the mother's health, reduces the chance of pregnancy complications, and ensures the best possible outcome for the baby.

Key Points

- Many STIs can be passed from mother to child during pregnancy, delivery, or breastfeeding, causing serious health complications.
- Untreated infections increase risks such as miscarriage, premature birth, low birth weight, stillbirth, and congenital conditions.
- Routine prenatal screening and treatment can prevent or reduce these risks, protecting both mother and baby.
- Early detection allows curable infections to be treated and chronic infections to be managed effectively.

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12.8: Common Types of STIs

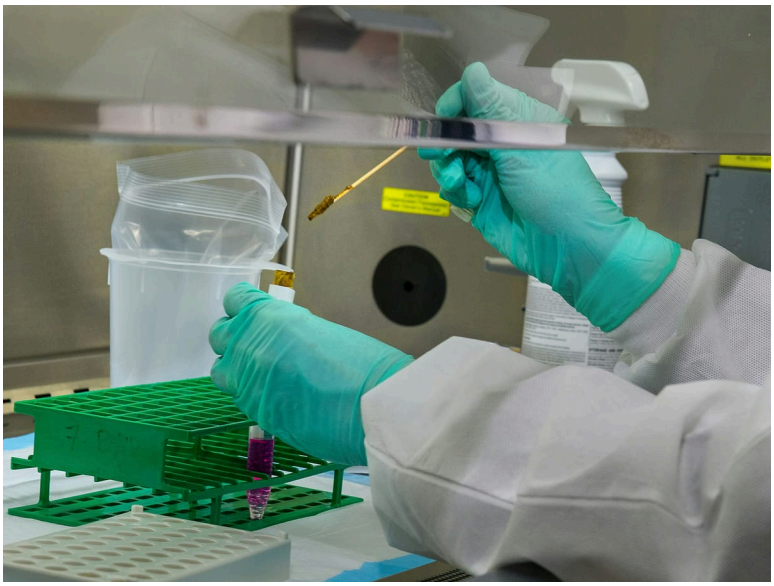


Figure 12.8.1: (Gloved person testing ; CDC via Unsplash)

Introduction

Sexually transmitted infections vary widely in their causes, symptoms, and consequences, but what many have in common is that they often go unnoticed until serious damage has already been done. From bacterial infections like chlamydia and gonorrhea that are fully curable with antibiotics, to viral infections like HIV and herpes that require lifelong management, understanding the specific nature of each infection is essential for protecting your health and the health of your partners. This section provides an overview of the most common STIs, including how they spread, what symptoms to watch for, how they are diagnosed and treated, and what can happen if they go untreated. Whether you are seeking information for yourself or simply want to be better informed, this knowledge is a powerful tool for prevention, early detection, and reducing the stigma that too often stands in the way of people getting the care they need.

Common STIs and Their Treatments

Sexually transmitted infections (STIs) are among the most common health concerns worldwide, with more than 20 different infections that can spread 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. Some of these infections are curable with medications, while others are lifelong but manageable with proper treatment. Understanding the most common STIs, their health effects, and available treatments is an important step toward prevention, early detection, and reducing stigma.

Curable vs. Non-Curable:

- **Curable**: Bacterial and parasitic infections (chlamydia, gonorrhea, syphilis, trichomoniasis).
- **Non-Curable but Treatable**: Viral infections (HIV, herpes, HPV, hepatitis).

The following section outlines several of the most common sexually transmitted infections (STIs), their symptoms, and available treatments.

Often asymptomatic; treatable with antibiotics.

- **HIV/AIDS (viral)**: Lifelong infection; controlled with antiretroviral therapy (ART).
- **Genital Herpes (viral)**: No cure; antiviral drugs reduce outbreaks.
- **HPV (viral)**: Some strains cause genital warts or cervical cancer; vaccines are available.
- **Hepatitis B (viral)**: Affects the liver; vaccines available.
- **Trichomoniasis (parasitic)**: Treatable with medication.
- **Zika (viral)**: Can cause birth defects if transmitted during pregnancy.

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 the CDC. Many STDs 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 STDs 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 12.8.1 is an overview of the rates of syphilis, chlamydia, and gonorrhea in the U.S. The overall burden of sexually transmitted infections (STIs) in the United States remains high, but recent data show encouraging signs of progress. In 2024, the combined number of reported cases of chlamydia, gonorrhea, and syphilis dropped by 9% compared to 2023, marking the third consecutive year of national decline. Specifically, chlamydia cases decreased 8% and gonorrhea cases fell 10%, both continuing downward trends. Primary and secondary syphilis also saw a notable 22% decline, though congenital syphilis, syphilis passed from mother to child during pregnancy, rose for the 12th straight year, reaching nearly 4,000 cases in 2024, a staggering increase of almost 700% compared to a decade ago. Despite these mixed trends, the total number of reported STIs still exceeded 2.2 million cases in 2024 and remains 13% higher than ten years earlier. Importantly, national data may not fully capture differences across regions and populations, where certain groups continue to face disproportionate impacts.

Table 12.8.1 Rates of Syphilis, Chlamydia, and Gonorrhea in the U.S.

Year	Rate of Syphilis	Rate of Chlamydia	Rate of Gonorrhea
1970	44.8	NA	NA
1975	37.3	NA	NA
1980	30.3	NA	NA
1985	28.4	17.4.0	383.0
1990	54.3	160.2	276.4
1995	26.0	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	475.0	123.0
2020	40.4	476.7	204.5
2021	53.3	495.5	214.0
2022	62.2	495.0	194.4
2023	62.5	492.2	179.5
2024	55.9	445.7	159.8

Table 12.8.1 Rates of syphilis, chlamydia, and gonorrhea in the United States from 1970 to 2024, shown in 5-year increments until 2020, then annually through 2024. All rates are reported per 100,000 population (Centers for Disease Control and Prevention, 2024). [8]

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 the CDC. Many STDs 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 STDs 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.

It is important to understand the risk factors and symptoms of STDs to protect yourself and your partners. It is also important to understand the impacts on your health if you do not get treatment.

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 can also 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.

Bacterial Vaginosis (BV)

Bacterial vaginosis (BV) is the most common vaginal condition among women ages 15–44. It occurs when an imbalance develops between "good" and "harmful" bacteria in the vagina. Although BV is not classified as a sexually transmitted infection, it is linked to sexual activity and can increase the risk of acquiring other STIs and pregnancy complications.

Signs and Symptoms

Many people with BV have no symptoms. Symptoms:

- 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
- Itching around the outside of the vagina

Risk Factors

More common in those who are sexually active, though it can occur without sexual activity.
Risk increases with douching, inconsistent condom use, or having new or multiple sex partners.
Rare in people who have never had sex.

How It Spreads

- The exact cause is unknown, but BV results from disrupted vaginal bacterial balance.
- Not spread through toilet seats, bedding, or swimming pools.
- Male partners do not require treatment, but BV can spread between female sex partners.
- BV rarely affects those who have never had sex.

Prevention

- Avoid douching.
- Use condoms consistently.
- Limit the number of sex partners.
- Abstinence eliminates risk.

Testing and Diagnosis

A healthcare provider examines vaginal discharge and may test vaginal fluid to confirm BV.

Treatment and Recovery

- Treated effectively with prescribed antibiotics.
- Important to complete all medication, even if symptoms resolve.
- BV can recur after treatment.

- Treating BV lowers the risk of other STIs but does not prevent recurrence.

Pregnancy Risk

- BV during pregnancy increases the likelihood of premature birth and low birth weight (less than 5.5 pounds).
- Treatment during pregnancy reduces these risks.

If Untreated

- BV may resolve on its own.
- Getting or transmitting HIV
- Delivering a baby too early if you have BV during pregnancy.
- BV can lead to an increased risk of getting other STIs like chlamydia and gonorrhea.
- Increases the chance of developing pelvic inflammatory disease (PID), which can cause infertility.

Chlamydia (Bacterial)

Chlamydia is one of the most common sexually transmitted infections (STIs) and can affect both men and women. It is often asymptomatic, but untreated infections can lead to serious health problems, especially in women. If symptoms occur, they may not appear until several weeks after having sex with a partner who has chlamydia. It can cause permanent damage to a woman's reproductive system. Complications include pelvic inflammatory disease (PID), infertility, chronic pelvic pain, and ectopic pregnancy. In men, complications are less common but can include testicular pain, swelling, and, rarely, infertility.

Signs and Symptoms

Chlamydia often causes no symptoms, but when present, they can differ by sex and site of infection.

- In women, symptoms may include abnormal vaginal discharge and a burning sensation during urination. Even without symptoms, an untreated infection can damage the reproductive system.
- In men, possible signs include penile discharge, burning during urination, and, less commonly, pain or swelling in the testicles.
- Rectal infections, which can occur in both men and women, may cause rectal pain, discharge, or bleeding, though many cases are asymptomatic.
- Anyone experiencing these symptoms or whose partner has signs of an STI should seek medical evaluation and testing

Risk Factors and Transmission

Chlamydia is spread through vaginal, anal, or oral sex without a condom, and pregnant individuals can transmit the infection to their babies during childbirth, leading to health complications for the newborn. Risk factors include having new or multiple sex partners and inconsistent condom use.
Because symptoms are often absent, regular testing is essential.

Prevention

The most effective prevention is abstaining from vaginal, anal, and oral sex. For sexually active individuals, consistent condom use and being in a mutually monogamous relationship with a tested, uninfected partner lowers risk. A pregnant woman with chlamydia can give the infection to her baby during childbirth. This can cause serious health problems for the baby. Treating chlamydia as soon as possible will make health problems for the baby less likely.

Testing and Diagnosis

Because most infections are asymptomatic, regular testing is essential. Annual screening is recommended for:

- Women under 25,

- Women over 25 with risk factors (multiple partners or a partner with an STI),
- Sexually active gay and bisexual men,
- Pregnant individuals (in certain cases). Diagnosis is made through urine tests or vaginal/cervical swabs.

Treatment and Recovery

Chlamydia is curable with antibiotics, but reinfection is common. Individuals should complete the full course of medication, abstain from sex until treatment is finished and their partners complete treatment, and be retested about three months later. While treatment eliminates the infection, it cannot reverse permanent damage already caused. Untreated infections increase the risk of acquiring or transmitting HIV.

Complications of Untreated Chlamydia

Chlamydia can cause serious long-term health problems if left untreated, even when no symptoms are present.
In women, it may lead to pelvic inflammatory disease (PID), which can result in scarring of the fallopian tubes, ectopic pregnancy, infertility, and chronic pelvic or abdominal pain.
In men, complications are less common but may include fever, pain in the tubes connected to the testicles, and, in rare cases, infertility.

If left untreated, chlamydia can cause serious long-term health problems, even when no symptoms are present.

- In women, complications include pelvic inflammatory disease (PID), which may lead to scarred fallopian tubes, ectopic pregnancy, infertility, and chronic pelvic or abdominal pain.
- In men, complications are less common but can involve fever, pain in the tubes around the testicles, and, in rare cases, infertility.
- For all individuals, untreated infection increases the risk of acquiring or transmitting HIV.

Gonorrhea (bacterial)

Gonorrhea is a common sexually transmitted infection (STI) that can infect the genitals, rectum, and throat. It is especially prevalent among young people ages 15–24. Although often asymptomatic, untreated gonorrhea can lead to serious and sometimes permanent health problems.

Signs and Symptoms

Many people have no symptoms. Most women do not have any symptoms, and if they do, they are often mild and can be mistaken for a bladder or vaginal infection.

- Women may experience burning during urination, increased vaginal discharge, or bleeding between periods.
- Men may notice burning with urination, a white, yellow, or green discharge from the penis, or painful/swollen testicles.
- Rectal infections may or may not have symptoms. Symptoms can cause discharge, pain, anal itching, soreness, bleeding, or painful bowel movements.

Risk Factors and Transmission

Anyone sexually active can get gonorrhea through vaginal, anal, or oral sex without a condom. Pregnant individuals can pass the infection to their baby during childbirth, potentially causing serious complications.

Prevention

The only certain way to avoid gonorrhea is to abstain from vaginal, anal, and oral sex. Risk can be reduced by consistent condom use and maintaining a mutually monogamous relationship with a tested, uninfected partner.

Testing and Diagnosis

Annual testing is recommended for:

- Sexually active women under 25,
- Older women with risk factors (new or multiple partners, partner with an STI), and
- Sexually active gay or bisexual men.
- Testing is also recommended in pregnancy. Diagnosis is typically made through urine tests or swabs from the throat, rectum, cervix, or urethra, depending on exposure. Treating health problems as soon as possible will make health problems for your baby less likely.

Treatment and Recovery

Gonorrhea is curable with the correct antibiotics, though increasing drug resistance makes treatment more challenging. It is important to take all prescribed medication and abstain from sex until treatment is complete (waiting for seven days after finishing medication). Retesting is recommended about three months after treatment, as reinfection is common. Some strains of gonorrhea are becoming drug-resistant.

Complications if Untreated

Untreated gonorrhea can cause serious and permanent health problems.

- Women: Pelvic inflammatory disease (PID), which can lead to scarring of fallopian tubes, infertility, ectopic pregnancy, and chronic pelvic pain.
- Men: Painful infection of the tubes around the testicles, and in rare cases, infertility.
- All individuals: Rarely, infection can spread to the blood or joints, which can be life-threatening. Untreated gonorrhea also increases the risk of acquiring or transmitting HIV.

Syphilis (bacterial)

Syphilis is a sexually transmitted infection (STI) that progresses in stages and can cause serious health problems if untreated. It is curable with antibiotics, but treatment cannot reverse damage that has already occurred. Babies can also be infected during pregnancy, resulting in congenital syphilis, which can cause severe complications or death.

Signs and Symptoms

There are four stages of syphilis. Each stage of syphilis has different signs and symptoms.

- Primary stage: A single or multiple sores. The sore is the location where syphilis entered the body. Sore, usually firm, round, painless sores (chancres) on the penis, vagina, anus, rectum, lips, or mouth. Sores usually last 3 to 6 weeks and heal on their own, but the infection continues. Infection will still continue after the sore is healed if you do not receive treatment. If the infection is not treated, it will move to the secondary stage.
- Secondary stage: Skin rash (including on palms and soles), mouth, vagina, or anus. The rash can present when the primary sore is healing or several weeks after healing. Rash can be on the palms of your hands and/or the bottoms of your feet and look rough, red, and reddish brown. The rash usually will not itch, and you may not notice it. Other symptoms include fever, swollen lymph nodes, sore throat, patchy hair loss, headaches, weight loss, muscle aches, or fatigue.
- Latent stage: No visible signs or symptoms, but the infection remains in the body.
- Tertiary stage: Most people with untreated syphilis do not develop tertiary syphilis. It may occur years later, damaging the heart, blood vessels, brain, and nervous system; it can be life-threatening. Tertiary syphilis damages your internal organs and can result in death. It is very serious and would occur 10-30 years after the infection began.
- Complications: Neurosyphilis (nervous system), ocular syphilis (eye), and otosyphilis (ear) can occur at any stage, causing neurological problems, vision loss, or hearing loss. Signs and symptoms of neurosyphilis may include severe headaches, muscle weakness or difficulty with movement, and changes in mental state such as trouble focusing, confusion, personality changes, or dementia that affects memory, thinking, and decision-making. Signs and symptoms of ocular syphilis may include eye pain, redness, changes in vision, or even blindness.
  Signs and symptoms of otosyphilis may include hearing loss, ringing or buzzing in the ears (tinnitus), and dizziness or vertigo,

which feels like you or your surroundings are moving or spinning.

Risk Factors and Transmission

Anyone sexually active can contract syphilis through direct contact with sores during vaginal, anal, or oral sex. Pregnant individuals can pass syphilis to their babies. Gay and bisexual men, along with some racial and ethnic minority groups, experience higher rates due to disparities in social, cultural, and economic conditions that make it difficult for sexually active people to stay healthy. Having syphilis also increases the risk of acquiring or transmitting HIV.

How Syphilis Spreads

You can get syphilis by direct contact with a syphilis sore during vaginal, anal, or oral sex. Women can also pass syphilis to their baby during pregnancy. You cannot get syphilis through casual contact with objects, such as toilet seats, doorknobs, swimming pools, hot tubs, bathtubs, or sharing clothing or eating utensils.

A pregnant mother who has syphilis can give the infection to her baby. Having syphilis can lead to a low-birth-weight baby. Baby could potentially be delivered early or stillborn (a baby born dead). Testing at least once during pregnancy is recommended. A Baby will not have signs or symptoms and should be tested right away at birth and treated if possible. Untreated babies can have health problems such as cataracts, deafness, or seizures, and can die.

Prevention

- Abstaining from sexual activity is the only certain prevention.
- Lower risk through consistent condom use and monogamous relationships with tested, uninfected partners.
- Pregnant individuals should be tested at least once during pregnancy to protect the baby.

Testing and Diagnosis

A sexually active individual should get tested regularly. Individuals who are gay or bisexual men, have HIV, are taking pre-exposure prophylaxis (PrEP) for HIV prevention, have partners who have tested positive, and have certain risk factors for syphilis, like living in a community with high rates of syphilis. Blood tests are most common for diagnosis; fluid from sores may also be tested. Women should be screened at the first prenatal visit, and some may need repeat testing later in pregnancy.

Treatment and Recovery

Syphilis is curable with prescribed antibiotics. Treatment might not undo any damage the infection can cause. Follow-up testing is necessary to confirm that treatment was successful. Having syphilis once does not provide immunity; reinfection is possible if exposed again, especially if partners remain untreated.

Human Papillomavirus (HPV)

Human papillomavirus (HPV) is the most common sexually transmitted infection (STI). There are many types of HPV, most of which cause no health problems and go away on their own. However, some types can lead to genital warts or several cancers, including cervical, anal, penile, vulvar, vaginal, and oropharyngeal cancers. Vaccines can prevent many of these complications.

Signs and Symptoms

- Most people with HPV never develop symptoms.
- Genital warts can develop in the genital area as small or large growths, appearing either singly or in clusters. They may be flat or raised and sometimes resemble a cauliflower-like shape.
- Warts may disappear, remain unchanged, or increase in size or number.
- HPV-related cancers may not show symptoms until later stages.
- Talk to your healthcare provider if you notice warts, unusual growths, lumps, or sores in your genital area, mouth, or throat.

Risk Factors and Transmission

HPV spreads mainly through vaginal, anal, or oral sex, as well as close skin-to-skin contact during sexual activity. It can be passed on by someone who has no signs or symptoms, and anyone sexually active can get HPV, even after having sex with only one person. Symptoms may not appear until years later, making it difficult to know when the infection first occurred.

Prevention

There are several steps you can take to reduce your risk of getting HPV and the health problems it may cause.

- The HPV vaccine is safe, effective, and recommended for adolescents and young adults; it prevents most HPV-related cancers and genital warts.
- Routine cervical cancer screening (Pap tests and HPV testing) for women ages 21–65 helps detect precancerous changes.
- Consistent condom use lowers risk, though it does not eliminate it, since HPV can infect areas not covered by condoms.
- Being in a mutually monogamous relationship reduces exposure.



Figure 12.8.2: Vaccines are available for HPV. (Injection; CDC via Unsplash)

Testing and Diagnosis

- No test exists to determine overall HPV status.
- Cervical HPV tests are used for women aged 30 and older as part of cancer screening.
- HPV is often discovered through abnormal Pap test results or when genital warts or HPV-related cancers appear.
- There are no approved HPV tests for the mouth, throat, or men in general.

Treatment and Recovery

- There is no cure for the virus itself, but related health problems can be treated.
- Genital warts can be managed with medical treatment or prescription medications, though they may return.
- Cervical precancer can be treated effectively if found early through screening. Prevention is always better than treatment.
- HPV-related cancers are more treatable when detected early.
- If you or your partner has genital warts, stop having sex until you no longer have warts.

Pregnancy and HPV

Pregnant women with HPV can get genital warts or develop abnormal cell changes on the cervix. Routine cervical cancer screening can help find abnormal cell changes. You should get routine cervical cancer screening even when you are pregnant.

Cancer Risk

HPV can lead to cervical cancer as well as cancers of the vulva, vagina, penis, anus, and the back of the throat (oropharyngeal cancer), which includes the base of the tongue and tonsils. These cancers usually develop many years after the initial infection. Genital warts and cancers are caused by different types of HPV, and there is no way to predict who will develop serious health problems. People with weakened immune systems, such as those with HIV, have a higher risk of developing complications from HPV.

Genital Herpes

Genital herpes is a common sexually transmitted infection (STI) caused by two viruses: herpes simplex virus type 1 (HSV-1) and herpes simplex virus type 2 (HSV-2). HSV-1 is often associated with oral herpes (cold sores), but it can also cause genital herpes through oral sex. HSV-2 is the most frequent cause of recurrent genital herpes. Genital herpes is common in the United States (U.S.). In 2018, CDC estimates show there were 572,000 new genital herpes infections in the U.S. among people aged 14 to 49.

Signs and Symptoms

- Blisters and sores: Outbreaks begin with one or more blisters on or around the genitals, rectum, or mouth. These blisters break open and turn into painful sores that may take a week or longer to heal.
- First outbreak symptoms: The initial episode can also include flu-like symptoms such as fever, body aches, or swollen lymph glands.
- Recurrences: People, especially those with HSV-2, may have repeated outbreaks. These tend to be shorter and less severe than the first outbreak.
- Long-term pattern: Although herpes is a lifelong infection, outbreaks often decrease in frequency over time.
- When to see a provider: Seek medical care if you or your partner develops symptoms such as unusual sores, foul-smelling genital discharge, painful urination, or bleeding between periods.

Risk Factors and Complications

Herpes infection increases the risk of acquiring or transmitting HIV because sores or skin breaks provide an entry point. It can also be more severe in people with weakened immune systems. During pregnancy, herpes can lead to miscarriage, preterm delivery, or neonatal herpes, a serious and sometimes fatal infection in newborns.

Transmission

Herpes spreads through vaginal, anal, or oral sex with someone who has the infection. You can contract herpes through direct contact with:

- Herpes sores
- Saliva from a partner who has oral herpes
- Genital fluids from a partner who has genital herpes
- Skin in the oral area of a partner with oral herpes
- Skin in the genital area of a partner with genital herpes

Prevention

- Abstaining from vaginal, anal, and oral sex is the only sure way to avoid herpes.
- Reducing risk includes consistent condom use, being in a mutually monogamous relationship with an uninfected partner, and avoiding sex during outbreaks.
- Daily antiviral medication taken by an infected partner can lower the risk of transmission.
- Avoid having vaginal, anal, or oral sex when your partner has herpes symptoms (i.e., during an outbreak).

Question

- Many STIs are asymptomatic.
  - Why does this make regular testing a critical part of prevention, even if you feel healthy?
- Imagine you are advising a friend about safer sex practices.
  - What three strategies would you emphasize to reduce their risk of contracting or spreading an STI?

Genital Herpes and Pregnancy

If you are pregnant and have genital herpes, regular prenatal care is essential. Genital herpes during pregnancy can increase the risk of miscarriage, premature birth, or passing the infection to your baby. Transmission is most likely to occur during delivery, which can result in a life-threatening condition called neonatal herpes.

To protect your baby, tell your healthcare provider if you have ever been diagnosed with herpes, had symptoms, or may have been exposed. Your provider may prescribe antiviral medication late in pregnancy to reduce the chance of an outbreak at delivery. At the time of birth, your provider will examine you for herpes sores. If sores or symptoms are present, a cesarean section (C-section) is usually recommended to lower the risk of passing herpes to the newborn.

Testing and Diagnosis

Providers may diagnose herpes by examining sores or testing fluid from lesions.
Blood tests can detect HSV antibodies if sores are absent, but cannot determine when or from whom the infection was acquired. Having an honest and open talk with your healthcare provider is important.

Treatment and Recovery

- There is no cure for herpes, but antiviral medications help manage the infection.
- Medicines can shorten outbreaks, reduce symptoms, and lower the risk of transmission.
- Daily suppressive therapy can reduce recurrence and transmission to partners.
- Even without symptoms, the virus can still spread, so open communication with partners is important.

If Untreated

Without treatment, herpes can cause painful sores, spread to other body parts through touch (e.g., eyes), and create risks during pregnancy for the mother and baby. In people with compromised immune systems, herpes infections can be severe.

Trichomoniasis

Trichomoniasis (often called “trich”) is a very common sexually transmitted infection (STI) caused by the protozoan parasite Trichomonas vaginalis. Most people with trich have no symptoms, yet the infection can persist for months or even years without treatment. The CDC estimates that there were more than two million trichomoniasis infections in 2018 (Centers for Disease Control and Prevention, 2025). [7]

Signs and Symptoms

- About 70% of people have no symptoms.
- Infection is more common in women than in men.
- Men may notice itching or irritation inside the penis, burning after urination or ejaculation, and penile discharge.
- Women may experience genital itching, burning, redness, or soreness; discomfort during urination; or vaginal discharge that may be clear, white, yellow, or green with a fishy odor.
- Symptoms can appear within 5–28 days of infection, but may also come and go or appear much later.
- Having trich can make sex feel unpleasant. Without treatment, the infection can last for months or even years.

Risk Factors

- More common in women than men, and more likely in older women than younger women.
- Risk increases with unprotected sex and having multiple partners.
- Infection can increase the risk of acquiring or spreading other STIs, including HIV.

How It Spreads

- Spread primarily through vaginal, anal, or oral sex without a condom.
- In women, infection is usually in the vagina, cervix, vulva, or urethra; in men, it is typically in the urethra.
- Can spread through penis-to-vagina or vagina-to-vagina contact.
- Rarely infects other body parts such as the hands, mouth, or anus.
- People can spread trich even if they have no symptoms.

Prevention

- Abstaining from sexual activity is the only sure prevention.
- Consistent condom use and being in a mutually monogamous relationship with a tested, uninfected partner reduce risk.
- Discussing STI risks with new partners before sex can help with informed decision-making.

Testing and Diagnosis

- Trich cannot be diagnosed based on symptoms alone.
- Laboratory testing of vaginal or urethral samples is required to confirm infection.

Treatment and Recovery

- Trich is the most common curable STI.
- Treated with oral medication (pills), which is also safe for pregnant women.
- Reinfection is common, occurring in about 1 in 5 people within three months.
- All sex partners should be treated at the same time to prevent reinfection.
- Avoid sex until treatment is complete for both partners.
- Retesting is recommended about three months after treatment, even if partners were treated.
- Not getting treatment

Pregnancy Risk

- Trichomoniasis during pregnancy increases the risk of preterm delivery and low birth weight.
- Treatment is safe and important to reduce risks for both mother and baby.

If Untreated

Trich can increase the risk of getting or spreading other sexually transmitted infections. For example, trich can cause genital inflammation, making it easier to get HIV, or pass it to a sex partner.

Pelvic Inflammatory Disease

Pelvic inflammatory disease (PID) is an infection of the female reproductive organs. It is most often a complication of untreated sexually transmitted infections (STIs) such as chlamydia or gonorrhea, but other non-sexually transmitted infections can also cause it. PID is serious and can lead to long-term health problems if untreated.

Signs and Symptoms

Many women have mild or no symptoms. When present, symptoms may include:

- Lower abdominal pain
- Fever
- Vaginal discharge with a foul odor
- Pain or bleeding during sex
- Burning sensation when urinating
- Bleeding between periods

Risk Factors

- Having an untreated STI
- Multiple sex partners or a partner with other partners
- Previous history of PID
- Being sexually active under age 25
- Douching
- Use of an intrauterine device (IUD), mainly in the first 3 weeks after insertion

How It Spreads

PID develops when bacteria spread from the vagina or cervix into the uterus, fallopian tubes, or ovaries. STIs, especially chlamydia and gonorrhea, are the most common causes.

Prevention

- Abstaining from vaginal, anal, or oral sex is the only certain prevention.

Lower risk by:

- Using condoms correctly and consistently
- Being in a mutually monogamous relationship with a tested, uninfected partner
- Getting regular STI testing, especially if under 25 or at higher risk

Testing and Diagnosis

No single test confirms PID. Diagnosis is based on medical history, pelvic exam, symptoms, and laboratory tests (such as STI testing).
Annual chlamydia and gonorrhea screening is recommended for sexually active women under 25, and for older women with risk factors.

- You should be examined by your doctor if you notice any of the symptoms.
- Promptly see a doctor if you think you or your sex partner(s) have or were exposed to an STI
- Promptly see a doctor if you have any genital symptoms such as an unusual sore, a smelly discharge, burning when peeing, or bleeding between periods
- Get a test for chlamydia and gonorrhea every year if you are sexually active and younger than 25 years of age
- Have an honest and open talk with your health care provider if you are sexually active and ask whether you should be tested for other STIs.

Treatment and Recovery

- PID can be cured with antibiotics if treated early.
- Treatment cannot reverse damage already done to the reproductive system. The longer an individual waits to get treated, the more likely they are to have complications from PID.
- It is critical to complete all prescribed medication and ensure recent sex partners are tested and treated to prevent

reinfection.
- While taking antibiotics, your symptoms may go away before the infection is cured.
- Sex should be avoided until both partners complete treatment.
- Having PID once increases the chance of getting it again if reinfected with an STI.

If Untreated

If diagnosed and treated early, the complications of PID can be prevented. Some of the complications of PID are:

- Formation of scar tissue both outside and inside the fallopian tubes, which can lead to tubal blockage
- Ectopic pregnancy (pregnancy outside the womb)
- Infertility (inability to get pregnant)
- Long-term pelvic/abdominal pain

Pregnancy Risk

One in 8 women with a history of PID experiences difficulties getting pregnant.

- PID can cause scarring in the fallopian tubes, leading to blocked tubes, infertility, or ectopic pregnancy.
- About 1 in 8 women with a history of PID have difficulty becoming pregnant.

HIV and AIDS

Human immunodeficiency virus (HIV) is a virus that attacks the body's immune system, specifically the CD4 cells (T cells), which help fight infections. If untreated, HIV can lead to acquired immunodeficiency syndrome (AIDS), the most severe stage of HIV infection. While there is no cure, effective treatment allows people with HIV to live long, healthy lives and reduces the risk of transmission.

Signs and Symptoms

- Many people do not have symptoms at first.
- Early stage (acute HIV): Flu-like symptoms may appear 2–4 weeks after infection, including fever, chills, rash, night sweats, sore throat, fatigue, mouth ulcers, and swollen lymph nodes.
- Chronic HIV: Symptoms may be mild or absent for years, but the virus continues to damage the immune system.
- Progression to AIDS: Severe immune system damage can cause rapid weight loss, recurring fever, extreme fatigue, prolonged swelling of lymph glands, chronic diarrhea, pneumonia, skin blotches, or neurological issues.

Risk Factors

- Having unprotected vaginal, anal, or oral sex with someone who has HIV.
- Having multiple sexual partners.
- Sharing needles, syringes, or other injection equipment.
- Receiving contaminated blood products (rare in the U.S. since screening began in 1985).
- Babies born to mothers with HIV can be infected during pregnancy, childbirth, or breastfeeding.

How It Spreads

HIV is transmitted through contact with certain body fluids from a person with HIV, including:

- Blood
- Semen and pre-seminal fluid
- Vaginal fluids
- Rectal fluids
- Breast milk

It is not spread through casual contact such as hugging, shaking hands, sharing food, or using the same toilet.

Prevention

Abstaining from sexual activity is the only certain prevention.

Lower risk by:

- Using condoms consistently and correctly.
- Being in a mutually monogamous relationship with a tested, uninfected partner.
- Taking pre-exposure prophylaxis (PrEP), a daily medicine that reduces the risk of HIV from sex or injection drug use.
- Avoid sharing needles or syringes.

Pregnant people with HIV should receive antiretroviral therapy (ART) to reduce transmission to the baby.

Testing and Diagnosis

- HIV can be diagnosed through laboratory or rapid tests that detect antibodies, antigens, or genetic material (RNA).
- Everyone ages 13–64 should be tested at least once, with more frequent testing for people at higher risk.
- Testing is also important for all pregnant women. Early diagnosis allows for immediate treatment and better outcomes.

Treatment and Recovery

- There is no cure, but HIV is treatable with antiretroviral therapy (ART).
- ART involves taking a combination of HIV medicines every day to suppress the virus.
- With consistent treatment, people with HIV can maintain an undetectable viral load, live healthy lives, and prevent sexual transmission of HIV ("U=U" – undetectable = untransmittable).
- Treatment must be lifelong. Stopping ART allows the virus to rebound.

Pregnancy Risk

Without treatment, mothers with HIV can pass the virus to their babies during pregnancy, labor, delivery, or breastfeeding. With proper ART, the risk of transmission can be reduced to less than 1%.

If Untreated

- HIV progressively weakens the immune system, making the body vulnerable to opportunistic infections and certain cancers.
- Untreated HIV typically progresses to AIDS, which is life-threatening.
- Without treatment, most people with AIDS survive about 3 years. With treatment, HIV can be managed as a chronic condition.

Key Points

- STIs are highly prevalent: One in five people in the U.S. is living with a sexually transmitted infection, and young people ages 15–24 account for nearly half of all new cases.
- Curable vs. treatable infections: Bacterial and parasitic STIs (such as chlamydia, gonorrhea, syphilis, and trichomoniasis) are generally curable with antibiotics or antiparasitic drugs, while viral STIs (HIV, herpes, HPV, hepatitis B) are not curable but can be managed with medication, vaccines, and preventive care.
- Asymptomatic infections are common: Many STIs do not cause noticeable symptoms, yet they can still be transmitted and cause long-term complications if left untreated, highlighting the importance of regular testing.
- Serious complications can occur: Untreated STIs may result in pelvic inflammatory disease (PID), infertility, pregnancy complications, cancer (e.g., cervical cancer from HPV), or life-threatening conditions such as HIV/AIDS.
- Prevention is possible: Safer sex practices—including consistent condom use, limiting the number of sexual partners, routine STI testing, and vaccination (e.g., HPV and hepatitis B)—are the most effective ways to reduce risk.
- National trends show mixed progress: Reported cases of chlamydia, gonorrhea, and syphilis declined in 2024 after years of increase, but congenital syphilis continues to rise sharply, showing that disparities persist across communities.

- Connection between STIs and HIV: Having an untreated STI increases the risk of acquiring or transmitting HIV, since sores or breaks in the skin create an entry point for the virus.
- Early detection and treatment save lives: Timely diagnosis, completing prescribed medication, and ensuring partners are treated are essential for recovery, reducing reinfection, and protecting long-term reproductive and overall health.

Attributions

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12.9: Comprehension Check

Summary

This chapter connects three important areas of personal and public health, relationships and sexuality, the immune system, and the prevention of infectious diseases, to help students understand how physical, emotional, and social wellness intersect.

It begins by exploring relationships, sexuality, and contraception, emphasizing that healthy relationships are built on trust, communication, respect, and mutual support. Students learn to recognize positive and negative relationship patterns and to practice effective communication and consent. The chapter also clarifies the differences between sex, gender, and sexuality, encouraging respect for diversity and self-awareness in identity and attraction. By reviewing reproductive anatomy, contraception methods, and abortion, students are empowered to make informed decisions that reflect their values, health needs, and circumstances.

The chapter then transitions to the immune system, describing how the body protects itself from harmful microorganisms through layers of defense, including physical barriers and specialized immune cells. Students learn how the innate and adaptive immune systems work together to identify, attack, and remember pathogens, and why vaccines are such powerful tools for long-term protection. The “chain of infection” model demonstrates how diseases spread and how simple preventive actions—like handwashing, vaccination, and staying home when sick—can break that chain and stop outbreaks before they grow into epidemics or pandemics.

Finally, the section on sexually transmitted infections (STIs) highlights how these diseases are transmitted, their symptoms and long-term health effects, and why regular screening and early treatment are essential. The chapter emphasizes that some infections, such as chlamydia, gonorrhea, and HIV, can be silent but serious, affecting not only personal health but also reproductive outcomes, including pregnancy. Students gain an understanding of the social and economic impact of STIs and how prevention strategies—such as consistent condom use, communication with partners, and testing—support both personal and community health.

Together, these sections reinforce that maintaining healthy relationships, supporting immune function, and preventing infection are all part of a comprehensive approach to well-being. By applying the knowledge and skills from this chapter, students can make informed, respectful, and proactive choices that promote lifelong health for themselves and others.

Test Your Understanding

- What qualities define a healthy relationship, and why are communication and mutual respect essential to maintaining one?
- How do the terms sex, gender, and sexuality differ from one another, and why is it important to understand these distinctions in modern health education?
- List two examples of unhealthy relationship patterns and explain how they can negatively affect emotional well-being.
- What are some of the most common contraceptive methods, and how do “typical use” and “perfect use” rates differ in measuring their effectiveness?
- Describe how the body’s innate and adaptive immune systems work together to fight infection. Include an example of each type of defense.
- What is the “chain of infection,” and how can it be interrupted to prevent disease spread? Give at least two examples of prevention strategies.
- Why are vaccines considered one of the most effective tools for disease prevention, and how does the immune system’s “memory” contribute to their success?
- What are some common sexually transmitted infections, and which types (bacterial, viral, or parasitic) are curable versus incurable?
- How can certain STIs affect pregnancy and newborn health, and why is prenatal testing important for prevention and treatment?
- Explain why understanding STI prevalence, prevention, and treatment is important not only for personal health but also for public health and healthcare costs.

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Chapter 12 Glossary

- **Abstinence**: The Centers for Disease Control and Prevention (CDC) defines abstinence as not having vaginal, oral, or anal sex.
- **Bone Marrow**: Soft, spongy tissue found inside large bones that produces red blood cells, white blood cells, and platelets. It exists in two forms: *red marrow*, which actively generates blood cells, and *yellow marrow*, which primarily stores fat. It plays a key role in treating blood diseases such as leukemia through bone marrow transplantation.
- **Curable**: (of a disease or condition) able to be cured.
- **Endemic:** Endemic means a disease that is always present in a population within a geographic area, typically year-round.
- **Epidemic:** An unexpected increase in the number of disease cases in a specific geographical area.
- **Infectious Agent:** A microbe or pathogen that can invade a host and cause disease.
- **Lymphocytes**: Small white blood cells critical for immune defense.
- **Lymph Nodes**: Bean-shaped structures that filter lymph fluid, trap pathogens, and house immune cells.
- **Mode of Transmission:** The way in which an infectious agent is transferred from an infected person or animal (source) to a susceptible host (new person or animal).
- **Monogamous**: Having or involving a sexual relationship with only one partner at a time.
- **Outbreak:** A sudden increase in the number of disease cases in a particular place and time, beyond what is normally expected.
- **Pandemic:** An epidemic that spreads globally.
- **Pathogens:** Microorganisms or infectious agents that can cause disease.
- **Perfect Use Effectiveness**:
- **Portal of Entry:** The route or pathway through which an infectious agent, such as a virus, bacterium, or parasite, gains access to the body of a host.
- **Portal of Exit:** The route through which an infectious agent leaves the body of an infected individual
- **Reservoir:** A place or environment where an infectious agent (such as a virus, bacterium, or parasite) can live and multiply.
- **Spleen**: The largest lymphatic organ, containing white blood cells that fight infection.
- **STI (Sexually Transmitted Infection)**: Refers to the presence of a virus, bacterium, parasite, or fungus in the body. A person can have an STI without symptoms.
- **STD (Sexually Transmitted Disease)**: Refers to the condition that develops when an STI causes noticeable symptoms or complications.
- **Susceptible Host:** A person who is vulnerable to infection and can be easily affected by a disease.
- **Thymus**: A small organ located behind the breastbone where T-cells mature.
- **Typical Use Effectiveness**:
- **Vaccination**: Treatment with a vaccine to produce immunity to a particular infectious disease or pathogen.

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12.12: Detailed Accessible Description

Figure 12.4.2: Organs of the Immune System

This infographic explains key parts of the human immune system, focusing on lymphocytes and major organs that produce, store, or support immune cells. It combines a central body diagram with labeled locations and short text descriptions of each organ's function. All information is conveyed through text and labels.

Overview of lymphocytes: Lymphocytes are small white blood cells that play a major role in defending the body against disease. There are two main types. B-cells produce antibodies that attack harmful substances. T-cells help destroy infected cells.

Central body diagram: A simplified human figure is shown with labels identifying where important immune system components are located. These include tonsils and adenoids in the upper throat area, the thymus in the upper chest, lymph nodes distributed throughout the body, lymphatic vessels forming a network, the spleen in the upper abdomen, the appendix in the lower abdomen, bone marrow inside bones, and Peyer's patches in the intestines. These labels emphasize that the immune system is distributed throughout the body.

Organ descriptions

1. Thymus: A small organ located just behind the breastbone. It is where T-cells mature and become capable of responding to infections.
2. Bone marrow: A soft tissue found in the center of bones. It produces white blood cells, including those that develop into lymphocytes.
3. Lymph nodes: Small structures found throughout the body that produce and store cells that fight infection and disease. When a person has an infection, lymph nodes may become enlarged or sore.
4. Spleen: The largest lymphatic organ in the body. It contains white blood cells that help fight infection and disease. It also helps regulate and filter blood.

Reading order and structure: The information can be read from the overview of lymphocytes, to the labeled body diagram, and then to the descriptions of individual organs. The layout supports understanding of both where these structures are located and how they function.

Key meaning: The immune system is made up of specialized cells and organs that work together to protect the body from infection. Lymphocytes are central to this process, and multiple organs support their development, storage, and activation across different parts of the body.

Figure 12.4.3: Chain of Infection

This infographic explains the chain of infection, a model that shows how infectious diseases spread. The information is arranged in a circular sequence around a central title, "Chain of Infection." Each step in the chain is labeled and includes a short definition and examples. The steps are connected in a continuous loop, indicating that infection spreads through a repeating cycle.

Central concept: At the center of the image is the title "Chain of Infection." Surrounding this title is a circular pathway made up of six connected stages. Each stage represents a link in the chain. The sequence can be followed in a clockwise direction.

Stage 1: Infectious Agents

- Definition: Micro-organisms capable of causing disease or illness.
- Examples listed: Bacteria, fungi, parasites, prions.

Stage 2: Reservoirs

- Definition: Places in which infectious agents live, grow, and reproduce.

- Examples listed: People, water, food.

Stage 3: Portals of Exit

- Definition: Ways in which an infectious agent leaves the reservoir.
- Examples listed: Blood, secretions, excretions, skin.

Stage 4: Modes of Transmission

- Definition: Ways in which the infectious agent is spread from the reservoir to a susceptible host.
- Examples listed: Physical contact, droplets, airborne.

Stage 5: Portals of Entry

- Definition: Ways in which the infectious agent enters the susceptible host.
- Examples listed: Mucous membrane, respiratory system, digestive system, broken skin.

Stage 6: Susceptible Host

- Definition: Individuals who may have traits that affect their susceptibility and severity of disease.
- Examples listed: Immune deficiency, diabetes, burns, surgery, age.

Structure and relationships: Each stage is presented as part of a continuous loop, emphasizing that all six stages are required for infection to occur and spread. The cycle shows that once an infectious agent reaches a susceptible host, the process can begin again.

Key meaning: The chain of infection model demonstrates that disease transmission depends on multiple connected factors. Interrupting any one stage in the chain can help prevent the spread of infection.

Figure 12.4.4: The Innate and Adaptive Immune System

Overall structure

The diagram illustrates how pathogens entering the body trigger three lines of defense: surface defenses, internal (innate) defenses, and adaptive immunity. A cross-section of the nasal cavity and throat sits at the top, with four gray arrows branching outward to the three defense panels below.

Top panel: Nasal cavity cross-section

Shows a side view of the nasal passage and throat. Two small squares mark magnified regions:

• Pathogens — labeled with an arrow pointing to the nasal lining, where small dots represent invading microbes on the mucous membrane surface.

• Palatine tonsil — labeled with an arrow pointing to the rounded tonsil tissue at the back of the throat, shown in cross-section with a folded, textured interior.

Four arrows lead out from this panel: two point down to “Innate Immunity,” and one points down to “Adaptive Immunity” (specifically toward the palatine tonsil’s germinal center panel below).

Surface Defenses panel (left, under Innate Immunity)

A close-up of the nostril and surrounding skin, showing three numbered surface barriers:

1. Skin — the outer layer shown covering the nose, forming a physical barrier against pathogen entry.

2. Hair — visible nasal hairs shown at the nostril opening, which filter incoming air and trap larger particles.

3. Mucus — small droplets shown coating the nasal lining, which trap pathogens before they can penetrate deeper tissue.

Internal Defenses panel (right, under Innate Immunity)

A cross-section of skin/tissue and a blood vessel, illustrating cellular responses beneath the surface. Histamine is labeled at the top, shown as small dots released near a blood vessel — histamine is a signaling chemical that triggers inflammation, increasing blood flow and vessel permeability so immune cells can reach the injury or infection site. Four numbered internal defenses are labeled with arrows pointing to specific cells in the illustration:

1. Mast cells and basophils (inflammatory response) — shown as large purple/lavender speckled cells; these release histamine and other chemicals that trigger inflammation.

2. Natural killer cells — shown as a purple cell with a distinct nucleus; these detect and destroy infected or abnormal cells without needing prior exposure to the pathogen.

3. Complement system — shown as a small green oval-shaped particle; this refers to a group of blood proteins that help destroy pathogens directly and enhance other immune responses.

4. Phagocytes — shown as a white amoeba-like cell with a purple nucleus, engulfing debris; this category includes three cell types listed beneath it:

- Monocytes — circulating precursor cells that develop into macrophages.

- Neutrophils — shown as a green cell; the most abundant white blood cells, quick to respond and engulf pathogens.

- Macrophages — large phagocytic cells that engulf and digest pathogens and cellular debris.

Adaptive Immunity panel (bottom): Germinal center of palatine tonsil

A large pink oval represents the germinal center inside the palatine tonsil, where adaptive immune cells are shown developing and interacting. Three numbered cell categories are labeled with arrows pointing into the oval:

1. T lymphocyte — arrow points to a branching, dendritic-looking cell in the center-right of the oval (this represents an antigen-presenting cell interacting with T cells).

2. Antigen-presenting cells — the same branching cell, which displays pathogen antigens to activate T and B lymphocytes.

3. B lymphocytes — arrows point to rounded purple-and-white cells in the lower portion of the oval.

Within the oval, four specific cell types are shown with labels and connecting arrows showing their relationships:

- T memory cells — small green-flecked purple cells at the top, shown connected to the antigen-presenting cell; these persist after an infection to enable a faster response if the same pathogen returns.

- T effector cells — similar purple cells below the memory cells, also connected to the antigen-presenting cell; these actively fight the current infection.

- B memory cells — round cells with a purple-and-white split appearance, shown connected to the antigen-presenting cell; like T memory cells, they persist for faster future responses.

- B effector cells — similarly shaped cells below the B memory cells, connected to the antigen-presenting cell; these actively produce antibodies during the current infection.

- Antibodies — small Y-shaped yellow structures scattered in the lower-left of the oval, labeled with an arrow; antibodies are produced by B effector cells and bind to specific antigens to neutralize pathogens or mark them for destruction.

How the pieces connect

Pathogens entering through the nasal passage encounter surface defenses (skin, hair, mucus) first. If they penetrate further, internal innate defenses (mast cells, natural killer cells, complement, phagocytes) respond quickly but non-specifically. Simultaneously, the palatine tonsil's germinal center activates the adaptive immune response, where antigen-presenting cells trigger T and B lymphocytes to mount a pathogen-specific attack and generate memory cells for long-term protection.

Figure 12.6.1: STIs Remain Common and Costly to the Nation's Health

This infographic presents three key statistics about sexually transmitted infections (STIs) in the United States for the year 2018. The information is organized into three sections from left to right, focusing on overall prevalence, new infections and age distribution, and economic impact. A background outline of the continental United States appears behind the content, but all information is fully conveyed through text.

Section 1: Overall Prevalence of STIs: The first section explains how common STIs are in the United States. It states that 1 in 5 people in the U.S. have an STI. It also states that this totals nearly 68 million infections in 2018. A row of five human figures is included as a visual representation of the "1 in 5" statistic, but the meaning is fully clear from the text alone.

Section 2: New Infections and Age Distribution: The second section focuses on the number of new infections and who is most affected. It states that there were 26 million new STIs in 2018. It then explains that almost half of new STIs were among youth aged 15 to 24 in the U.S. A horizontal dotted line separates these two pieces of information, but it does not change the meaning.

Section 3: Economic Impact: The third section presents the financial cost of STIs. It states that new STIs total nearly 16 billion dollars in direct medical costs. A money bag icon appears next to this figure to represent cost, but the text fully communicates the information.

Key Takeaways: STIs are widespread, affecting 1 in 5 people in the United States. There were 26 million new infections in 2018. Young people aged 15 to 24 account for nearly half of new cases. The direct medical cost of new STIs is approximately 16 billion dollars. These statistics show that STIs are common, especially among young people. This highlights the importance of prevention, accurate information, and access to sexual health education in school and physical activity settings.

Figure 12.6.3: STIs Cost the U.S. Healthcare System Billions Each Year

The infographic summarizes the direct medical costs of sexually transmitted infections (STIs) in the United States. It highlights a total of 16 billion dollars in annual direct medical costs, who bears a large share of these costs, and how much each major STI contributes. The design uses a large money-bag icon on the left and a wavy cost-by-infection line across the bottom. Color emphasizes key numbers and groups but is not needed to understand the information.

Overall summary: The central message is that total direct medical costs for STIs are 16 billion dollars. This total includes costs across multiple infections and population groups.

Population shares of total cost: The infographic identifies two population groups and their share of total direct medical costs. Youth aged 15 to 24 account for 26 percent of total costs. Women account for 25 percent of total costs.

Combined cost for selected infections: The infographic highlights that chlamydia, gonorrhea, and syphilis together account for 1.1 billion dollars in direct medical costs. These infections are described as common and preventable.

Costs by individual infection: A sequence along the bottom lists specific infections and their associated direct medical costs. These values are presented as individual estimates:

- HBV: 46 million dollars
- HSV-2: 91 million dollars
- Trichomoniasis: 144 million dollars
- Syphilis: 174 million dollars
- Gonorrhea: 271 million dollars
- Chlamydia: 691 million dollars

- HPV: 775 million dollars
- HIV: 13.7 billion dollars

Reading order and structure: The information can be read from the central total cost, then to the population shares, then to the highlighted combined cost of selected infections, and finally to the detailed list of costs by infection along the bottom.

Key meaning: The infographic emphasizes that STIs create a substantial financial burden in terms of direct medical costs. A large portion of these costs is associated with young people and women. While some infections have relatively lower individual costs, HIV accounts for the largest share by a wide margin. The combined costs of common and preventable infections such as chlamydia, gonorrhea, and syphilis are also significant.

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13: SUBSTANCE USE AND MISUSE



Figure 13.1: (Red Eye by Diane Picchiottino on Unsplash)

Introduction to Substance Use and Misuse

Substance use and injury prevention are vital components of personal and public health. Understanding the broad scope of issues related to addiction, alcohol and tobacco use, drug misuse, and injury risk empowers individuals to make healthier decisions and supports broader community efforts to reduce harm. From the biological and psychological roots of addiction to the societal consequences of risky behavior and violence, these topics intersect with nearly every aspect of human development and well-being. Whether intentional or unintentional, many injuries and addictions are preventable with education, early intervention, and supportive environments.

This module explores the science behind addiction, highlighting the factors that influence drug misuse, the effects of commonly used substances, and the importance of treatment and prevention strategies. It also addresses the significant health risks posed by alcohol, tobacco, caffeine, and emerging products like e-cigarettes. By understanding how substances affect the brain and body, and how behavior becomes compulsive and destructive over time, individuals are better equipped to recognize warning signs, seek help, and support others in recovery.

In addition, this content examines the leading causes of unintentional and intentional injuries, from falls and motor vehicle crashes to violence, abuse, and suicide. Injury prevention strategies, such as safe environments, behavioral interventions, and community-wide support systems, are emphasized throughout. The goal is to empower learners not only to assess their risk but also to promote safety, resilience, and healthier choices in their homes, schools, and communities.

Learning Objectives

- Explain the nature of addiction as a chronic brain disease, including how it develops and impacts behavior and health.
- Identify biological, psychological, and environmental risk and protective factors for substance use and addiction.
- Recognize common types of drugs and behavioral addictions, including their effects on the brain and body.
- Describe the short-term and long-term health consequences of drug, alcohol, tobacco, and e-cigarette use.
- Define a standard drink and Blood Alcohol Concentration (BAC), and explain how alcohol affects individuals differently by gender, age, and body size. Distinguish between moderate, binge, and heavy drinking, and understand the health risks of excessive alcohol use.
- Summarize the health impacts of tobacco products, including cigarettes, smokeless tobacco, and secondhand smoke.
- Explain the risks associated with electronic cigarettes and their current regulatory status.

- Describe effective treatment and cessation strategies for substance and behavioral addictions, including behavioral therapies and medications.
- Differentiate between unintentional and intentional injuries, and identify common causes of each.
- Identify prevention strategies for unintentional injuries, including those related to falls, drowning, motor vehicles, fires, and poisoning.
- Explain the risks and safety measures for driving, cycling, and pedestrian activities.
- Recognize forms and impacts of intentional injuries, including intimate partner violence, child abuse, sexual violence, firearm violence, and suicide.
- Understand the public health approach to violence prevention, including the Social-Ecological Model and community-level strategies.
- Identify national and local resources for addiction recovery, injury prevention, crisis response, and violence support services.

13.1: Addiction
13.2: Recreational Drugs
13.3: Alcohol
13.4: Tobacco
13.5: Caffeine
13.6: Unintentional and Intentional Injury
13.7: Comprehension Check
13.8: Glossary
13.9: References

Thumbnail: Close-up of a left eye looking to the right. (Red Eye by Diane Picchiottino on Unsplash)
This chapter was remixed and authored by Rusty Johnson.

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13.1: Addiction



Figure 13.1.1: (Handcuffs and a Glass; Bermix Studio via Unsplash)

Introduction

Addiction is a complex and widespread issue that impacts individuals, families, and communities across the globe. Whether it begins with curiosity, peer influence, or an attempt to cope with stress or mental health struggles, drug use can quickly spiral into dependency and addiction. Understanding the science behind addiction, how it affects the brain, why certain people are more vulnerable, and the social and biological factors involved, is essential for prevention, treatment, and recovery. This section explores the nature of addiction, the reasons people turn to drugs, the consequences of abuse, and the most commonly misused substances in society today.

Drug Addiction

Drug addiction is a chronic brain disorder marked by compulsive drug seeking and use, despite harmful consequences. It alters brain structure and function, affecting areas responsible for judgment, decision-making, learning, and self-control. While the initial decision to use drugs is often voluntary, repeated use can lead to physical and psychological dependence. Addiction affects people from all walks of life and is influenced by a combination of genetic, environmental, and developmental factors. Understanding drug addiction is crucial for recognizing its warning signs, reducing stigma, and promoting effective prevention and treatment strategies.

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.



Figure 13.1.2: Addiction often comes from a continuance of expired prescription drugs. (Mix of Pills; Myriam Zilles via Unsplash)

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 or Peer Pressure

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 (National Institute on Drug Abuse, 2020). [63]

If drugs are enjoyable and useful, what's the problem?

When they first use a drug, people may perceive what seems 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.

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 (National Institute on Drug Abuse, 2020). [63]



Figure 13.1.3: Cigarette smoking is one of the most difficult addictions to deal with. (Man Smoking by Reza Mehrad via Unsplash)

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, school, and in the neighborhood, or biological, for instance, a person's genes, stage of development, and even a person's gender or ethnicity.

Table 13.1.1: 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?

Where someone lives or goes to school and work can affect the risks 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 (National Institute on Drug Abuse, 2020). [63]

What biological factors increase the risk of addiction?

Many factors can increase a person's risk of becoming addicted.

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 they 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

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 (National Institute on Drug Abuse, 2020). [63]

What other factors increase the risk of addiction?

Besides the factors of our environment and genetics, other factors can increase the risk of addiction as well.

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 (National Institute on Drug Abuse, 2020). [63]

Question

- How might growing up in a household where drugs or alcohol are misused affect a child's future choices?
- Think about your own school or community environment.
  - What protective factors can help reduce the risk of addiction among young people?
- Why do you think peers become such a powerful influence during adolescence?



Figure 13.1.4: Intravenous drugs can increase the level of addiction by sending the narcotic straight into the bloodstream. (Vials and Needles by Hennie Stander via Unsplash)

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 person's 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 **withdrawal** symptoms. Withdrawal symptoms vary depending on the type of drug dependence and may include tremors (shaking), cravings, agitation, nausea, sweating, or mood changes (National Institute on Drug Abuse, 2020). [63]

Despite being aware of these harmful outcomes, many people who use drugs continue to take them, which is the nature of addiction.

What are some of the 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, missed work, or problems with keeping a job.

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.



Figure 13.1.5: Being addicted and under the influence most of the time can impair judgement and coordination. (Man in Gray Polo Shirt by Mishal Ibrahim via Unsplash)

Drug abuse not only harms the individual using drugs, but it can also deeply affect everyone connected to them. When a person or their loved one struggles with drug abuse, daily life can feel chaotic and unpredictable. The impact on the family can be significant and far-reaching:

- A person with a drug problem is dealing with a disease that can cause emotional and physical harm to the entire family.
- Drug abuse creates intense stress for parents, siblings, children, grandparents, and others living in the home.
- Family conflict often increases due to the challenges brought on by substance abuse.
- The behavior of the person using drugs may upset neighbors and friends, leading to feelings of embarrassment or shame for the family.

Families living with a drug-abusing member may face situations such as:

- The individual may not follow through on promises or responsibilities.
- Their attention may be consumed by obtaining and using drugs, making them unreliable.
- They might lie or steal to support their drug use.
- They could lose their job due to drug-related issues.
- They may stay out all night or disappear without explanation.
- They might engage in harmful or illegal behavior they would not consider if they were sober.

The broader consequences of drug abuse can include fighting and violence at home or in the community, financial problems, academic and workplace difficulties, broken relationships, child neglect or abuse, car accidents, and legal troubles such as arrest or incarceration (National Institute on Drug Abuse, 2020). [63]

Treatment for Drug Addiction

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 (National Institute on Drug Abuse, 2020). [64]



Figure 13.1.6: Sometimes treatment for addiction involves using other drugs that can also be addictive. (Two Hands Holding a Red and Blue Pill by Frank Tunder via Unsplash)

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 use. 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 (National Institute on Drug Abuse, 2020). [64]

Addiction Treatment

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-1970's, 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 (National Institute on Drug Abuse, 2020). [64]



Figure 13.1.7: A meeting of Alcoholics Anonymous. (ChatGPT Free license via OpenAI)

Successful treatment has several steps

Successful drug addiction treatment is a comprehensive, multi-step process that addresses both the physical and psychological aspects of substance use. Recovery requires more than simply stopping drug use; it involves ongoing care, support, and treatment tailored to an individual's unique needs. The five key components of effective treatment include detoxification, behavioral counseling, medication, evaluation and treatment of co-occurring conditions, and long-term follow-up. Together, these steps form a foundation for lasting recovery and a healthier future.

Detoxification

Detoxification, or "detox," is the process of allowing the body to clear itself of drugs while managing the symptoms of withdrawal. It is often the first step in treatment and typically takes place in a medically supervised setting. Withdrawal symptoms can vary depending on the drug and severity of addiction and may include anxiety, nausea, seizures, or even life-threatening complications. Medical staff may administer medications to ease symptoms and ensure safety. While detox removes substances from the body, it does not address the psychological aspects of addiction, which is why further treatment is essential.

Behavioral counseling

Behavioral counseling is the core component of most addiction treatment programs. It helps individuals identify and change destructive thinking patterns and behaviors related to drug use. Counseling may occur individually, in groups, or with family members. Behavioral therapies also help improve communication, rebuild relationships, and promote healthy lifestyle changes.

Common approaches include:

Cognitive-behavioral therapy (CBT): Helps patients recognize triggers, develop coping strategies, and prevent relapse.

Contingency management: Offers rewards for staying drug-free.

Behavioral therapies also help improve communication, rebuild relationships, and promote healthy lifestyle changes.: Builds the individual's motivation to change.

Medication

Medications can be used during different stages of recovery to manage withdrawal symptoms, reduce cravings, and treat co-occurring mental health issues. Medication-assisted treatment (MAT) is especially effective when combined with behavioral

therapies.

For example:

- Methadone, buprenorphine, or naltrexone for opioid addiction
- Disulfiram, acamprosate, or naltrexone for alcohol use disorder
- Medications for anxiety, depression, or other mental health conditions

Evaluation and Treatment

Many people struggling with substance use disorders also suffer from co-occurring mental health conditions such as depression, anxiety, PTSD, or bipolar disorder. A comprehensive treatment plan must include screening and treatment for these issues. Integrated treatment, where both the substance use and mental health disorders are addressed together, leads to better outcomes. Untreated mental health conditions can increase the risk of relapse.

Long-term Follow-up

Addiction is a chronic disease, and long-term follow-up is critical to maintaining sobriety. Long-term follow-up helps patients stay accountable, manage stressors, and build a drug-free lifestyle. Since relapse can occur, these supports are vital for recognizing early warning signs and taking action quickly.

After the initial treatment phase, ongoing support may include:

- Outpatient therapy
- Sober living homes
- 12-step or peer support groups (e.g., AA, NA)
- Regular check-ins with healthcare providers

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 person's 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 (Alavi et al, 2012). [2]

Experts have identified six criteria to determine a behavioral addiction:

- Salience: Domination of a person’s life by an activity
- Euphoria: A ‘buzz’ or a ‘high’ is derived from the activity
- Tolerance: The activity has to be undertaken to a progressively greater extent to achieve the same ‘buzz.’
- Withdrawal Symptoms: Cessation of the activity leads to the occurrence of unpleasant emotions or physical effects
- Conflict: The activity leads to conflict with others or self-conflict
- Relapse and Reinstatement: Resumption of the activity with the same vigor after attempts to abstain, negative life consequences, and neglect of job, educational or career opportunities (National Institute on Drug Abuse, 2020). [64]



Figure 13.1.8: Behavior can be a form of addiction, as demonstrated with gambling addiction. (Poker by Keenan Constance via Unsplash)

More to Explore

As with drug addiction, the best treatment for behavioral addiction is prevention. Research some of the most common behavioral addictions:

- Gambling Addiction
- Shopping Addiction
- Internet Gaming Addiction

Key Points

- Addiction is a brain disease. It alters brain structure and function, especially areas related to judgment, self-control, and behavior, making drug use compulsive over time.
- People use drugs for various reasons. These include feeling good, coping with stress or mental illness, enhancing performance, or due to peer pressure, especially among adolescents.
- Risk and protective factors influence addiction. Genetics, early drug use, environmental factors (such as family and peer influences), and brain development all impact a person's vulnerability.
- Drug use affects the brain's reward system. Most drugs flood the brain with dopamine, leading to feelings of pleasure. Continued use alters this system, causing tolerance, dependence, and reduced ability to feel pleasure naturally.
- Drug abuse has widespread consequences. It affects not only the user but also families and communities, leading to issues like violence, job loss, child neglect, crime, and health problems.

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13.2: Recreational Drugs



Figure 13.2.1: (Man Smoking Marijuana; Elsa Olofsson on Unsplash)

Introduction

Recreational drugs are substances taken for pleasure rather than for medical purposes, often to alter mood, perception, or consciousness. These drugs can be legal, like alcohol, nicotine, and marijuana, in some states, or illegal, like heroin and cocaine. While some may view recreational drug use as a way to relax or enhance social experiences, it carries significant health risks, including addiction, physical harm, mental health issues, and impaired decision-making. The effects vary widely depending on the substance, method of use, and individual factors, and even casual use can lead to serious and sometimes life-threatening consequences.

Drug Facts

Drug use and addiction remain serious public health challenges, affecting individuals, families, and communities across the globe. A wide variety of substances, including both legal and illegal drugs, can alter the brain and body in dangerous ways, especially when misused or abused. This chapter provides an overview of commonly used and abused substances, their short- and long-term health effects, and the risks associated with use. Understanding the physical, psychological, and social consequences of each drug is critical for prevention, early intervention, and informed decision-making (National Institute on Drug Abuse, 2023). [68]

Marijuana

Marijuana, also known as cannabis, is a psychoactive drug derived from the Cannabis plant. It is most commonly smoked but can also be consumed in edibles, vaped, or used as oils or tinctures. The main active chemical in marijuana is THC (tetrahydrocannabinol), which affects the brain by binding to cannabinoid receptors, leading to altered perception, mood changes, impaired memory, and coordination issues.



Figure 13.2.2: A cannabis plant. (Person Holding Silver and Black Scissors; CRYSTALWEED cannabis via Unsplash)

While some people use marijuana for medical purposes, such as pain relief, nausea control, or appetite stimulation, it can also lead to negative effects, especially with heavy or long-term use. These may include difficulty thinking, increased anxiety, and dependence. In adolescents, regular marijuana use can impair brain development and reduce motivation and academic performance (National Institute on Drug Abuse, 2021). [66]

Table 13.2.1: 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 are born with problems involving attention, memory, and problem-solving.

Synthetic Cannabinoids

Synthetic cannabinoids are human-made mind-altering chemicals that are 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 (National Institute on Drug Abuse, 2021). [67]

Table 13.2.2: Possible Health Effects of Synthetic cannabinoids

Time	Effects
Short-term	Rapid heart rate, vomiting, violent behavior, suicidal thoughts, altered perception, and 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.

Quiz on Cannabinoids

1. The main psychoactive chemical in marijuana is:
   a. CBD
   b. THC
   c. GABA
   d. Dopamine
2. Regular marijuana use during adolescence can impair brain development and reduce motivation. (True/False)
3. Name one serious short-term effect and one long-term effect of synthetic cannabinoids.

Cocaine

Cocaine is a powerful and highly addictive stimulant drug made from the leaves of the coca plant native to South America. It increases levels of dopamine in the brain, producing short-term feelings of intense euphoria, energy, and alertness. However, these effects are short-lived and often followed by anxiety, restlessness, and intense cravings for more.



Figure 13.2.3: (Cocaine; Colin Davis on Unsplash)

Cocaine can be snorted, smoked (in the form of crack cocaine), or injected. Its use significantly increases the risk of heart attack, stroke, seizures, and other serious health problems. Long-term use can lead to addiction, paranoia, irritability, and damage to the heart, brain, and nasal tissues (if snorted). Despite its risks, cocaine is often abused recreationally, especially in social settings, because of its rapid and intense effects (National Institute on Drug Abuse, 2021). [65]

Table 13.2.3: 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.
Other Health-related Issues	Pregnancy: premature delivery, low birth weight, and smaller head circumference. Risk of HIV, hepatitis, and other infectious diseases from shared needles.

Methamphetamine

Methamphetamine (commonly known as meth) is a powerful and highly addictive stimulant that affects the central nervous system. It appears as a white, odorless, bitter-tasting crystalline powder that can be swallowed, snorted, smoked, or injected. Meth dramatically increases the amount of dopamine in the brain, resulting in intense feelings of euphoria, increased energy, and alertness.



Figure 13.2.4: Used methamphetamine pipe. (Meth Pipe; JR via Pixabay)

However, these effects come at a high cost. Meth use can lead to serious health issues, including extreme weight loss, severe dental problems ("meth mouth"), anxiety, paranoia, hallucinations, and violent behavior. Long-term use can cause irreversible damage to the brain, affecting memory, decision-making, and emotional regulation. Methamphetamine is also associated with a high potential for addiction and compulsive use, even after just a few uses (National Institute on Drug Abuse, 2009). [59]

Table 13.2.4: Possible Health Effects of Methamphetamine

Time	Effect
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"), and 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.

Quiz on Cocaine and Methamphetamine

1. Cocaine produces its powerful effects by increasing the levels of which neurotransmitter in the brain?
   a. GABA
   b. Dopamine
   c. Serotonin
   d. Acetylcholine
2. Long-term snorting of cocaine can lead to nasal damage and loss of smell. (True/False)
3. What are two hallmark physical health consequences of long-term methamphetamine use?
4. Which of the following is NOT a short-term effect of methamphetamine?
   a. Increased wakefulness
   b. Decreased appetite

c. Irregular heartbeat
d. Improved memory and decision-making

Prescription CNS Depressants

Prescription CNS (central nervous system) **depressants** are medications that slow brain activity to help treat conditions like anxiety, panic disorders, acute stress reactions, and sleep disorders. Common types include benzodiazepines (e.g., Valium, Xanax), barbiturates (e.g., phenobarbital), and sleep medications (e.g., zolpidem/Ambien).



Figure 13.2.5: (Xanax Bottles; Davide Zacchello on Unsplash)

These drugs work by enhancing the effects of the neurotransmitter GABA, which reduces brain activity and produces a calming or sedating effect. While effective when used as prescribed, CNS depressants can be dangerous when misused. Abuse can lead to drowsiness, confusion, poor coordination, slowed breathing, and even overdose. Long-term misuse may result in dependence, tolerance, and withdrawal symptoms, making them highly risky without medical supervision (National Institute on Drug Abuse, 2012). [61]

Table 13.2.5: 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, and slowed breathing.
Long-term	Physical dependence, withdrawal, possibility of seizures from the 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 CNS (central nervous system) **stimulants** are medications used to increase alertness, attention, and energy. They are commonly prescribed to treat conditions such as attention-deficit hyperactivity disorder (ADHD) and narcolepsy. Common examples include amphetamine-based drugs (e.g., Adderall) and methylphenidate (e.g., Ritalin, Concerta).



Figure 13.2.6: (Prescription Ritalin Bottle; David Trinks via Unsplash)

These stimulants work by increasing levels of the brain chemicals dopamine and norepinephrine, which enhance focus and alertness. When used as prescribed, they can be safe and effective, but misuse—such as taking higher doses, using without a prescription, or using them to boost academic or athletic performance—can lead to serious risks. These include increased heart rate, high blood pressure, anxiety, insomnia, and in some cases, addiction or cardiovascular complications (National Institute on Drug Abuse, 2012). [61]

Table 13.2.6: 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.
Other Health-related Issues	At high doses, prescription stimulants can lead to a dangerously high body temperature, an irregular heartbeat, heart failure, and seizures.

Quiz on CNS Depressants and Stimulants

1. CNS depressants like benzodiazepines and barbiturates work by decreasing the effects of GABA in the brain. (True/False)
2. What is a potential danger when CNS depressants are combined with alcohol?
   a. Hallucinations
   b. Rapid heart rate
   c. Dangerous slowing of breathing and heart rate
   d. Increased appetite
3. List one common prescription CNS stimulant and the condition it is usually prescribed to treat.
4. Misuse of prescription stimulants at high doses can cause:
   a. Hallucinations and paranoia
   b. Constipation
   c. Euphoria and relaxation
   d. Increased appetite

Prescription Opioids

Prescription **opioids** are powerful pain-relieving medications used to treat moderate to severe pain, often after surgery, injury, or for chronic health conditions. Common examples include oxycodone (OxyContin, Percocet), hydrocodone (Vicodin), morphine, codeine, and fentanyl.

These drugs work by binding to opioid receptors in the brain and spinal cord, reducing the perception of pain and producing feelings of relaxation and euphoria. While effective when taken as prescribed, opioids carry a high risk of tolerance, dependence, and addiction. Misuse—such as taking higher doses, using without a prescription, or combining with alcohol or other drugs—can lead to serious side effects, including respiratory depression, overdose, and death. The widespread misuse of these medications has contributed to the ongoing opioid epidemic in the U.S. and other parts of the world (National Institute on Drug Abuse, 2018). [62]

Table 13.2.7: 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 illegal, highly addictive opioid drug made from morphine, a natural substance extracted from the seed pod of the opium poppy plant. It typically appears as a white or brown powder or as a sticky black substance known as “black tar heroin.” It can be injected, snorted, or smoked, with injection being the most common method.



Figure 13.2.7: (Holding a Syringe; Jair Lázaro via Unsplash)

Heroin quickly enters the brain and binds to opioid receptors, producing intense feelings of euphoria, warmth, and pain relief. However, these effects are short-lived and often followed by drowsiness, nausea, and severe itching. Heroin use carries serious

risks, including addiction, overdose, and death, especially when mixed with other substances like fentanyl. Long-term use can lead to collapsed veins, infections, liver and kidney disease, and damage to the brain's ability to regulate decision-making and behavior (National Institute on Drug Abuse, 2018). [62]

Table 13.2.8: 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 used medically to treat severe pain, especially after surgery or in cancer patients. It is 50 to 100 times more potent than morphine. Prescription fentanyl is available in various forms, including patches, lozenges, and injections.



Figure 13.2.8: Forms of fentanyl. (ChatGPT Free License via OpenAI)

Illegally manufactured fentanyl is often mixed with other drugs like heroin, cocaine, or counterfeit pills, often without the user's knowledge, greatly increasing the risk of overdose and death. Even a tiny amount—as little as 2 milligrams—can be fatal. Fentanyl works by binding to opioid receptors in the brain to block pain and produce intense euphoria, but it also slows breathing and heart rate. Overdose symptoms include extreme drowsiness, slowed or stopped breathing, and loss of consciousness. It is one of the leading causes of opioid-related deaths in the U.S. today (National Institute on Drug Abuse, 2021). [71]

In recent years, fentanyl has emerged as a leading driver of overdose deaths in the United States due to its high potency and widespread contamination of the illicit drug supply. Fentanyl, a synthetic opioid that is up to 50 times stronger than heroin and 100 times stronger than morphine, is increasingly being mixed into other recreational drugs such as cocaine, methamphetamine, and counterfeit prescription pills (National Institute on Drug Abuse, 2023). [69] Many users are unaware that their drugs contain fentanyl, which greatly increases the risk of accidental overdose. Even trace amounts can be lethal, making unintentional exposure particularly dangerous for people without opioid tolerance (Centers for Disease Control and Prevention, 2024). [20]

The surge in fentanyl-related deaths highlights a growing public health crisis fueled by this hidden contamination. According to the CDC, synthetic opioids, primarily fentanyl, were involved in nearly 70% of all drug overdose deaths in 2022 (Centers for Disease Control and Prevention, 2024). [20] Law enforcement agencies have reported widespread circulation of counterfeit pills designed to look like legitimate prescription medications such as oxycodone or alprazolam, but actually laced with fentanyl (Drug Enforcement Administration, 2022). [36] This deception makes it nearly impossible for users to know what they are consuming, often leading to fatal consequences. Addressing this crisis requires expanded access to fentanyl test strips, naloxone distribution, and education campaigns to raise awareness of the hidden dangers in the recreational drug supply (National Institute on Drug Abuse, 2023). [69]

Narcan

Narcan, the brand name for naloxone, is an opioid antagonist medication that rapidly reverses the effects of opioid overdose by binding to opioid receptors and displacing harmful opioids such as heroin or fentanyl. It is widely recognized as a lifesaving intervention and has become a cornerstone of public health strategies addressing the opioid crisis. Today, Narcan is effectively used by first responders, healthcare providers, and increasingly by community members, thanks to expanded over-the-counter availability and harm reduction initiatives (National Institute on Drug Abuse, 2023). [70] When administered promptly, Narcan can restore normal breathing within minutes in individuals experiencing respiratory depression due to overdose (Centers for Disease Control and Prevention, 2024). [31] Its effectiveness and safety have led to widespread distribution in schools, libraries, and community centers, reflecting a shift toward empowering the public to respond to overdoses and reduce preventable deaths (Substance Abuse and Mental Health Services Administration, 2023). [82]

Quiz on Prescription Opioids, Heroin, and Fentanyl

1. Prescription opioids and heroin both bind to opioid receptors in the brain, reducing pain and creating euphoria. (True/False)
2. Which of the following is a major risk of long-term heroin use?
   a. Collapsed veins
   b. Increased appetite
   c. Improved immune function
   d. Heightened alertness
3. Why is fentanyl considered especially dangerous compared to other opioids?

Table 13.2.9: Possible Health Effects of Fentanyl

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, and death.

Hallucinogens

Hallucinogens are a category of drugs that cause profound changes in perception, mood, and thought. They can distort a person's sense of reality, leading to hallucinations—seeing, hearing, or feeling things that aren't actually there. Common hallucinogens include LSD (acid), psilocybin (magic mushrooms), peyote, Dimethyltryptamine (DMT), and mescaline.



Figure 13.2.9: Psilocybin Cubensis hallucinogenic mushrooms. (Magic Mushrooms by Pretty Drugthings via Unsplash)

These drugs typically affect serotonin receptors in the brain, altering sensory perception, emotional regulation, and thinking. Effects can include vivid visuals, a distorted sense of time, spiritual experiences, or intense emotional shifts. While some people use hallucinogens for recreational or ritual purposes, they can also cause confusion, anxiety, paranoia, and panic. In rare cases, users may experience long-lasting psychosis or hallucinogen-persisting perception disorder. Though not considered physically addictive, hallucinogens can still lead to risky behavior and psychological dependence (National Institute on Drug Abuse, 2012). [60]

Table 13.2.10: 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.

More to explore

Visit these websites for in-depth information on these drugs and others:

- The National Institute on Drug Abuse (NIDA)
- The National Institute on Drug Abuse - Drug Facts

Key Points

- Marijuana affects perception, memory, coordination, and motivation, especially for youth and during pregnancy. Long-term use can impair brain development and cause respiratory issues.
- Synthetic cannabinoids (fake weed) are unpredictable and dangerous, often causing rapid heart rate, psychosis, and even death—especially when mixed with opioids like fentanyl.

- Cocaine is a powerful stimulant that increases energy and euphoria but can lead to severe health risks such as heart attacks, paranoia, and brain damage; long-term use can cause serious nasal and gastrointestinal damage.
- Methamphetamine is highly addictive and damages the brain, teeth, and skin. It causes extreme behavioral changes and can lead to irreversible cognitive and emotional issues.
- Prescription CNS depressants slow brain activity and are used for anxiety and sleep disorders, but misuse can lead to overdose, especially when combined with alcohol.
- Prescription CNS stimulants (e.g., Adderall, Ritalin) are used to treat ADHD but can be misused for performance enhancement, leading to heart problems, psychosis, or addiction.
- Prescription opioids effectively manage pain but carry a high risk of addiction, overdose, and death, especially when misused or mixed with alcohol or other drugs.
- Heroin is an illegal opioid that produces intense euphoria but leads to serious health issues like collapsed veins, organ damage, and a high risk of fatal overdose.
- Fentanyl is a synthetic opioid 50–100 times more potent than morphine; just 2 milligrams can be fatal. It is a major contributor to opioid-related deaths in the U.S.
- Successful addiction treatment includes five key steps: detoxification, behavioral counseling, medication, evaluation of co-occurring conditions, and long-term follow-up. Treatment must be ongoing and individualized to prevent relapse and support lasting recovery.

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13.3: Alcohol



Figure 13.3.1: (Full Bar; Susie Burleson via Unsplash)

Introduction

Alcohol use is a widespread and socially accepted practice in the United States, but its effects on health, behavior, and overall well-being are often underestimated. From understanding what constitutes a standard drink and how alcohol is metabolized to recognizing the signs of excessive use and its impact on various organs, it is crucial to be informed about the risks associated with alcohol consumption. This comprehensive overview explores how alcohol affects the body and brain, outlines safe drinking guidelines, highlights the dangers of abuse, and presents effective strategies for reducing or quitting alcohol use. It also introduces evidence-based treatment options that support long-term recovery and healthier lifestyle choices.

Alcohol Use

Alcohol is one of the most commonly used substances in the United States, and while moderate consumption is socially accepted, its effects on the body and behavior are significant and often underestimated. This overview explores the impact of alcohol use, the risks associated with high blood alcohol concentration (BAC), and the long-term consequences of alcohol abuse (National Institute on Alcohol Abuse and Alcoholism, 2021). [56]

College

Alcohol use remains one of the most common substances consumed by college students in the United States, often tied to socialization, peer pressure, and campus culture. National surveys indicate that nearly 50% of full-time college students ages 18 to 22 reported drinking alcohol in the past month, and about 28% engaged in binge drinking, defined as consuming five or more drinks on one occasion for men and four or more for women (Substance Abuse and Mental Health Services Administration, 2022). [81] This level of consumption not only places students at risk for immediate harms such as accidents, injuries, and academic difficulties but also increases the likelihood of developing long-term alcohol use disorders. The normalization of heavy drinking in college environments contributes to a culture where risky behaviors are often overlooked.

The consequences of alcohol misuse among college students are significant and far-reaching. The National Institute on Alcohol Abuse and Alcoholism estimates that each year, approximately 1,500 college students die from alcohol-related unintentional injuries, including motor vehicle crashes (National Institute on Alcohol Abuse and Alcoholism, 2023). [58] In addition, about 696,000 students are assaulted annually by another student who has been drinking, and roughly 97,000 students experience

alcohol-related sexual assault or date rape. Beyond these immediate harms, excessive alcohol consumption also undermines student success, with around 1 in 4 students reporting academic problems such as missed classes, falling behind, or poor exam performance due to drinking (National Institute on Alcohol Abuse and Alcoholism, 2023). [58] These statistics highlight the urgent need for evidence-based prevention and intervention strategies on college campuses to reduce both the prevalence and the adverse outcomes of alcohol use.

Understanding Intoxication Levels: Blood Alcohol Concentration (BAC)

A blood alcohol test measures the level of alcohol in a person's blood, typically conducted using a breathalyzer or a blood test. A **blood alcohol concentration (BAC)** greater than 0.08% is generally considered an indicator of intoxication, meaning there are 0.08 grams of alcohol for every 100 milliliters of blood. In the United States, all states have adopted 0.08% as the legal BAC limit for operating a motor vehicle for drivers aged 21 and older, except for Utah, which lowered its legal limit to 0.05% in 2018.

The liver is the primary organ responsible for metabolizing alcohol, but it can only process a limited amount at a time, averaging approximately one standard drink per hour. If a person consumes more alcohol than the liver can process, intoxication occurs. As BAC increases, the effects of alcohol intensify, along with the risk of harm. High BAC levels can lead to blackouts (gaps in memory), loss of consciousness (passing out), and even death.



Figure 13.3.2: (Drunk Driving; Aedrian Salazar via Unsplash)

It is important to recognize that the "one drink per hour" guideline is only an average, as the time required for the body to metabolize alcohol varies from person to person. Factors such as biological differences between men and women, whether food has been consumed, and the quantity of alcohol consumed all influence how quickly alcohol is processed (National Highway Traffic Safety Administration, 2015). [53]

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).

Examples of BAC Differences

- A male and a female who weigh the same, eat the same meal, and drink the same amount of alcohol will have different BACs. Women tend to have higher body fat percentages 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 break down alcohol, thus impacting the body's 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 men.
- A person who regularly drinks can build up tolerance because their body may increase production of the enzymes that break down 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 the 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.
- The absorption of alcohol depends on how quickly it moves through the stomach, a process known as the gastric emptying rate. When the stomach is empty, gastric emptying increases, allowing alcohol to be absorbed more rapidly. Conversely, when the stomach is full, gastric emptying slows down, causing alcohol absorption to take longer (Mumenthaler et al, 1999). [50]

Alcohol Consumption Levels

While most U.S. adults consume alcohol, the Dietary Guidelines for Americans advise limiting intake and recommend that those who do not drink continue to abstain. For those who choose to drink, moderate alcohol consumption is defined as up to one drink per day for women and up to two drinks per day for men.



Figure 13.3.3: Pressure to drink often comes from peers in social situations. (Drinks of the Dance Floor; Abstral Official via Unsplash)

Excessive alcohol use should be avoided, including binge drinking, heavy drinking, and any drinking by pregnant women or individuals under 21. Binge drinking is the most common form of excessive alcohol use and significantly raises blood alcohol concentration (BAC), increasing the risk of harm.

Data shows that about 66% of adults aged 21 to 59 have consumed alcohol in the past month, and nearly half of those report binge drinking, often more than once a month.

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.

Some people 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 (National Institute on Alcohol Abuse and Alcoholism, n.d.). [55]

Health Effects of Alcohol Abuse

Excessive alcohol consumption, whether on a single occasion or over time, can have serious health consequences. Alcohol affects various parts of the body in different ways, leading to a range of potential health issues.

Brain

Alcohol consumption significantly impacts the brain by interfering with its communication pathways, altering both its structure and function. These disruptions can lead to changes in mood and behavior, impairing a person's ability to think clearly and move with coordination. Additionally, alcohol use is linked to learning and memory problems, potentially contributing to conditions like dementia and poor academic performance. Mental health issues such as depression and anxiety are also commonly associated with alcohol abuse. Furthermore, alcohol can contribute to various social problems, including decreased productivity, strained family relationships, and unemployment. It is also a major factor in violent behaviors, including homicide, suicide, sexual assault, and intimate partner violence, further emphasizing its detrimental effects on both individuals and society.

Heart

Excessive alcohol consumption, whether over an extended period or in a single heavy drinking session, can have serious consequences for heart health. One major risk is **cardiomyopathy**, a condition in which the heart's ability to pump blood effectively is impaired, potentially leading to heart failure. Alcohol can also cause **arrhythmias**, or irregular heartbeats, which may increase the risk of severe cardiovascular complications. Additionally, heavy drinking is a known contributor to high blood pressure, a major risk factor for stroke and other heart-related diseases. These effects highlight the significant strain alcohol places on the cardiovascular system, increasing the likelihood of life-threatening conditions.

Liver

Heavy alcohol consumption puts significant strain on the liver, leading to various forms of liver damage and inflammation. One common condition is **steatosis**, or fatty liver, in which excess fat accumulates in the liver, potentially causing inflammation, cell death, and scarring that can progress to liver fibrosis. **Alcoholic hepatitis**, another consequence of heavy drinking, results in liver inflammation and the formation of scar tissue, further impairing liver function. If liver damage continues, fibrosis can develop, where persistent inflammation leads to excessive scarring, increasing the risk of cirrhosis, liver failure, and portal hypertension, often requiring a liver transplant. In advanced cases, cirrhosis occurs, permanently scarring the liver and severely compromising its ability to function, highlighting the severe and potentially fatal impact alcohol has on this vital organ.

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 breasts.

Immune System

Excessive alcohol consumption can weaken the immune system, making the body more vulnerable to disease. Chronic drinkers are more susceptible to illnesses such as pneumonia and tuberculosis compared to those who consume alcohol in moderation or abstain. Additionally, consuming large amounts of alcohol on a single occasion can impair the body's ability to fight off infections for up to 24 hours after intoxication.

Risky Sexual Behaviors

Having unprotected sex or sex with multiple partners can result in unintended pregnancy or sexually transmitted diseases, including HIV. These situations often arise when consuming alcohol due to the lowering of inhibitions when intoxicated, combined with the social aspect of drinking (National Institute on Alcohol Abuse and Alcoholism, 2022). [57]

Rethinking Drinking

Alcohol consumption affects the body in many ways, influencing not just short-term behavior but also long-term health. While some accept moderate drinking, alcohol adds discretionary calories to the diet, can contribute to nutrient imbalances, and poses increased risks, especially for women and those who develop tolerance. Despite common beliefs about alcohol's potential heart benefits, the evidence is unclear, and heavy or frequent use can cause serious damage to organs like the liver. Understanding these risks and how alcohol interacts with the body is essential for making informed choices about drinking.

Alcohol and Caloric 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, can also contribute to added sugars and saturated fat intake. Thus, regular consumption of alcoholic beverages can make it challenging for adults to meet food group and nutrient needs while not consuming excess calories.

Alcohol Tolerance

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 of 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.

Are Female Risk Factors Higher than Males'?

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.

Is Drinking Good for the Heart in Lower Amounts?

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 the risk of heart disease), and others show this may not be true. Thus, there is no solid conclusion to this question, and it warrants more research.

Can the Liver be Protected?

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 a liver transplant. The best way to protect liver health is by staying within low-risk drinking limits or, for those who already have liver damage or signs of an alcohol problem, by quitting.

Also, it's best if people who drink avoid acetaminophen (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 (Mitchell et al, 2020). [49]

Quitting or Reducing Alcohol

The first step in addressing alcohol consumption is determining whether cutting down or quitting is the best approach. When considering quitting, it is important to recognize that there is no one-size-fits-all solution, and individuals should explore options that best suit their needs. Changing habits such as smoking, overeating, or excessive drinking requires significant effort, and success may not come on the first attempt. Setbacks are common, but each attempt provides valuable lessons and brings individuals closer to their goal. Regardless of the chosen approach, it is essential to give it a fair trial and remain persistent in the process.

More to Explore: Cutting Back or Quitting Completely

If you want to reduce your consumption, review the following website and select two or three to try in the next week or two:

- Tips to Try Cutting Back on Alcohol

It may help to have reminders to reinforce your decision to make a change, such as automated smartphone alerts that you send yourself.

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. The National Institute on Alcohol Abuse and Alcoholism has a tool on its website to help you find the support needed.

- 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 resources:

- NIAAA Adolescent Treatment Resources
- Partnership for Drug Free Kids

Evidence-Based Behavioral Treatments

This section elaborates on four evidence-based therapeutic approaches commonly used in the treatment of substance use and

mental health disorders. These include Cognitive Behavioral Therapy (CBT), which focuses on identifying and changing harmful thinking patterns; Motivational Enhancement Therapy (MET), which aims to strengthen a person's internal motivation for change; Contingency Management (CM), which uses positive reinforcement to encourage sobriety; and 12-Step Facilitation Therapy (TSF), which supports engagement with peer-based recovery programs. Each method offers a distinct pathway to recovery, tailored to meet individuals where they are in their journey toward healing.

Cognitive-Behavioral Therapy (CBT)

Widely used and evidence-based, **Cognitive Behavioral Therapy (CBT)** is a form of psychotherapy that focuses on the connection between thoughts, feelings, and behaviors. The core idea of CBT is that negative or distorted thinking patterns contribute to emotional distress and unhealthy behaviors, and by identifying and changing these patterns, individuals can improve their mental health and coping skills.

CBT helps individuals recognize harmful thoughts (called cognitive distortions), challenge them with evidence, and replace them with more balanced, realistic thinking. It also emphasizes behavioral strategies, such as gradually facing fears, developing problem-solving skills, and reinforcing positive behaviors. CBT is structured, goal-oriented, and often short-term, and it is used to treat a wide range of issues, including depression, anxiety, addiction, and eating disorders.

Motivational Enhancement Therapy

Motivational Enhancement Therapy (MET) is a counseling approach designed to help individuals strengthen their internal motivation to change problematic behaviors, particularly substance use. It is based on the principles of motivational interviewing and focuses on resolving a person's ambivalence about change rather than confronting them directly.

MET typically involves a few structured sessions in which the therapist provides personalized feedback, helps the individual explore their values and goals, and supports their autonomy in making decisions. The therapist uses empathy and non-judgmental dialogue to guide the person toward recognizing the consequences of their behavior and building confidence in their ability to change. MET is often used as part of addiction treatment and is effective in increasing engagement and reducing substance use.

Contingency Management Approaches

Contingency Management (CM) is a behavioral therapy approach that uses positive reinforcement to encourage healthy behaviors and reduce substance use. The core idea is simple: individuals receive tangible rewards (such as vouchers, cash, or privileges) for meeting specific goals, like submitting drug-free urine samples, attending counseling sessions, or adhering to a treatment plan.

By linking positive outcomes to desired behaviors, CM helps reshape motivation and supports behavior change. It is especially effective in treating addiction, including stimulant and opioid use disorders. Research shows that CM can improve treatment retention, reduce relapse, and increase abstinence by reinforcing progress in a structured and immediate way.

12-Step Facilitation Therapy (TSF)

12-Step Facilitation Therapy (TSF) is a structured, evidence-based approach designed to help individuals engage with and benefit from 12-step programs like Alcoholics Anonymous (AA) or Narcotics Anonymous (NA). Unlike the programs themselves, TSF is a professional therapeutic intervention that introduces clients to the core principles and practices of the 12-step philosophy.

TSF encourages acceptance of addiction as a chronic, progressive disease, recognition of the need for abstinence, and surrender to a higher power or support network. The therapy typically involves individual sessions that focus on understanding the 12 steps, increasing motivation to participate in group meetings, and addressing barriers to engagement. The goal is to foster long-term recovery by helping clients build a support system and adopt a new way of life centered around mutual aid and accountability (National Institute on Alcohol Abuse and Alcoholism, n.d.). [54]

Key Points

- BAC and Legal Limits: Blood Alcohol Concentration (BAC) measures intoxication; 0.08% is the legal limit in most states, and

alcohol is metabolized at about one drink per hour, though this varies by individual.

- Health Risks of Alcohol: Excessive drinking impacts nearly every organ, damaging the brain, heart, liver, pancreas, and immune system, and increases the risk of certain cancers and dangerous behaviors.
- Gender Differences: Women are more affected by alcohol due to lower body water content and enzyme activity, leading to higher BAC levels and increased health risks at lower consumption levels.
- Drinking Guidelines: Moderate drinking is up to 1 drink/day for women and 2 for men; binge and heavy drinking significantly increase the risk of harm.
- Nutritional Impact: Alcohol adds discretionary calories and may contribute to poor nutrition, making it harder to meet dietary needs without exceeding caloric limits.
- Treatment Options: Evidence-based therapies, like CBT, MET, Contingency Management, and 12-Step Facilitation, are effective in helping individuals reduce or quit alcohol use and support long-term recovery.

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13.4: Tobacco



Figure 13.4.1: (Cigarette Butts; Pawel Czerwinski via Unsplash)

Introduction

Tobacco use remains one of the most significant public health challenges in the United States, despite decades of awareness campaigns and declining smoking rates. Once widely endorsed—even by doctors—tobacco was promoted as a safe and even beneficial product; however, since the landmark 1964 Surgeon General's Report linking smoking to serious health conditions, public perception and regulation have shifted dramatically. Today, tobacco use is known to cause a wide range of diseases, including cancer, heart disease, and respiratory illnesses, and is the leading preventable cause of death. This overview explores the health effects of tobacco and nicotine products—including cigarettes, smokeless tobacco, and e-cigarettes—the dangers of secondhand smoke, and the benefits and strategies for quitting tobacco use.

Tobacco Use - History

"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, which was known as the Surgeon General's Report on Smoking and Health. The report ranked 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, including a ban on cigarette advertising in broadcast media. With this report and the two acts, cigarette smoking began to decline (Cummings & Proctor, 2014). [35]

It is now well known, documented, and accepted that all forms of tobacco are harmful, and there is no safe level of exposure

to smoking. 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 12.5% (almost 13 of every 100 adults) in 2020 (Centers for Disease Control and Prevention, 2024). [24]

Take a Closer Look

Tobacco smoke contains more than 7,000 chemical components, and at least 250 of these chemicals are harmful to human health. Some of the chemicals, and where they are commonly found besides cigarettes, include:

- Carbon monoxide is emitted from vehicle exhaust
- Nicotine is found in pesticides
- Arsenic and DDT are used in insecticides
- Hydrogen cyanide was used in the gas chambers in World War II, and is currently used in rat poison
- Acetone is a paint stripper and is a component of nail polish remover
- Ammonia is used in household cleaning products
- Butane and methanol are found in fuel
- Cadmium is in car batteries
- Formaldehyde is used as a tissue and specimen preservative, commonly found in science labs (Centers for Disease Control and Prevention, 2024). [26]

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. 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 (National Center for Chronic Disease Prevention and Health Promotion, 2014). [51]

California became a national leader in protecting the public from secondhand smoke by pioneering some of the earliest and most comprehensive clean indoor air laws in the United States. In 1994, California enacted legislation that banned smoking in most workplaces, and by 1998, the law was extended to include all bars, taverns, and restaurants, making it the first state to implement such a broad prohibition (California Department of Public Health, 2017). [6] These laws were grounded in evidence showing that secondhand smoke exposure causes lung cancer, heart disease, and other serious health conditions in nonsmokers (U.S. Department of Health and Human Services, 2006). [86] California's approach not only protected employees in the hospitality industry but also set a precedent that influenced many other states and municipalities to adopt similar regulations, contributing to widespread cultural and policy shifts toward smoke-free environments nationwide (Centers for Disease Control and Prevention, 2010). [9]

Question

- Tobacco advertisements once promoted cigarettes as healthy or glamorous.
  - How do you think these messages influenced public behavior before scientific evidence about tobacco's harms was widely known?
- The 1964 Surgeon General's Report was a turning point in public awareness.
  - Why do you think this report had such a major impact compared to earlier warnings about smoking?

Electronic Cigarettes

Electronic cigarettes, or **e-cigarettes**, have rapidly gained popularity as an alternative to traditional tobacco products, particularly

among youth and adults seeking a perceived safer option. Often referred to as “vapes,” “e-cigs,” or “ENDS” (electronic nicotine delivery systems), these battery-powered devices produce a nicotine-laced aerosol that mimics the act of smoking. While e-cigarettes generally contain fewer harmful chemicals than conventional cigarettes, they are not without risk. The aerosol can include nicotine, heavy metals, and other toxic substances, raising concerns about their safety. Although some view e-cigarettes as a potential smoking cessation tool, they are not FDA-approved for that purpose, and current evidence remains inconclusive.



Figure 13.4.2: (Man in Hoodie Vaping; Nery Zarate via Unsplash)

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 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 (Centers for Disease Control and Prevention, 2024). [32]

College-Aged Student Use

Vaping has become increasingly common among college-aged students, driven by perceptions that e-cigarettes are less harmful than traditional cigarettes. Research indicates that many students view vaping as a safer alternative to smoking, while also associating it with social acceptance and stress relief (Trumbo & Harper, 2013). [85] The flavors, sleek designs, and ease of

concealment make e-cigarettes particularly appealing to young adults who are navigating independence and social pressures in college environments. However, this normalization of vaping has raised concerns about nicotine dependence and the potential gateway effect toward other tobacco products.

Patterns of use among college students often reflect both experimentation and habitual behavior. National survey data show that e-cigarette use is highest among young adults aged 18 to 24, with a substantial proportion reporting use within the past 30 days (Centers for Disease Control and Prevention, 2024). [18] Unlike older populations, college students tend to vape in social contexts, often sharing devices at parties, in dorms, or while studying. The episodic but frequent nature of this use contributes to a unique pattern of intermittent but heavy exposure, which may increase susceptibility to long-term nicotine addiction (Jones & Hill, 2020). [42]

Importantly, patterns of vaping on college campuses are also influenced by broader cultural and policy factors. Universities that implement comprehensive smoke- and vape-free campus policies tend to see lower rates of use, suggesting that institutional environments play a role in shaping student behaviors (American College Health Association, 2022). [4] At the same time, ongoing debates around marketing practices and regulation continue to affect student perceptions of harm and acceptability. Understanding these patterns is essential for developing effective prevention and cessation strategies tailored to the college student population, who are at a formative stage of their health behaviors.

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, 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 (Hartmann-Boyce et al, 2021). [39]

Smokeless 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), and dissolvables (lozenges, sticks, strips, or orbs).

Dangers of 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 (Centers for Disease Control and Prevention, 2024) [27]

Question

- E-cigarettes are often marketed as safer than traditional cigarettes.
  - Based on what you've read, do you think this perception is accurate?
  - Why or why not?
- Some e-cigarettes have been found to contain nicotine even when labeled "nicotine-free."

- What concerns does this raise about consumer safety and regulation?
- If e-cigarettes contain fewer chemicals than traditional cigarettes, why do you think public health experts are still cautious about recommending them?
- What are some reasons why people might choose e-cigarettes over regular cigarettes?
  - Do you think these reasons outweigh the risks?
- In your opinion, should e-cigarettes be promoted as a tool for quitting smoking, or should they be discouraged until more research is available?
  - Explain your reasoning.

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.



Figure 13.4.3: (Doctor Visit; National Cancer Institute on Unsplash)

Smoking and Cancer

Cigarette smoking is responsible for about one-third of all cancer cases, affecting many parts of the body, including the blood (acute myeloid leukemia), bladder, cervix, colon, rectum, esophagus, kidney, renal pelvis, larynx, liver, mouth, throat, pancreas, stomach, trachea, lungs, and bronchi. This means that if no one smoked, one out of every three cancer deaths in the United States could be prevented.

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 from any other type of cancer. Although the risks of smoking are clearer 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 (Centers for Disease Control and Prevention, 2024). [25]

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 brain
- Damage 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 (Centers for Disease Control and Prevention, 2024) [25]

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. 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 (Centers for Disease Control and Prevention, 2023). [11]

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 about 5 minutes while 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 (Centers for Disease Control and Prevention, 2024). [25]

Quitting Smoking

Although quitting smoking can be challenging due to nicotine dependence and the habits associated with tobacco use, the health benefits of smoking cessation are both immediate and profound. Within just 20 minutes of quitting, heart rate and blood pressure

begin to drop. Within 12 hours, carbon monoxide levels in the blood return to normal. Over the following weeks and months, circulation improves, lung function increases, and coughing and shortness of breath decrease. Long-term, the risk of developing serious health conditions drops significantly. One year after quitting, the risk of coronary heart disease is about half that of a smoker's. After 5 to 10 years, the risk of stroke can fall to that of a non-smoker. The risk of cancers, particularly those of the mouth, throat, esophagus, and lungs, also declines with each year of sustained abstinence. Quitting smoking not only enhances life expectancy but also improves quality of life by boosting energy, enhancing taste and smell, and reducing exposure to harmful secondhand smoke for others.

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.
- After 12 hours, the carbon monoxide level in your blood drops to normal.
- In 2-12 weeks, circulation improves, and lung function increases.
- In 1-9 months, coughing and shortness of breath decrease.
- In 1 year, the risk of coronary heart disease is about half that of a smoker's.
- In 5 years, stroke risk is reduced to that of a nonsmoker.
- After 10 years, the 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.
- After 15 years, the risk of coronary heart disease is that of a nonsmoker.
- People who quit smoking will have an improved sense of smell, and food will taste better (Centers for Disease Control and Prevention, 2023). [12]

How does quitting smoking impact life expectancy?

Quitting smoking is widely recognized as one of the most impactful decisions individuals can make to improve their health and quality of life, regardless of age or how long they've smoked. The CDC highlights that quitting can reduce the risk of premature death and potentially add up to 10 years to one's lifespan. It also lowers the likelihood of developing serious health conditions such as cardiovascular diseases, chronic obstructive pulmonary disease (COPD), various cancers, and adverse reproductive outcomes. These benefits extend even to those already diagnosed with diseases like heart disease or COPD, offering significant improvements in both prognosis and daily well-being (Centers for Disease Control and Prevention, 2023). [12]

When it comes to cardiovascular health, quitting smoking yields swift and powerful results. The risk of coronary heart disease declines sharply within one to two years of cessation, while the risk of stroke eventually approaches that of individuals who have never smoked. On the respiratory front, giving up smoking reduces the risk of developing COPD, slows its progression, and alleviates symptoms such as coughing and shortness of breath. Additionally, quitting enhances overall lung function and decreases the incidence of respiratory infections like pneumonia and bronchitis. Perhaps most crucially, cessation cuts the risk of various cancers, including lung, bladder, pancreatic, esophageal, and others, over time, offering measurable, long-term protective effects (Centers for Disease Control and Prevention, 2023). [12]

Quitting smoking also delivers important gains for reproductive and immune health, benefiting both the smoker and those around them. Among pregnant individuals, cessation before or during pregnancy significantly reduces the risk of delivering a low birth weight or small-for-gestational-age baby, and reduces the chance of preterm delivery—supporting healthier outcomes for mother and child. Moreover, by quitting, smokers protect their family, friends, and coworkers from the dangers of secondhand smoke exposure. On the immune-system front, while smoking detrimentally affects immune function, abstinence allows for gradual recovery: white blood cell counts normalize, healing improves, and the immune system becomes stronger, increasing resistance to infections and promoting overall health (Centers for Disease Control and Prevention, 2023). [12]

The body begins recovering rapidly after the last cigarette: heart rate and blood pressure drop within minutes, carbon monoxide levels normalize in a matter of days, and improvements in lung function and circulation follow in the weeks to months that come. Even for those who have smoked heavily for many years, these benefits accumulate, slowly aligning health risks closer to those of non-smokers. In essence, quitting smoking is not only a life-saving choice, but also one that empowers healing, reinvigoration, and

long-term health—providing enhanced quality of life at every stage post-cessation (Centers for Disease Control and Prevention, 2023). [12]



Figure 13.4.4: Smoking can be a lifetime habit. (Senior Smoker; Naman Sood on Unsplash)

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 (Centers for Disease Control and Prevention, 2023). [12]

Should someone already diagnosed with cancer 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 (Centers for Disease Control and Prevention, 2023). [12]

Question

- Within minutes of quitting smoking, the body begins to recover.
  - Which of the short-term improvements (e.g., heart rate, blood pressure, carbon monoxide levels) do you think would be most noticeable to someone who has just quit?
- Which long-term health benefits (e.g., reduced risk of stroke, cancer, or heart disease) do you think would most motivate a smoker to quit, and why?

Treatments for Tobacco Addiction

Tobacco addiction is a chronic disease that often requires multiple attempts to quit. Although some smokers can 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 quit-line, 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 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 (Centers for Disease Control and Prevention, 2023). [15]

Key Points

- Smoking was once widely promoted, even by doctors, until the 1964 Surgeon General's Report linked smoking to serious diseases. This marked a turning point in public awareness and regulation.
- Tobacco use is the leading preventable cause of death in the U.S., responsible for over 480,000 deaths annually and causing diseases such as cancer, cardiovascular disease, and chronic respiratory conditions.
- Exposure to secondhand smoke is harmful and deadly, contributing to thousands of deaths and health issues annually, particularly among children and nonsmokers.
- E-cigarettes deliver nicotine through vapor and may contain fewer toxins than traditional cigarettes, but they are not harmless and are not FDA-approved for smoking cessation.
- Products like chewing tobacco and snuff still carry serious health risks, including cancers and cardiovascular issues, and may lead to nicotine addiction.
- Nicotine is highly addictive, altering brain chemistry similarly to other drugs like heroin. It stimulates the release of dopamine and adrenaline, reinforcing addiction.
- Quitting smoking yields immediate health benefits, such as improved heart rate and lung function, and significantly lowers

risks of cancer, heart disease, and early death.
- People who quit smoking at any age can extend their life expectancy, with those quitting by age 34 gaining up to 10 additional years.
- Effective smoking cessation includes behavioral treatments (e.g., counseling) and pharmacological aids like nicotine replacement therapy (NRT), bupropion, and varenicline.
- Scientists are exploring new approaches like nicotine vaccines and combination therapies to improve long-term quitting success and reduce relapse rates.

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13.5: Caffeine



Figure 13.5.1: PROZIS 200mg caffeine capsules. Packaging states that it is "Used by athletes worldwide." Caffeine Pills; Jorge Franganillo via Unsplash

Introduction

Caffeine is one of the most widely consumed psychoactive substances in the world, primarily known for its stimulating effects on the central nervous system. Found naturally in a variety of plants, caffeine is commonly used to increase alertness and combat fatigue. Its widespread use spans across cultures and age groups, making it a significant subject of study in nutrition, public health, and behavioral sciences. Understanding where caffeine comes from is essential for assessing its impact on health and consumption patterns globally.

Sources of Caffeine

Caffeine is a naturally occurring stimulant found in the leaves, seeds, or fruits of more than 60 plant species, including coffee beans, tea leaves, cacao pods, and kola nuts. Globally, the most common sources of caffeine consumption are coffee, tea, soft drinks, energy drinks, and chocolate products. In addition to naturally caffeinated foods and beverages, caffeine is also added to many commercially manufactured products such as sodas, energy shots, and certain over-the-counter medications for alertness or headache relief (Juliano & Griffiths, 2005). [44]

Historical Context and Cultural Significance

Caffeine use has deep historical roots and significant cultural relevance worldwide. Archaeological evidence suggests that humans have consumed caffeine-containing plants for thousands of years. Tea use in China dates back to at least 2737 BCE, and coffee cultivation and consumption emerged in Ethiopia, spreading through the Arab world by the 15th century. Over time, caffeine consumption has become deeply ingrained in social, religious, and economic practices, from the coffeehouses of 17th-century Europe, which served as hubs of intellectual exchange, to modern-day rituals like morning coffee or afternoon tea. These traditions continue to influence how societies view and use caffeine today, often framing it as both a socially acceptable and culturally valued stimulant (Weinberg & Bealer, 2001). [88]



Figure 13.5.2: "I drink coffee for your protection." Morning Coffee; M o e; Unsplash

Public Perception and Social Norms

Caffeine is widely perceived as a safe, socially acceptable substance that enhances alertness and productivity. Unlike many other psychoactive substances, its use is often normalized and even encouraged in work, academic, and social settings. Cultural narratives frequently portray caffeine as essential to daily functioning, reinforcing norms around regular consumption through marketing, workplace culture, and media representation. Despite potential risks associated with excessive intake, public concern over caffeine use tends to be minimal, and its consumption remains largely unregulated in most parts of the world (Temple et al, 2017). [83]

Question

- What was your first memory of caffeine?
  - Was it a family tradition, a treat, or something you tried on your own?
- Do you think caffeine use is encouraged in your environment (home, school, work)?
  - Why or why not?
- What do you think would happen if caffeine suddenly became a regulated substance like alcohol or tobacco?

Patterns of Caffeine Consumption

Caffeine consumption patterns vary widely across populations, influenced by demographic characteristics, situational contexts, and individual behaviors. Understanding these patterns is essential to evaluating caffeine's role in public health, particularly in relation to potential dependence and health risks. This section examines who consumes caffeine, under what circumstances, and how certain patterns of use, especially heavy or high-risk consumption, may contribute to problematic outcomes.

Demographics

Public perception of caffeine as a benign, even beneficial, substance contributes to its widespread use across diverse demographic groups. Surveys indicate that caffeine consumption begins early in life, with adolescents and young adults often using it to enhance alertness and academic performance. Among adults, coffee remains the primary source of caffeine, particularly in workplace settings where its use is often socially reinforced. Gender differences also emerge, with men generally consuming more caffeine overall, while women tend to prefer certain sources such as tea. [49] Socioeconomic status, cultural background, and age further shape patterns of caffeine consumption, reflecting broader social norms that influence both how much caffeine people consume and how they view its risks and benefits.

Situational and Contextual Factors

Caffeine consumption is often driven by situational and contextual factors tied to daily routines, work demands, and social environments. Many individuals consume caffeine as part of morning rituals to combat fatigue or improve focus, while others increase intake during periods of heightened stress, such as exams or work deadlines. Social settings, including gatherings at cafés or shared breaks among colleagues, also reinforce caffeine use as a normative behavior. Marketing and advertising further shape these patterns by positioning caffeinated products as essential tools for productivity, alertness, and social connection (Heckman et al, 2010). [40] These factors contribute to the entrenchment of caffeine in cultural practices and individual habits.

High-Risk Patterns and Heavy Use

While moderate caffeine consumption is generally considered safe, high-risk patterns and heavy use can lead to significant health concerns. Individuals who consume large quantities, often exceeding 400 mg per day, may experience heightened risks of anxiety, sleep disturbances, gastrointestinal issues, and cardiovascular problems. High-dose consumption is particularly prevalent among adolescents and young adults through energy drinks and caffeine-containing supplements, which are frequently used to enhance athletic or academic performance. These patterns of use are associated with increased rates of dependence, withdrawal symptoms, and co-use with other substances, highlighting the need for greater public health attention (Meredith et al, 2013). [46]

Track Your Consumption

Track your caffeine intake for 24-48 hours, being sure to include:

- Time of consumption
- Type of beverage/product
- Estimated caffeine amount
- Reason or context for consuming (tired, stressed, social, habit, etc.)

Were you surprised by your caffeine use? What situations led to consumption?

Caffeine Dependence and Withdrawal

Caffeine dependence and withdrawal are increasingly recognized as significant public health concerns, particularly given caffeine's widespread use and social acceptability. Regular, sustained consumption can lead to tolerance, wherein greater amounts are needed to achieve the same stimulating effects, and cessation often results in withdrawal symptoms that can impair daily functioning. This section explores the neurobiological and behavioral mechanisms underlying tolerance, the range and severity of withdrawal symptoms, the impact on individuals' daily lives, and the factors that increase the risk of developing caffeine dependence.

Tolerance Development

Tolerance to caffeine develops with regular, prolonged use, requiring individuals to consume higher doses to achieve the same stimulant effects. This physiological adaptation results from changes in adenosine receptor density and sensitivity in the central nervous system, reducing caffeine's ability to block the fatigue-promoting effects of adenosine over time. Tolerance can develop to some, but not all, of caffeine's effects; for example, research shows that tolerance often develops to caffeine-induced alertness and sleep disruption, but less consistently to cardiovascular responses like increased blood pressure (Fredholm et al, 1999). [38] Understanding the mechanisms of tolerance is critical in recognizing the cycle of escalating use that characterizes caffeine dependence.

Withdrawal Symptoms

Caffeine withdrawal is a clinically recognized condition characterized by a range of physical and psychological symptoms that emerge within 12 to 24 hours after cessation or significant reduction of intake. Common symptoms include headache, fatigue, decreased alertness, irritability, depressed mood, and difficulty concentrating. In some cases, withdrawal symptoms can be

severe enough to interfere with daily functioning, lasting from two to nine days, depending on the individual and level of prior consumption. The onset, intensity, and duration of withdrawal symptoms are influenced by the amount and frequency of prior caffeine use, highlighting the physiological dependence potential of this widely consumed stimulant (Juliano & Griffiths, 2005). [44]

Impact on Daily Functioning

Caffeine dependence and withdrawal can significantly impair daily functioning across work, school, and social domains. Withdrawal symptoms such as fatigue, headaches, and reduced cognitive performance often lead to decreased productivity and increased absenteeism, particularly in individuals with high habitual consumption. Studies have shown that even moderate withdrawal can result in notable declines in attention, mood, and psychomotor performance, which may disrupt daily activities and interpersonal relationships. These impairments often contribute to a cycle of continued caffeine use to alleviate withdrawal symptoms and restore normal functioning, reinforcing dependence over time (Smith, 2002). [79]

Risk Factors for Dependence

Several factors increase the likelihood of developing caffeine dependence. High daily intake, particularly among individuals consuming more than 300 mg per day, is strongly associated with a greater risk of dependence and withdrawal symptoms. Younger age groups, including adolescents and young adults, may be more vulnerable due to patterns of high-volume consumption from energy drinks and specialty coffee beverages. Genetic predispositions influencing caffeine metabolism and sensitivity also contribute to dependence risk, as do psychological factors such as using caffeine to manage mood, stress, or fatigue. Finally, social and cultural environments that normalize or promote high caffeine use can reinforce patterns leading to dependence (Rogers et al, 2010). [78]

Example Scenario

Taylor is a college student who drinks two large coffees and an energy drink daily to stay alert for classes and a part-time job. Over the weekend, Taylor forgot their caffeine and spent the day exhausted, with a pounding headache and trouble focusing. They vow to stop using caffeine altogether, but are back at the coffee shop by Monday morning.

- What symptoms is Taylor experiencing?
- What are the physical and behavioral signs of dependence?
- Why is it difficult for Taylor to stop using caffeine?
- What advice would you give Taylor?

Health Effects of Chronic High-Dose Caffeine Use

Chronic high-dose caffeine use has been linked to a range of potential health effects across multiple body systems. While moderate caffeine intake is generally considered safe for most individuals, excessive and sustained consumption can contribute to adverse outcomes, including cardiovascular strain, sleep disruption, mood disturbances, and gastrointestinal issues. Emerging research also suggests possible impacts on reproductive health and neurological functioning. This section reviews the evidence on the health consequences associated with chronic high-dose caffeine use, examining its effects on cardiovascular health, sleep, mental health, metabolism, reproductive outcomes, and cognitive processes.



Figure 13.5.3: Energy Drinks; Jorge Franganillo on Unsplash

Cardiovascular Effects

High-dose, long-term caffeine consumption has been associated with various cardiovascular effects, including elevated blood pressure and increased heart rate. While moderate caffeine intake does not appear to significantly increase the risk of hypertension in most healthy adults, evidence suggests that chronic high-dose use — generally above 400 mg per day — may contribute to sustained blood pressure elevation, particularly in individuals with existing hypertension or cardiovascular risk factors. Additionally, heavy caffeine use has been linked in some studies to arrhythmias and other cardiac events, although findings are mixed and may depend on individual sensitivity and genetic factors influencing caffeine metabolism (Mesas et al, 2011). [47]

Sleep Disturbances and Insomnia

Chronic high-dose caffeine consumption is strongly associated with sleep disturbances and insomnia. Caffeine blocks adenosine receptors in the brain, reducing feelings of sleepiness and delaying the onset of sleep. High habitual intake, particularly in the afternoon or evening, can lead to reduced total sleep time, increased sleep latency, and poorer sleep quality. These effects are more pronounced among individuals with slower caffeine metabolism and can contribute to a cycle of daytime fatigue and further caffeine use. Over time, persistent sleep disruption may have broader implications for cognitive functioning, mood regulation, and overall health (Clark & Landolt, 2017). [34]

Anxiety and Mood Disorders

Chronic high-dose caffeine use has been linked to increased risk of anxiety and mood disturbances. As a central nervous system stimulant, caffeine can heighten arousal and exacerbate symptoms of anxiety, particularly in sensitive individuals or those with pre-existing anxiety disorders. High intake is also associated with jitteriness, restlessness, and irritability, which can negatively impact mood and social functioning. Some studies suggest a dose-dependent relationship, where moderate consumption may improve mood and alertness, but excessive use contributes to heightened anxiety and depressive symptoms. These effects underscore the importance of considering individual vulnerability and total daily intake when evaluating caffeine's impact on mental health (Lara, 2010). [45]

Gastrointestinal and Metabolic Impacts

Chronic high-dose caffeine consumption can have notable effects on the gastrointestinal system and metabolic processes. High caffeine intake stimulates gastric acid secretion, which may exacerbate symptoms of gastroesophageal reflux disease (GERD) and contribute to stomach discomfort in sensitive individuals. Additionally, excessive caffeine can accelerate gastrointestinal

motility, potentially leading to diarrhea or abdominal cramping. Metabolically, while moderate caffeine use is associated with increased energy expenditure and fat oxidation, chronic high-dose intake may disrupt glucose regulation and contribute to insulin resistance in some populations, particularly when combined with high-sugar caffeinated beverages (Reyes & Cornelis, 2018). [77]

Neurological and Cognitive Effects

Chronic high-dose caffeine consumption can have complex effects on neurological and cognitive functioning. While moderate caffeine intake is often associated with enhanced alertness, attention, and reaction time, excessive and prolonged use may lead to negative outcomes, including increased risk of dependence, heightened nervousness, and cognitive fatigue due to sleep disruption. Some studies suggest that chronic high-dose caffeine use may alter brain receptor sensitivity and contribute to changes in neural plasticity, although findings are mixed regarding long-term cognitive decline or protection. Individual differences in genetic factors influencing caffeine metabolism also play a role in determining whether high intake leads to beneficial or detrimental cognitive outcomes (Nehlig, 2010). [73]

True or False?

- "Caffeine causes dehydration."
- "Energy drinks are safe if you don't drink coffee."
- "Everyone metabolizes caffeine at the same rate."
- "Caffeine always improves performance."

Caffeine Use in Vulnerable Populations

Caffeine use patterns and potential risks can vary significantly across vulnerable populations, who may experience unique health effects or increased susceptibility to dependence. Adolescents and young adults often engage in high-volume consumption, particularly through energy drinks, which can impact development and mental health. Pregnant and lactating individuals face concerns about fetal and infant exposure. Those with substance use disorders may use caffeine as a substitute or co-ingest it with other substances, potentially complicating treatment. Older adults, meanwhile, may experience heightened sensitivity to caffeine's effects on sleep, cardiovascular function, and bone health. This section explores these issues in depth.

Adolescents and Young Adults

Adolescents and young adults are among the highest consumers of caffeine, often through energy drinks, specialty coffee beverages, and sodas. This age group is particularly vulnerable to the negative effects of high-dose caffeine, including sleep disruption, increased anxiety, and potential cardiovascular strain. Research has linked excessive caffeine intake in youth to poorer academic performance, risk-taking behaviors, and higher rates of substance co-use, including alcohol and tobacco. Because the developing brain is more sensitive to stimulants, high caffeine consumption during adolescence may also impact neurological development and increase the likelihood of dependence later in life (Temple, 2009). [84]



Figure 13.5.4: Younger populations might start to encounter the effects of caffeine through drinking soda. Two Women Holding Soda; Sidral Mundet on Unsplash

Pregnant and Lactating Individuals

Caffeine consumption during pregnancy and lactation raises important health considerations. Caffeine readily crosses the placenta, and the fetus lacks the metabolic capacity to efficiently process it, potentially prolonging exposure. High maternal caffeine intake has been associated with increased risk of miscarriage, low birth weight, and fetal growth restriction. Similarly, caffeine is transferred into breast milk, albeit at lower concentrations, and may contribute to irritability and sleep disturbances in infants (American College of Obstetricians and Gynecologists, 2020). [5] As a precaution, many health organizations recommend limiting caffeine intake during pregnancy to minimize potential risks (Chen et al, 2014). [33]

Individuals with Substance Abuse Disorders

Caffeine use is common among individuals with **substance use disorders (SUDs)**, often serving as a socially acceptable stimulant that may be used to counteract sedation or fatigue associated with other substances, such as alcohol or opioids. Research suggests that individuals in treatment for SUDs frequently consume high levels of caffeine, which can complicate recovery by exacerbating anxiety, sleep disturbances, and withdrawal symptoms from other substances. Additionally, patterns of excessive caffeine use may mirror addictive behaviors seen with other drugs, potentially reinforcing dependence cycles. Despite these risks, caffeine use is rarely addressed in SUD treatment settings, highlighting the need for greater awareness and integrated care approaches (Hughes et al, 2016). [41]

Older Adults

Caffeine consumption among older adults presents unique considerations due to age-related physiological changes that can increase sensitivity to its effects. Reduced metabolic clearance of caffeine in older individuals may prolong its stimulant action, potentially exacerbating sleep disturbances, increasing nighttime awakenings, and worsening insomnia. High caffeine intake has also been linked to increased risk of bone loss and fractures, particularly in populations with low calcium intake. Additionally, excessive caffeine may contribute to cardiovascular issues, such as elevated blood pressure and arrhythmias, which are more prevalent in older populations. Consequently, moderation of caffeine intake is often recommended in this age group to minimize health risks (Nawrot et al, 2003). [72]

Cultural and Social Factors Influencing Caffeine Use

Caffeine consumption is deeply embedded in cultural and social practices around the world, reflecting historical traditions, societal norms, and individual identities. From the communal coffeehouses of the Middle East and Europe to the modern

prevalence of energy drinks and specialty cafés, caffeine use is shaped by cultural values, peer influences, gender roles, and socioeconomic factors. Rituals and symbolic meanings attached to caffeine-containing beverages further reinforce their role in daily life, work, and social connections. This section explores how these cultural and social dimensions contribute to patterns of caffeine use and perceptions of its risks and benefits.

Historical and Cultural Traditions

Caffeine-containing beverages have played a central role in social and cultural traditions across centuries. Coffee, tea, and cacao originated in different regions — coffee in Ethiopia and Yemen, tea in China, and cacao in Mesoamerica — and each developed rich cultural practices around their preparation and consumption. In Europe, coffeehouses emerged in the 17th century as important centers of political debate and intellectual exchange, while tea ceremonies in East Asia became deeply ingrained in spiritual and social customs. These traditions continue to shape modern caffeine use, embedding it in rituals of hospitality, relaxation, and productivity across diverse cultures (Weinberg & Bealer, 2001). [88]



Figure 13.5.5: Some cultures get caffeine from tea more than coffee and soda. Hot Tea; Max Chen; Unsplash

Social Norms and Peer Influence

Social norms and peer influence play a significant role in shaping caffeine consumption behaviors. In many cultures, caffeine use is seen as a normal, even necessary, part of daily life, particularly in work and academic settings where productivity and alertness are valued. Among adolescents and young adults, peer groups often reinforce caffeine use through shared consumption of coffee, sodas, or energy drinks, framing it as a socially acceptable or trendy behavior. Marketing further amplifies these norms by associating caffeinated products with success, sociability, and modern lifestyles, which can increase initiation and habitual use across diverse populations (Petit et al, 2019). [75]

Gender and Socioeconomic Differences

Caffeine consumption patterns often differ by gender and socioeconomic status, reflecting broader social and cultural dynamics. Studies have shown that men generally consume higher total amounts of caffeine, often preferring coffee and energy drinks, while women are more likely to consume tea and specialty coffee beverages. Socioeconomic factors also influence patterns of use; individuals with higher income and education levels tend to consume more coffee, often as part of professional or social routines, whereas those from lower socioeconomic backgrounds may consume more caffeinated sodas or convenience-store energy drinks. These differences highlight how access, marketing, and cultural norms shape caffeine use across diverse populations (Mitchell et al, 2020). [49]

Rituals and Symbolic Meanings

Caffeine-containing beverages often carry deep ritualistic and symbolic meanings that transcend their pharmacological effects. For many, the daily cup of coffee or tea serves as a comforting routine that marks transitions in the day, such as waking up, taking a break, or socializing with others. In various cultures, serving coffee or tea symbolizes hospitality, friendship, and respect. These rituals help reinforce social bonds and community identity, embedding caffeine use into personal and collective traditions. Such symbolic associations contribute to the normalization and persistence of caffeine consumption, making it not just a habit but a meaningful social practice (Pettigrew et al, 2015). [76]

Question

- What caffeinated drinks do you consume most, and when?
- How did you first start drinking caffeine? Who influenced you?
- What role does caffeine play in your social life, identity, or routine?

Treatment and Management of Problematic Caffeine Use

Problematic caffeine use, characterized by dependence, withdrawal symptoms, or excessive consumption leading to health issues, requires a structured approach to treatment and management. Effective strategies begin with accurate assessment and screening, followed by tailored interventions that may include behavioral therapy, gradual reduction plans, or, in some cases, pharmacological support. Managing withdrawal symptoms and providing education and supportive services are also critical components in helping individuals reduce or eliminate problematic caffeine use. This section explores evidence-based methods for assessing, treating, and supporting individuals seeking to change their caffeine consumption patterns.

Assessment and Screening Tools

Effective treatment of problematic caffeine use begins with accurate assessment and screening. Several validated tools exist to identify caffeine dependence, problematic patterns, and withdrawal symptoms. The Caffeine Consumption Questionnaire (CCQ) and the Caffeine Use Disorder Questionnaire (CUDQ) are commonly used instruments that assess daily intake, dependence criteria, and associated distress. Clinical interviews and standardized checklists can also help practitioners evaluate the severity of caffeine-related problems and tailor interventions accordingly. Early and systematic screening is essential for differentiating problematic use from socially normative consumption, guiding appropriate clinical responses (Addicott, 2014). [1]

Behavioral Interventions

Behavioral interventions are central to managing problematic caffeine use, particularly in individuals exhibiting dependence or difficulty reducing intake. Cognitive-behavioral therapy (CBT) approaches focus on identifying triggers, restructuring beliefs about caffeine's perceived benefits, and developing alternative coping strategies for fatigue or stress. Motivational interviewing techniques can enhance readiness to change and support gradual reduction of goals. Self-monitoring of intake, combined with reinforcement of reduction efforts, has also proven effective in helping individuals establish healthier patterns of caffeine use. These interventions are particularly valuable because they address both the psychological and situational drivers of excessive consumption (Juliano et al, 2012). [43]



Figure 13.5.6: "I love coffee with all my heart." Coffee Love; mohamad sai on Unsplash

Gradual Tapering Strategies

Gradual reduction of caffeine intake is often recommended as the most effective and tolerable approach for managing problematic caffeine use and minimizing withdrawal symptoms. Tapering strategies involve systematically decreasing daily caffeine consumption over days or weeks, allowing the body to adjust to lower levels of intake while reducing the intensity of withdrawal symptoms such as headaches, fatigue, and irritability. Research suggests that reducing caffeine by 25–50% every few days, or replacing high-caffeine beverages with lower-caffeine alternatives, can help individuals successfully decrease dependence and maintain long-term reductions in use (Juliano & Griffiths, 2005). [44]

Pharmacological Approaches

While behavioral strategies and gradual tapering are primary methods for managing problematic caffeine use, pharmacological interventions may offer additional support in some cases. Over-the-counter analgesics, such as ibuprofen or acetaminophen, are often used to alleviate caffeine withdrawal headaches. Some studies have explored the potential of using adenosine receptor modulators or other pharmacotherapies to mitigate withdrawal symptoms, though no medications are currently approved specifically for caffeine dependence treatment. Given the limited evidence base, pharmacological approaches are generally considered adjunctive to behavioral strategies rather than standalone treatments (Evans & Griffiths, 1999). [37]

Managing Withdrawal Symptoms

Managing withdrawal symptoms is a crucial aspect of reducing problematic caffeine use, as these symptoms often drive continued consumption and relapse. Common strategies include gradual tapering to reduce the severity of headaches, fatigue, irritability, and difficulty concentrating. Adequate hydration, regular sleep schedules, and stress management techniques such as relaxation exercises or light physical activity can also alleviate symptoms. Over-the-counter pain relievers may help with headache management, though they should be used cautiously to avoid medication overuse headaches. Supportive counseling and patient education can further assist individuals in navigating withdrawal and sustaining long-term reduction (Juliano & Griffiths, 2005). [44]

Patient Education and Support Resources

Patient education and support services are vital components in the treatment of problematic caffeine use. Providing clear information about caffeine's effects, potential health risks of excessive consumption, and strategies for gradual reduction empowers individuals to make informed decisions about their intake. Educational materials should address common myths about caffeine and highlight the benefits of moderation. Support services, such as counseling, peer support groups, or integrated care

within substance use treatment programs, can reinforce behavioral changes and encourage withdrawal and tapering. Combining education with structured support increases the likelihood of sustained reductions and improved health outcomes (Striley et al, 2011). [80]

More to Explore

Caffeine Informer - Offers comprehensive data on caffeine content in products, symptoms of caffeine overdose and withdrawal, and tips for reducing consumption.

American Academy of Sleep Medicine - Includes information on how caffeine affects sleep and contributes to dependence. Offers practical guidance for improving sleep hygiene, which is often impacted by heavy caffeine use.

Key Points

- Caffeine is a widely consumed psychoactive substance found naturally in coffee, tea, cacao, and kola nuts.
- Historically, caffeine use has deep cultural roots, influencing rituals and social practices worldwide.
- It is perceived as safe and socially acceptable, and is often used to boost alertness and productivity.
- Consumption patterns vary by demographics, context, and marketing influences, with high use common in youth and workplace settings.
- High-dose use (over 400 mg/day) is linked to dependence, sleep problems, anxiety, and health risks.
- Regular use leads to tolerance, requiring increased intake for the same effects due to neuro-adaptations.
- Withdrawal causes headaches, fatigue, mood changes, and cognitive decline, disrupting daily functioning.
- Vulnerable groups, adolescents, pregnant individuals, those with substance use disorders, and older adults face greater risks.
- Chronic high-dose use is associated with cardiovascular strain, gastrointestinal issues, reproductive risks, and mental health effects.
- Effective management includes screening, behavioral therapy, gradual tapering, withdrawal symptom relief, and patient education.

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13.6: Unintentional and Intentional Injury



Figure 13.6.1: Injuries, whether intentional or not, happen every day. (Sportsmanship; Hanson Lu on Unsplash)

Introduction

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 caused 24.8 million people to visit their doctor and 97.9 million to visit the emergency room, with an additional 1.2 million people visiting 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 (National Center for Health Statistics, 2019). [52]

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

Table 13.6.1: Year 2023 Intentional and Unintentional Death Rates

Cause of Death	Number of Deaths	Deaths per 100,000 people
Unintentional fall	47,026	14.04
Motor vehicle traffic	43,273	12.92

Cause of Death	Number of Deaths	Deaths per 100,000 people
Unintentional poisoning	100,304	29.95
All poisoning deaths	109,522	32.70
Firearm homicides	17,927	5.35
All firearm deaths	46,728	13.95
All homicides	22,829	6.82
Firearm suicides	27,300	8.15
Suffocation suicides	12,023	3.59
Poisoning suicides	5,944	1.78
All suicides	49,316	14.73
All injury deaths	300,899	89.84
All unintentional deaths	222,698	66.49

Data for Table 13.6.1 was collected from the Centers for Disease Control's WISQARS online database (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2025). [7]

More to Explore

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), along with the CDC and NIH, provides research-based evidence and resources to meet goals to reduce injuries.

Visit the NCIPC website, which was launched in 1992 to focus specifically on injuries as an important topic for public health:

- National Center for Injury Prevention and Control

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 falls each year, with one out of five falls causing serious injury. Traumatic brain injuries (TBIs) and hip fractures are the most common serious injuries. The injuries associated with falls impact a person's 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.



Figure 13.6.2: As people age, it is important to monitor mobility due to the risk of a fall. (Cobblestone Stroll; wJ on Unsplash)

Fall risk and prevention tips

- **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 the 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 (Centers for Disease Control and Prevention, 2024). [21]

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.

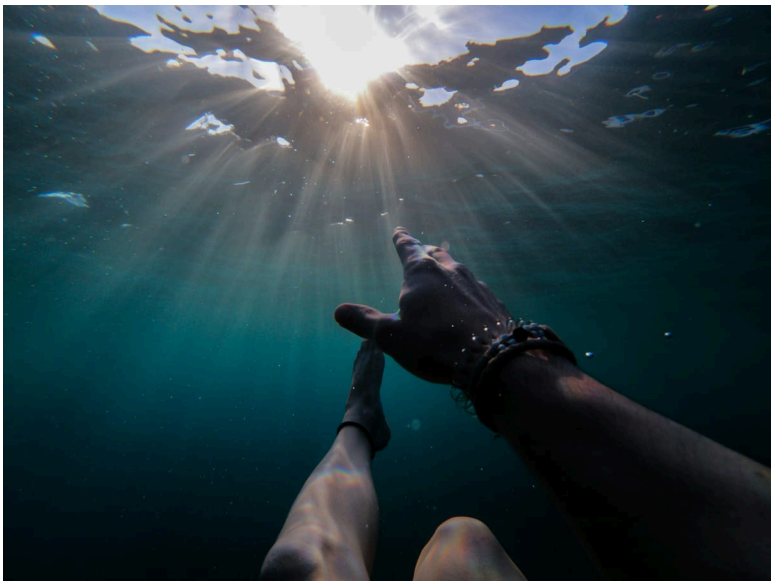


Figure 13.6.3: For drowning victims, the surface can be agonizingly close, yet out of reach within seconds. (Sinking; Cristian Palmer on Unsplash)

Drowning risk and prevention tips

Drowning is a serious and often preventable risk that can occur in many different settings. One major factor is a lack of swimming ability. Both adults and children are encouraged to participate in formal swim lessons, which can significantly reduce their risk. Another common risk factor is missing or ineffective pool fencing. Research shows that a four-sided isolation fence, which completely separates the pool area from the house and yard, reduces a child's risk of drowning by 83 percent compared to traditional three-sided property line fencing that encloses the entire yard but does not block access to the pool. Close supervision is also critical, as drowning can happen quickly and quietly in lakes, oceans, swimming pools, bathtubs, or even buckets of water, even when lifeguards are present. The buddy system, in which individuals swim with a partner, is an additional safeguard that can save lives.

Location also plays a role in drowning risk. For infants under the age of one, two-thirds of drowning incidents occur in bathtubs. Among children ages one to four, most drownings happen in home swimming pools, while more than half of fatal and nonfatal drownings among people ages fifteen and older occur in natural waters such as lakes, rivers, or oceans. Natural water settings present unique hazards, such as rip currents in the ocean, that swimmers should be aware of. Not wearing a life jacket is another major risk factor. Life jackets are proven to prevent drowning during water activities, particularly boating and swimming. In 2019, the United States Coast Guard reported 613 boating-related deaths, 79 percent of which were due to drowning. Alarmingly, 86 percent of those who drowned were not wearing life jackets.

Substance use further increases drowning risk, particularly among adolescents and adults. Alcohol is involved in up to 70 percent of deaths associated with water recreation, nearly one in four emergency department visits for drowning, and about one in five reported boating deaths. Drug use can pose similar dangers by impairing judgment, coordination, and reaction time around water. Taken together, these factors highlight the importance of swimming lessons, proper barriers, vigilant supervision, life jacket use, and sober behavior as key strategies in preventing drowning and promoting water safety (Centers for Disease Control and Prevention, 2024). [29]

Motor Vehicle Crashes

In 2020, more than 40,000 people died in motor vehicle crashes in the United States, which is more than 110 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 2020 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 (Centers for Disease Control and Prevention, 2024). [23]

Distracted Drivers

Distracted driving occurs when a driver engages in another activity that diverts attention from the road, increasing the risk of a motor vehicle crash. There are three main types of distracted driving. Visual distraction happens when drivers take their eyes off the road. Manual distraction occurs when drivers take their hands off the wheel. Cognitive distraction happens when drivers take their minds off the task of driving.



Figure 13.6.4: Eyes on the road isn't enough; a driver mentally engaged with a device is impaired even when looking up. (Distracted Driver; Frankie Cordoba via Unsplash)

In 2019, distracted driving contributed to 3,100 deaths and about 424,000 injuries in motor vehicle crashes. Not all of the people killed by distracted drivers were in cars. About one in five of those who died were walking, riding bicycles, or otherwise outside of a vehicle at the time of the crash.

Distracted driving is preventable. Drivers should avoid multitasking while behind the wheel. Adjusting mirrors, selecting music, eating, making phone calls, or reading texts and emails should be done before or after the trip, not during it (Centers for Disease Control and Prevention, 2024). [23]

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% (Centers for Disease Control and Prevention, 2024). [23]



Figure 13.6.5: Children are especially vulnerable in a car, and should always be properly secured. (Child Safety Seat; Daisy D on Unsplash)

Seatbelts

Although most drivers follow these safety measures on every trip, there are still millions who don't. 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 (Centers for Disease Control and Prevention, 2024). [23]

Teen Drivers

In 2019, nearly 2,400 teenagers in the United States between the ages of 13 and 19 were killed in motor vehicle crashes, and about 258,000 were treated in emergency departments for crash-related injuries. This means that each day, approximately seven teenagers lose their lives in motor vehicle crashes, while hundreds more are injured. The impact extends beyond health to economic costs. In 2018, motor vehicle crash deaths among teenagers ages 15 to 19 resulted in an estimated 4.8 billion dollars in medical expenses and work loss.

Certain groups of teenagers face especially high risks when driving. Male drivers, teenagers who drive with teen or young adult passengers, and newly licensed drivers are among the most vulnerable to crashes. These groups are more likely to engage in risky driving behaviors or lack the experience needed to respond safely to challenging situations on the road.

Several risk factors increase the likelihood of crashes among teens. Inexperience, nighttime and weekend driving, failure to wear seat belts, distracted driving, speeding, and alcohol or drug use all contribute significantly to the danger. These factors highlight the importance of education, parental guidance, and policy measures aimed at reducing risks and protecting young drivers (Centers for Disease Control and Prevention, 2024). [23]



Figure 13.6.6: Young drivers often take more risks. (Teen Driver; LVL9 Studio on Unsplash)

Older drivers

In 2019, about 8,000 older adults aged 65 and older were killed in traffic crashes, and more than 250,000 were treated in emergency departments for crash-related injuries. This means that each day, more than 20 older adults lose their lives and nearly 700 are injured in motor vehicle crashes. Drivers aged 70 and older experience higher crash death rates per mile driven compared to middle-aged drivers between the ages of 35 and 54. These higher death rates are primarily linked to older adults' increased vulnerability to injury during a crash. Across all age groups, male drivers consistently have substantially higher death rates than female drivers.

Age-related declines can also influence driving ability. Reductions in vision, changes in cognitive functioning such as reasoning and memory, and physical changes associated with aging may all impact an older adult's capacity to drive safely. These challenges highlight the importance of regular health assessments, awareness, and strategies to help older adults maintain both independence and safety on the road (Centers for Disease Control and Prevention, 2024). [23]

Impaired driving

Every day in the United States, 29 people die in motor vehicle crashes that involve an alcohol-impaired driver. This equals one death every 50 minutes. The impact of these crashes is not only tragic but also costly, with alcohol-related crashes totaling more than 44 billion dollars each year. Drugs other than alcohol, both legal and illegal, also play a significant role in traffic incidents. They are involved in about 16 percent of motor vehicle crashes. In 2018, approximately 12.6 million people reported driving under the influence of marijuana or other illicit drugs, further contributing to the dangers on the road (Centers for Disease Control and Prevention, 2024). [23]



Figure 13.6.7: Driving while under the influence of marijuana or other drugs is just as dangerous as driving when intoxicated from alcohol. (Impaired Driving; Elsa Olofsson on Unsplash)

Pedestrian Safety

In 2020, more than 7,000 pedestrians were killed on roads across the United States in crashes involving motor vehicles. This equals about one death every 75 minutes. Several major risk factors contribute to pedestrian fatalities, including alcohol use, speeding, and the location of the crash. Older adults are especially vulnerable. Although adults aged 65 and older made up only about 17 percent of the U.S. population, they accounted for 20 percent of all pedestrian deaths in 2020.

Pedestrian injuries and deaths can be reduced through safer behaviors and environmental choices. Increasing visibility, using crosswalks and designated sidewalks or paths, and staying alert rather than being distracted by devices such as headphones can help prevent accidents. In addition, avoiding walking when impaired by alcohol or drugs significantly reduces the risk of being involved in a fatal crash. These strategies, combined with responsible driving practices, are essential for improving pedestrian safety (Centers for Disease Control and Prevention, 2024). [23]

Motorcycle Safety

In 2020, more than 5,500 motorcyclists lost their lives on roads in the United States, and over 180,000 were treated in emergency departments for crash-related injuries. Motorcycle helmets play a critical role in saving lives and preventing serious harm. In 2017 alone, helmets were estimated to have saved 1,872 lives, and an additional 749 lives could have been saved if every motorcyclist had worn one. Research shows that helmets are 37 percent effective for riders and 41 percent effective for passengers in preventing deaths. They also reduce the risk of head injury by 69 percent, making them one of the most effective protective measures for motorcyclists (Centers for Disease Control and Prevention, 2024). [23]



Figure 13.6.8: Several motorcyclists, most of whom are not wearing helmets. (Motorcycles in Traffic; Aldrin Rachman Pradana on Unsplash)

Bicycle Safety

Bicycle trips account for only about 1 percent of all travel in the United States, yet bicyclists make up more than 2 percent of the people who die in crashes involving motor vehicles. Each year, nearly 1,000 bicyclists are killed and more than 130,000 are injured in road crashes across the country. Adults between the ages of 55 and 69 experience the highest bicycle death rates, while adolescents, teens, and young adults have the highest rates of bicycle-related injuries treated in emergency departments. Male bicyclists face a particularly elevated risk, with death rates six times higher and injury rates five times higher than those of females (Centers for Disease Control and Prevention, 2024). [23]

Fires

Fire spreads quickly, and in less than 30 seconds, a small flame can grow into a major fire. In 2019, there were 1,291,500 reported fires in the United States, which caused 3,704 deaths, 16,600 injuries, and resulted in 14.8 billion dollars in property damage. Taking steps to improve home fire safety is essential for protecting lives and property.

Smoke alarms are a critical first line of defense. They should be installed on every level of the home, as well as inside and outside of all sleeping areas. Alarms should be tested regularly to ensure they work properly and replaced every ten years. Fire safety in the kitchen is also vital. Cooking should never be left unattended, and burners should be turned off if leaving the kitchen. Flammable objects should be kept away from the cooking area, and pot handles should be turned toward the back of the stove to prevent accidental spills.

Home heating equipment presents additional risks. Flammable objects should be kept away from fireplaces, wood stoves, space heaters, or radiators. Extension cords should never be used with space heaters, and heaters should have an automatic shut-off feature if tipped over. Chimneys should also be inspected regularly to reduce fire hazards. Smoking in the home greatly increases the risk of fires. Smoking should never occur in bed or when drowsy, and cigarettes should always be completely extinguished, ideally using water to ensure they are fully out.

Extra care should be taken with young children and older adults. Children must be kept away from anything that gets hot, and matches and lighters should be stored out of their reach. Teaching children how to escape the home in the event of a fire is also important. Older adults may require assistance to exit quickly and safely during an emergency. By following these precautions, families can significantly reduce the risk of home fires and protect the people most vulnerable to them (U.S. Fire Administration, Federal Emergency Management Agency, 2023). [87]



Figure 13.6.9: Behind every deployed hose line is a home, and often a family, whose lives will never be quite the same. (First Responders; Albert Stoynov on Unsplash)

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.

More to Explore

There are 2 ways to get help from Poison Control:

- Online at Web Poison Control
- 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 is 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, cramps, nausea, vomiting, diarrhea, and fever. Some foods are more associated with food-borne 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 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.



Figure 13.6.10: You don't have to touch it to be harmed. Urushiol from poison oak can transfer through clothing, tools, and even pet fur. (Poison Oak; James Whitney on Unsplash)

Everyone is at risk for **Carbon monoxide (CO)** poisoning. CO is 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 in homes and businesses (American Association of Poison Control Centers, 2020). [3]

Question

- Have you or someone you know ever experienced an injury that could have been prevented?
- What safety measures might have helped?

Intentional Injuries

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.



Figure 13.6.1: Man in a protest march holding a sign that says, "Stop Gun Violence". (Protest; Chip Vincent on Unsplash)

The Individual

Individual factors such as age, education, income, substance use, or history of abuse impact the risk of violence. A focus on attitudes, beliefs, and behaviors, along with training on conflict resolution, safe dating, and healthy relationships, may positively impact their risk of violence.

Relationships

A person's closest social circle-peers, partners, and family members-influences their behavior and contributes 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 (Centers for Disease Control and Prevention, 2023). [14]

Community Violence

Violence that occurs outside the home between non-intimate parties, whether strangers or acquaintances, is broadly defined as **community violence**. 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, 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 increased 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.



Figure 13.6.11: Silhouettes of masked rioters around a large fire. (Riot; Cristian Castillo on Unsplash)

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 (Centers for Disease Control and Prevention, 2024). [28]

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.



Figure 13.6.12: Many people experiencing partner violence feel trapped. (Love Shouldn't Hurt; Sydney Latham on Unsplash)

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 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 (Centers for Disease Control and Prevention, 2024). [19]

IPV Prevention Includes

Preventing intimate partner violence and teen dating violence requires a comprehensive approach that addresses skills, relationships, environments, and supports. Teaching safe and healthy relationship skills is a key step. Social-emotional learning programs for youth help them build communication and conflict-resolution abilities, while healthy relationship programs for couples provide tools to strengthen partnerships and reduce harmful behaviors.

Engaging influential adults and peers is also critical. Men and boys can serve as allies in prevention, while bystander empowerment and education encourage people to step in and stop harmful behaviors before they escalate. Family-based programs further reinforce positive values and support systems. Disrupting the developmental pathways that lead to partner violence begins early. Strategies include early childhood home visitation, preschool enrichment with family engagement, parenting skills programs, and treatment for children, youth, and families who may be at risk.

Creating protective environments helps reduce risks across communities. This can be accomplished by improving school climate and safety, adopting stronger organizational policies to foster positive workplace cultures, and modifying the physical and social environments of neighborhoods to encourage safety and connectedness. Strengthening economic supports for families is another important strategy. Initiatives that improve household financial security and provide better work-family supports can reduce stress and the conditions that may contribute to violence.

Finally, supporting survivors is essential to increasing safety and lessening harm. Victim-centered services, housing programs, and legal protections from first responders and civil systems all play a role. Patient-centered healthcare approaches and

specialized treatment and support programs for survivors of intimate partner violence, including teen dating violence, are also vital. Addressing workplace injuries linked to violence is part of this effort as well. Together, these strategies provide a multi-level framework for preventing violence and supporting healthier, safer communities.

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.



Figure 13.6.1: (Sexual Violence Awareness; Mika Baumeister on Unsplash)

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

Sexual violence is a widespread issue that affects both women and men. More than one in three women and one in four men have experienced sexual violence involving physical contact during their lifetimes. Nearly one in five women and one in thirty-eight men have experienced completed or attempted rape, and one in fourteen men has been made to penetrate someone, either completed or attempted, during their lifetime.

Sexual violence often begins at a young age. One in three female rape victims reported that their first experience occurred between the ages of 11 and 17, and one in eight reported that it happened before the age of 10. Among male rape victims, nearly one in four said their first experience occurred between the ages of 11 and 17, and about one in four reported that it happened before the age of 10.

The consequences of sexual violence are also costly. Recent estimates place the lifetime cost of rape at more than 122,000 dollars per victim, a figure that includes medical expenses, lost productivity, criminal justice activities, and other related costs. These statistics highlight both the widespread nature of sexual violence and the significant toll it takes on individuals and society (Centers for Disease Control and Prevention, 2024). [17]

Sexual Violence Prevention Includes

Promoting social norms that protect against violence is an essential part of prevention. Bystander approaches encourage individuals to step in and prevent harmful behavior, while mobilizing men and boys as allies fosters shared responsibility for creating safer communities.

Teaching skills to prevent sexual violence is another important strategy. Social-emotional learning helps youth build empathy, communication, and problem-solving abilities. Adolescents benefit from learning healthy and safe dating and relationship skills, and promoting healthy sexuality encourages respect and consent in relationships. Empowerment-based training further equips individuals with the confidence and tools to protect themselves and others.

Providing opportunities to empower and support girls and women also plays a significant role in prevention. Strengthening economic supports for women and families reduces financial vulnerability, while creating leadership opportunities for girls builds confidence and resilience that can protect against future violence.

Creating protective environments helps reduce risks across schools, workplaces, and communities. Improving safety and monitoring in schools, establishing and consistently enforcing workplace policies, and addressing community-level risks through environmental approaches are all effective strategies. Finally, supporting victims and survivors is essential to lessening harms. Victim-centered services, treatment programs for survivors of sexual violence, and interventions for at-risk children and families can prevent future problem behaviors, including sex offending, while promoting healing and recovery (Centers for Disease Control and Prevention, 2024). [17]

Question

- What are some signs of intimate partner violence or abuse?
- How can someone safely seek help or support others in these situations?

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.



Figure 13.6.13: Like any public health crisis, firearm violence is preventable and treatable. (Revolver; Alejo Reinoso on Unsplash)

Firearm injuries are a serious public health problem. In 2020, there were 45,222 firearm-related deaths in the United States, which is 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 a 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 at 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 (Centers for Disease Control and Prevention, 2024). [22]

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 (Centers for Disease Control and Prevention, 2024). [22]

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 (Centers for Disease Control and Prevention, 2023). [13]

Prevention Strategies Include

One important strategy to address the opioid crisis is increasing and maximizing the use of prescription drug monitoring programs. These state-run databases track prescriptions for controlled substances, helping to improve opioid prescribing practices, inform clinical decision-making, and protect individuals who may be at risk of misuse. Education is also critical. Learning about the risks of prescription opioids and understanding the resources available for those struggling with opioid use disorder can help prevent misuse and encourage individuals to seek help when needed.

Treatment plays a central role in addressing opioid use disorder. Expanding access to substance use disorder treatment services, particularly Medication-Assisted Treatment and Medications for Opioid Use Disorder, provides effective, evidence-based care that improves recovery outcomes. In addition, reversing overdoses is a key life-saving measure. Expanding access to naloxone, a medication that can rapidly reverse the effects of an opioid overdose, ensures that both community members, such as family and neighbors, and service providers, such as first responders, are prepared to act quickly in emergencies. Together, these strategies form a comprehensive approach to prevention, treatment, and harm reduction (Centers for Disease Control and Prevention, n.d.). [8]

Child Abuse and Neglect

Child abuse and **neglect** are serious public health problems that can have long-term impacts on health, opportunity, and well-being. 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 of 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 (Centers for Disease Control and Prevention, 2023). [10]

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

Certain factors can increase a child's vulnerability to abuse and neglect. Young age is a significant risk factor, as infants and toddlers are more dependent on caregivers, less able to communicate effectively, and have higher care needs. Children under the age of four are particularly at risk for severe physical abuse and neglect. Disabilities or special needs, whether physical, cognitive, emotional, or behavioral, can also heighten the risk. These challenges may increase caregiver stress, and children with developmental delays may struggle to disclose abuse. Behavioral problems, such as conduct issues, hyperactivity, or defiance, can contribute to caregiver frustration, placing children perceived as "difficult" at greater risk. Similarly, children experiencing mental health issues such as anxiety, depression, or attachment disorders may be more susceptible to neglect or emotional abuse.

Poor attachment or emotional bonding with parents further increases the likelihood of abuse, particularly emotional or physical neglect. Children who are unwanted or unplanned may be treated more harshly or neglected by caregivers. Substance exposure, whether prenatal or postnatal, also creates heightened risk, as children exposed to drugs or alcohol in utero or who live in substance-abusing environments are vulnerable to multiple forms of abuse and neglect.

Additional factors include prior victimization or trauma, which raises the likelihood of re-victimization, especially in institutional or familial settings. Children with limited social support or who experience isolation from protective adults are less likely to disclose abuse and more likely to remain in harmful situations. Gender may also play a role in some contexts, with research suggesting that girls are at higher risk of sexual abuse, while boys are more often subjected to physical abuse. These overlapping factors underscore the complex circumstances that can place children at increased risk and highlight the importance of protective relationships, social support, and early intervention (Centers for Disease Control and Prevention, 2023). [10]

Risk Factors for Perpetration

Several caregiver-related factors increase the risk of child abuse and neglect. Caregivers who struggle with drug or alcohol issues or who experience mental health challenges, including depression, are at higher risk of perpetrating abuse. A lack of understanding of children's needs or developmental stages can also contribute to harmful behaviors. Adults who were abused or neglected as children may repeat patterns of maltreatment, and young or single parents or those with many children may face added strain that increases risk. Low education levels, limited income, and high levels of parenting or economic stress further heighten vulnerability. Disciplinary practices also play a role, as caregivers who rely on spanking or corporal punishment are more likely to engage in abusive behaviors. The presence of caregivers in the home who are not biological parents can also be a factor, as can attitudes that accept or justify violence and aggression.

Family Risk Factors

Certain family dynamics create additional risks. Families with household members in jail or prison may experience added instability and stress. Families that are socially isolated or disconnected from extended relatives, friends, or neighbors lack protective social supports. Exposure to other types of violence, including intimate partner violence, further increases the likelihood of abuse. High levels of family conflict and negative communication styles also create environments where children are more vulnerable.

Community Risk Factors

Community conditions strongly influence family and child well-being. Communities with high levels of violence and crime, poverty, and limited educational or economic opportunities place families at greater risk. High unemployment rates, combined with easy access to drugs and alcohol, can intensify stress and unhealthy coping behaviors. Communities where neighbors do not know or support one another and where resident involvement is low provide fewer protective networks. A lack of community activities for young people, unstable housing situations with frequent moves, and widespread food insecurity further weaken protective factors. Together, these conditions create environments where abuse and neglect are more likely to occur, underscoring the importance of strengthening community supports and resources.

Prevention Strategies

Strengthening economic support to families is a key strategy for preventing child abuse and neglect. Policies that strengthen household financial security and provide family-friendly work options reduce stress on caregivers and create more stable environments for children. Changing social norms to support parents and encourage positive parenting is equally important.

Public engagement and education campaigns can promote healthier parenting practices, while legislative approaches that reduce the use of corporal punishment help foster safer, more nurturing homes.

Providing quality care and education early in life also plays a critical role. Preschool enrichment programs that involve families support children's development and prepare them for school success. Improving the quality of child care through stronger licensing and accreditation standards ensures that young children are cared for in safe and supportive environments. Enhancing parenting skills is another vital prevention approach. Early childhood home visitation programs, along with initiatives that focus on parenting skills and family relationship building, give caregivers the tools they need to raise children in healthy and supportive ways.

Intervening to lessen harms and prevent future risk is essential for children who have already been exposed to abuse or neglect. Enhanced primary care services can help identify and address concerns early. Behavioral parent training programs provide practical strategies for improving parenting practices, while treatment services can lessen the immediate harm of abuse and neglect. Additional interventions that prevent problem behavior and reduce the likelihood of future involvement in violence also support healthier long-term outcomes for children and families (Centers for Disease Control and Prevention, 2023). [10]

Suicide

Suicide is death caused by injuring oneself with the intent to die. A suicide attempt is when someone harms themselves with the 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 (Centers for Disease Control and Prevention, 2024). [16]

Suicide Prevention Strategies

Preventing suicide requires a comprehensive set of strategies that strengthen supports, improve care, and reduce risks. Strengthening economic supports is a foundational step, which includes policies that enhance household financial security and promote housing stability. These measures reduce stressors that can contribute to suicide risk. Strengthening access to and delivery of suicide care is also essential. Expanding coverage of mental health conditions in health insurance policies, addressing provider shortages in underserved areas, and implementing systems changes that promote safer suicide care all help ensure that individuals receive timely and effective treatment.

Creating protective environments further reduces risks. Efforts to limit access to lethal means among those at risk of suicide, implementing organizational policies and supportive workplace cultures, and developing community-based policies to reduce excessive alcohol use all contribute to safer surroundings. Promoting connectedness is another powerful protective factor. Peer

norm programs and community engagement activities encourage stronger social ties and a sense of belonging, which can buffer against feelings of isolation and despair.

Teaching coping and problem-solving skills also plays a critical role in prevention. Social-emotional learning programs help youth build resilience and manage stress, while parenting skill and family relationship programs strengthen healthy dynamics within families. Identifying and supporting people at risk ensures that individuals in crisis do not slip through the cracks. Gatekeeper training, crisis intervention, and treatment for those at risk of suicide, along with specialized care to prevent re-attempts, provide essential safety nets. Finally, lessening harms and preventing future risk involves **postvention** efforts to support those affected by suicide, as well as safe reporting and messaging practices that avoid glamorizing or normalizing suicide. Together, these strategies form a comprehensive framework for suicide prevention that addresses both immediate needs and long-term protective factors (Centers for Disease Control and Prevention, 2024). [16]

More to Explore

Need help? Know someone who does?

Contact the National Suicide Prevention Lifeline

- Call 1-800-273-TALK (1-800-273-8255)
- Use the Lifeline Crisis Chat

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 Lifeline

You can also connect 24/7 to a crisis counselor by texting the Crisis Text Line

- Text HOME to 741741.

Key Points

- Injuries, both intentional and unintentional, are responsible for 4.4 million deaths globally each year, making up nearly 8% of all deaths. In the U.S., unintentional injuries are the leading cause of death for people under 45.
- The most common causes include falls (especially among older adults), motor vehicle crashes, drowning, poisoning, and fires. Falls and unintentional poisonings alone account for tens of thousands of deaths annually.
- Intentional injuries such as homicide, intimate partner violence, sexual violence, and community violence result in significant physical, emotional, and economic consequences and disproportionately affect young people and marginalized communities.
- Distracted driving, impaired driving, lack of seatbelt or car seat use, and risky behaviors among teens and older drivers contribute to high injury and fatality rates from car crashes.
- In 2020, over 45,000 people died from firearm-related injuries in the U.S., with suicides and homicides making up the majority. Men, youth aged 15–34, and certain racial/ethnic groups face higher risks.
- Suicide remains a top cause of death, with nearly 46,000 U.S. deaths in 2020. Risk factors include mental health conditions, past trauma, and limited access to care. More than 90% of suicide survivors do not die by suicide later.
- At least 1 in 7 children experience abuse or neglect annually in the U.S., with poverty as a major risk factor. Abuse leads to long-term health, developmental, and economic consequences.
- Prevention involves multi-level approaches—addressing individual behaviors, relationships, community conditions, and societal norms. Strategies include early education, economic supports, safe environments, bystander training, and access to care.

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13.7: Comprehension Check

Summary

This chapter explores the interconnected public health challenges of substance use, addiction, and injury. Addiction is a chronic brain disease driven by biological, psychological, and social factors, requiring individualized treatment and long-term support. Recreational drug use—including substances like marijuana, opioids, and stimulants—can lead to addiction, physical harm, and mental health issues, with some drugs posing life-threatening risks even in small doses.

Alcohol, tobacco, and caffeine while legal, are also associated with serious health consequences. Excessive alcohol use damages organs and impairs judgment, while tobacco use—especially nicotine—is highly addictive and a major cause of preventable death. Evidence-based treatments such as counseling, medications, and behavioral therapies are essential for recovery.

The chapter also highlights injury and violence prevention. Unintentional injuries like falls and car crashes, and intentional injuries such as suicide and violence, are leading causes of death for those under 45. Addressing these issues requires a comprehensive public health approach that combines education, community support, and policy change to reduce risk and promote safety.

Test Your Understanding

- What factors contribute to the development of addiction as a chronic brain disease?
- Why is understanding both the short- and long-term effects of recreational drugs important?
- What makes fentanyl particularly dangerous compared to other drugs?
- List two major health risks associated with excessive alcohol use.
- What are three evidence-based treatments for reducing or quitting alcohol use?
- Why is nicotine considered highly dangerous, even in secondhand exposure?
- Describe two potential health risks associated with chronic high-dose caffeine consumption.
- How do social norms and cultural traditions influence patterns of caffeine consumption across different populations?
- What types of injuries are categorized as intentional and unintentional?
- What key strategies are recommended to prevent injuries and reduce harm in communities?

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Chapter 13 Glossary

- **12-Step Facilitation Therapy (TSF)**: An individual therapy that introduces clients to the core principles of 12-step programs and motivates them to become actively involved in fellowship meetings to maintain sobriety and reduce relapse risk.
- **Addiction**: A brain disease that results in the inability to stop using a drug or engaging in a behavior, even when it causes physical, emotional, social, or legal problems.
- **Alcohol**: A chemical compound (ethanol) that, when consumed, affects the brain and body by slowing down brain function and neural activity.
- **Alcoholic Hepatitis**: A condition characterized by inflammation and damage to liver cells as a direct result of chronic alcohol use, often accompanied by fatty liver and fibrosis, and in severe cases, may progress to cirrhosis or liver failure.
- **Arrhythmias**: A disruption in the normal rhythm of the heart, affecting the rate or pattern of heartbeats.
- **Blood Alcohol Concentration (BAC)**: The ratio of alcohol to blood in the body, typically measured in grams of alcohol per deciliter (g/dL) of blood.
- **Carbon Monoxide (CO)**: A poisonous gas formed when fuels do not burn completely. Because it is invisible and undetectable without a sensor, it is often referred to as a "silent killer."
- **Cardiomyopathy**: A group of diseases that affect the structure and function of the myocardium (heart muscle), reducing the heart's efficiency and often leading to serious cardiovascular complications.
- **Child Abuse**: Any act or failure to act that results in a child's harm, potential harm, or threat of harm, including physical, emotional, sexual abuse, or neglect.
- **Cirrhosis**: A progressive liver condition characterized by scarring of liver tissue that interferes with the liver's ability to perform essential functions such as detoxifying the blood, producing proteins, and aiding in digestion.
- **Cocaine**: A central nervous system stimulant that produces short-term pleasurable effects but can lead to serious mental and physical health problems.
- **Cognitive Behavioral Therapy (CBT)**: A goal-oriented, structured form of talk therapy that focuses on the connection between thoughts, feelings, and behaviors.
- **Community Violence**: A type of violence that happens outside the home and typically involves unrelated individuals who may or may not know each other, often occurring in settings like streets, parks, or schools.
- **Contingency Management**: A structured behavioral intervention in which individuals receive rewards or incentives (such as vouchers, privileges, or prizes) for meeting specific behavioral goals, such as attending therapy sessions, submitting negative drug tests, or adhering to medication regimens.
- **Depressants**: Substances that reduce arousal and stimulation in the central nervous system.
- **Detoxification**: A medically supervised process that helps individuals safely eliminate addictive substances from the body while managing the physical and psychological effects of withdrawal.
- **Drug Overdose**: A toxic and dangerous reaction to a substance (or substances) that overwhelms the body's normal functioning, often leading to serious health complications or death if not treated promptly.
- **E-Cigarettes**: Electronic nicotine delivery systems (ENDS) designed to simulate smoking by producing a vapor or aerosol instead of smoke.
- **Fentanyl**: A synthetic opioid analgesic that is 50 to 100 times more potent than morphine.
- **Firearm Violence**: The threatened or actual use of a gun to cause harm, intimidate, or exert power over others.
- **Hallucinogens**: Substances that profoundly alter a person's sensory perception, emotional state, and consciousness, often causing visual or auditory hallucinations, distorted sense of time, and altered thinking or reality.
- **Heroin**: A powerful, illegal opioid that rapidly affects the brain, producing intense feelings of euphoria and pain relief, but also leading to tolerance, dependence, and addiction.
- **Intimate Partner Violence (IPV)**: Physical, sexual, psychological, or emotional abuse, stalking, or economic control by a current or former partner or spouse.
- **Marijuana**: A drug made from the dried leaves, flowers, stems, and seeds of the cannabis plant, containing THC and other cannabinoids that alter brain function, affecting mood, perception, and behavior.
- **Methamphetamine**: A synthetic stimulant drug that causes a rapid and intense high, followed by dangerous physical and psychological effects.
- **Motivational Enhancement Therapy (MET)**:
- **Neglect**: The chronic failure to meet an individual's basic physical, emotional, medical, educational, or safety needs, especially when the person is unable to meet those needs themselves.
- **Nicotine**: A stimulant drug that affects the central nervous system, producing short-term pleasurable effects like alertness and relaxation, while also causing dependence and addiction with repeated use.
- **Nicotine Replacement Therapies (NRT)**: A tobacco cessation aid that delivers controlled amounts of nicotine to the body

to ease withdrawal symptoms and support quitting, while breaking the behavioral habit of smoking or chewing tobacco.

- **Opioids**: Natural, synthetic, or semi-synthetic substances that interact with opioid receptors in the brain to reduce pain and produce pleasurable effects.
- **Pancreatitis**: A condition in which the pancreas becomes inflamed, often causing abdominal pain, digestive problems, and complications with blood sugar regulation.
- **Peer Pressure**: The social influence from peers that encourages an individual to adopt certain behaviors, beliefs, or actions, often to gain acceptance or avoid rejection.
- **Physical Violence**: The use of physical force with the intent to harm, control, intimidate, or punish another person. It includes actions that cause bodily pain, injury, or physical suffering.
- **Postvention**: A set of organized responses and support activities that occur after a suicide to aid survivors in grief, prevent suicide contagion, and stabilize the affected community.
- **Protective Factors**: Strengths, supports, or resources that decrease the likelihood of harmful outcomes and increase a person's ability to cope with challenges or stress.
- **Psychological Aggression**: The use of communication or behavior to inflict emotional pain, exert control, or undermine a person's sense of self-worth or safety.
- **Recreational Drugs**: Psychoactive substances used voluntarily for enjoyment or leisure, rather than for therapeutic or medical purposes.
- **Risk Factors**: Any attribute, exposure, or situation that raises the probability of a negative health or behavioral outcome.
- **Sexual Violence**: Any sexual act, attempt to obtain a sexual act, or other act directed against a person's sexuality using coercion, force, threats, manipulation, or when the victim is unable to consent.
- **Smokeless Tobacco**: Tobacco products that are consumed without combustion, typically by chewing, sucking, or sniffing, and are absorbed through the lining of the mouth or nose.
- **Stalking**: A course of conduct directed at a specific person that would cause a reasonable person to feel fear or distress.
- **Steatosis**: The build-up of fat in the liver cells, which can impair liver function and, over time, lead to inflammation, fibrosis, and potentially cirrhosis or liver failure.
- **Stimulants**: Substances that speed up the body's systems, especially the central nervous system, leading to increased heart rate, blood pressure, and energy levels.
- **Substance Use Disorders**: Medical conditions in which the recurrent use of alcohol, drugs, or other substances leads to significant impairment, distress, or health risks. They are characterized by symptoms such as cravings, loss of control, tolerance, withdrawal, and continued use despite negative consequences.
- **Suicide**: The intentional, self-inflicted death of an individual. It is typically associated with overwhelming psychological pain, hopelessness, or the belief that life is no longer worth living.
- **Synthetic Cannabinoids**: Laboratory-created drugs that interact with the same brain receptors as THC but often in stronger and more unpredictable ways, leading to severe health risks.
- **Tobacco**: A plant in the Nicotiana genus, most commonly Nicotiana tabacum, whose leaves are harvested, cured, and processed for use in various products, including cigarettes, cigars, pipe tobacco, and smokeless tobacco
- **Tolerance**: The body's reduced response to a drug or alcohol after repeated use, requiring higher doses to achieve the desired effect (e.g., euphoria, pain relief, intoxication).
- **Withdrawal**: The body's response to the absence of a drug on which it has become physically or psychologically dependent

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GLOSSARY

Comprehensive Glossary

Word(s)	Definition
12-Step Facilitation Therapy (TSF)	An individual therapy that introduces clients to the core principles of 12-step programs and motivates them to become actively involved in fellowship meetings to maintain sobriety and reduce relapse risk.
Abstinence	The Centers for Disease Control and Prevention (CDC) defines abstinence as not having vaginal, oral, or anal sex.
Acceptable Macronutrient Distribution Ranges (AMDRs)	One of the standards that make up the Dietary Reference Intakes; recommended intake ranges for protein, fat, and carbohydrates as percentages of total daily calories.
Acrophobia	An intense fear of heights that triggers anxiety or panic in high places, often treated with therapy or relaxation techniques.
Actin Myofilaments	Thin protein filaments found in muscle fibers. Actin is also involved in maintaining the structure and shape of the muscle fiber.
Action Potential	An electrical signal that travels along a neuron or muscle cell, triggered by a change in the cell's membrane potential. Action potentials are essential for nerve function, muscle movement, and various physiological processes.
Active Stretching	A type of stretching where the individual uses their own muscles to hold a stretch without the assistance of an external force.
Activities of Daily Living (ADLs)	Basic self-care tasks, such as bathing, dressing, and household chores, that physical activity can help older adults perform more easily and independently
Acute Sleep Deprivation	Short-term, temporary loss of sleep that impairs performance, alertness, and mood.
Acute Stress	A short-term physiological and psychological response to an immediate perceived threat or challenge.
Adaptations	The physiological changes that occur in the body in response to consistent physical activity or training. These adaptations can include increased cardiovascular efficiency, improved muscular strength and endurance, enhanced flexibility, and better metabolic function, all of which help the body perform exercise more efficiently over time.
Added Sugars	Sugars and syrups that are added to foods or beverages during processing or preparation. This includes ingredients like table sugar, honey, syrups, and sweeteners added during cooking, baking, or manufacturing.
Addiction	A brain disease that results in the inability to stop using a drug or engaging in a behavior, even when it causes physical, emotional, social, or legal problems.
Adenosine Triphosphate	Is the basic form of cellular energy found in the body. The energy source for cellular processes.

Word(s)	Definition
Adenosine Triphosphate (ATP)	The primary energy carrier in cells, fueling essential biological processes like muscle contraction, nerve signaling, and metabolism. It releases energy when its high-energy phosphate bonds are broken.
Adequate Intakes (AIs)	Recommended average daily nutrient intake levels based on observed or experimentally determined estimates of nutrient consumption when scientific evidence is insufficient to establish a Recommended Dietary Allowance (RDA). They are used as a guide to ensure nutritional adequacy.
Adipose (Fat) tissue	A type of connective tissue that stores energy in the form of fat and provides insulation and cushioning for the body. It also functions as an endocrine organ by releasing hormones that influence metabolism and appetite.
Adipose Tissue	Body fat that makes up the fat mass in body composition; includes subcutaneous (under skin) and visceral (around organs) fat.
Adrenaline (Epinephrine)	A hormone and neurotransmitter released by the adrenal glands during stress or excitement that increases heart rate, blood pressure, and energy availability.
Aerobic Exercise	Continuous, rhythmic physical activity that uses large muscle groups and relies primarily on oxygen for energy production.
Aerobic Metabolism	Produces ATP using oxygen to break down glucose, fats, and proteins. It provides sustained energy for endurance activities and produces carbon dioxide and water as byproducts.
Agility	The ability to rapidly change direction, speed, or position of the body with control and efficiency. It involves a combination of balance, coordination, reaction time, and quickness, making it essential for sports and activities that require sudden movements and adjustments.
Agonist	An agonist is the muscle that contracts to produce a specific movement.
Agoraphobia	An anxiety disorder characterized by an intense fear of situations where escape may be difficult or help unavailable, often leading to avoidance of crowded places, public transportation, or open spaces.
Agreeableness	A personality trait reflecting compassion, cooperation, trust, and a tendency to prioritize social harmony.
Alcohol	Ethanol, the intoxicating ingredient in beer, wine, and spirits that provides 7 calories per gram. It is not essential for health, and excessive intake can lead to serious health problems.
Alcoholic Hepatitis	A condition characterized by inflammation and damage to liver cells as a direct result of chronic alcohol use, often accompanied by fatty liver and fibrosis, and in severe cases, may progress to cirrhosis or liver failure.
Allostatic Load	The cumulative wear and tear on the body's systems caused by chronic stress and repeated activation of the stress response.
Alpha-linolenic acid (18:3)	An essential omega-3 fatty acid found mainly in plant sources such as flaxseed, chia seeds, walnuts, and canola oil. The body cannot produce ALA, so it must come from the diet and can be partially converted into other omega-3 fats like EPA and DHA.
Alström	syndrome**: A rare inherited disorder causing vision and hearing loss, obesity, diabetes, heart disease, and organ damage. There is no cure, but symptoms can be managed.

Word(s)	Definition
Alveoli	Tiny air sacs in the lungs that allow the exchange of oxygen and carbon dioxide betweenn the lungs and blood.
American College of Sports Medicine [ACSM]	A professional organization that provides guidelines and research on exercise science and sports medicine.
Anabolic Steroids	Synthetic substances that mimic testosterone, promoting muscle growth and performance. They can cause hormonal imbalances, liver damage, and cardiovascular issues and are illegal without a prescription.
Anaerobically	Refers to activities that occur without oxygen, like weightlifting or sprinting, relying on stored energy sources and producing lactic acid.
Android Shape	A fat distribution pattern where fat is stored mainly in the abdomen and upper body. It is linked to a higher waist-to-hip ratio and a greater risk of heart disease, diabetes, and metabolic syndrome due to excess visceral fat.
Anger	An emotional response to perceived threats, frustration, or injustice, often involving physiological changes and the urge to take action.
Angina	Also known as angina pectoris, is chest pain or discomfort that occurs when part of your heart muscle does not get enough oxygen-rich blood.
Angiogram	A coronary angiogram is a test that uses X-rays to look at the heart's blood vessels, called the coronary arteries.
Anhedonia	The inability to experience pleasure or interest in once enjoyable activities.
Animal-based protein	Protein that comes from foods such as meat, poultry, fish, eggs, and dairy products. These proteins are considered “complete” because they contain all nine essential amino acids the body needs.
Annulus Fibrosus	The tough outer layer of an intervertebral disc that surrounds the nucleus pulposus and provides structural integrity.
Anorexia Nervosa	An eating disorder marked by extreme food restriction, fear of gaining weight, and a distorted body image, resulting in dangerously low body weight.
Antagonist	A muscle that opposes the action of the agonist.
Anti-Inflammation Diet	A way of eating that focuses on consuming foods that reduce inflammation in the body. It emphasizes fruits, vegetables, whole grains, healthy fats (like olive oil and nuts), and lean proteins while limiting processed foods, added sugars, and unhealthy fats.
Antioxidants	Compounds that protect the body’s cells from damage caused by free radicals, which can contribute to aging and disease. Common dietary antioxidants include vitamins C and E, beta-carotene, and selenium.
Anus	The terminal opening through which feces are expelled from the body.
Anxiety	A feeling of unease, worry, or apprehension about a potential future threat or uncertain outcome.
Anxiety Disorders	Mental health disorders characterized by excessive fear, worry, or nervousness that interfere with daily functioning.
Aorta	The body's largest artery; receives blood from the left ventricle and distributes it to the body.

Word(s)	Definition
Aortic Valve	The heart valve between the left ventricle and the aorta that prevents the back flow of blood into the left ventricle.
Appetite Suppressants	Reduce hunger and cravings, aiding weight management by affecting hormones, digestion, or neurotransmitters.
Arachnophobia	An intense fear of spiders and other arachnids, causing significant anxiety or avoidance behavior when encountering them.
Arrhythmia	An arrhythmia is a heart rhythm that isn't normal. Your heart may be beating too fast when you're at rest or just not beating in a regular pattern.
Arrhythmias	A disruption in the normal rhythm of the heart, affecting the rate or pattern of heartbeats.
Arteries	Vessels that carry blood away from the heart.
Arteriosclerosis	Hardening of the arteries.
Arthritis	A condition involving inflammation of the joints, leading to pain, stiffness, and reduced mobility.
Articular Cartilage	Smooth cartilage that covers the ends of bones at synovial joints to allow for smooth movement and reduce friction.
Articular Surfaces	The surfaces of bones that come into contact at a joint.
Asthma	A chronic respiratory condition where the airways become inflamed and narrowed, causing difficulty breathing, wheezing, coughing, and shortness of breath. Symptoms can be triggered by allergens, exercise, cold air, or stress.
Atherosclerosis	A condition in which fatty deposits, cholesterol, and other substances build up on the inner walls of arteries, forming plaques. This buildup can narrow or block arteries, reducing blood flow and increasing the risk of cardiovascular diseases such as heart attacks and strokes.
ATP Molecules	The primary energy carrier in cells, fueling muscle contractions, metabolism, and cellular functions. ATP is regenerated through aerobic and anaerobic pathways, supporting physical activity and biological processes.
Atrium	One of the two upper chambers of the hear in which blood collects before passing to the ventricles.
Atrophy	The loss of muscle or tissue mass due to disuse, aging, injury, or disease. It occurs when muscle fibers shrink, but can be slowed with exercise and nutrition.
Attribution Theory	A psychological theory that examines how individuals explain the causes of behavior and events, attributing outcomes to internal factors (like ability or effort) or external factors (like luck or situational influences).
Autogenic Inhibition	A reflex relaxation of the muscle in response to high tension, often activated during stretching.
Autonomic Nervous System (ANS)	The branch of the PNS that regulates involuntary body functions such as heart rate, digestion, and respiratory rate, operating automatically without conscious control.
Avoidance	A defense mechanism where individuals unconsciously evade situations, thoughts, or emotions that cause anxiety or distress, providing temporary relief but often hindering long-term resolution.

Word(s)	Definition
Axon	The long, cable-like extension of a motor neuron that carries electrical impulses (action potentials) away from the cell body toward muscle fibers.
Balance	Ability to maintain control of body position while stationary or in motion. It involves coordination, stability, and strength to prevent falls, enhance performance, and efficiently execute movements in sports and physical activities.
Ball-and-Socket Joints	Joints that allow movement in all directions, such as the shoulder and hip.
Ballistic Stretching	A type of stretching that uses bouncing or jerking movements to increase range of motion.
Bardet-Biedl syndrome	A rare genetic disorder causing vision loss, obesity, extra fingers/toes, kidney issues, and developmental delays. It has no cure, but symptoms can be managed.
Bariatric Surgery	A weight-loss procedure that reduces stomach size or alters digestion to help limit food intake and promote weight loss.
Basal Metabolic Rate	The amount of energy the body requires at rest to maintain essential life functions such as breathing, circulation, and cell production. It represents the minimum number of calories needed to sustain vital bodily processes while at complete rest.
Basal Metabolic Rate (BMR)	- **Bio-Electrical Impedance**: A method for estimating body composition by measuring how easily a low electrical current passes through the body. Since muscle conducts electricity better than fat, the resistance (impedance) helps estimate body fat percentage.
Behavioral Treatment	A therapy that helps individuals change unhealthy behaviors by using strategies like goal setting, self-monitoring, and positive reinforcement to improve health and well-being.
Benign tumor	A benign tumor is a non-cancerous growth of cells that does not spread to other parts of the body.
Beta-Alanine	A non-essential amino acid that boosts carnosine levels, delaying muscle fatigue and enhancing endurance and performance.
Beta-Blockers	Medications that reduce physical symptoms of anxiety, such as rapid heart rate and trembling, by blocking the effects of adrenaline on the body.
Binge Eating Disorder	An eating disorder characterized by regularly consuming large amounts of food in a short period while feeling a loss of control, often followed by guilt or distress, but without compensatory behaviors like purging.
Biological Sex	The physical and genetic characteristics a person is assigned at birth, typically categorized as male or female.
Bipolar Disorder	A mood disorder characterized by extreme mood swings, including manic episodes of elevated energy and activity, depressive episodes of sadness and low energy, and sometimes mixed episodes with symptoms of both.
Blood Alcohol Concentration (BAC)	The ratio of alcohol to blood in the body, typically measured in grams of alcohol per deciliter (g/dL) of blood.
Blood Pressure	The force exerted by blood on the walls of the blood vessels, created by the pumping action of the heart.
Blood Vessels	Transport blood, oxygen, and nutrients throughout the body. They include arteries (carry blood away from the heart), veins (return blood to the heart), and capillaries (exchange gases and nutrients).

Word(s)	Definition
Body Composition	The proportion of fat, muscle, bone, and other tissues in the body. It is a key indicator of overall health and fitness, often measured to assess the ratio of lean mass to body fat.
Body Dysmorphic Disorder	A mental health condition where a person becomes excessively preoccupied with perceived flaws or defects in their physical appearance, which are often minor or unnoticeable to others, leading to significant distress and impaired daily functioning.
Body Dysmorphic Disorder (BDD)	A mental health condition in which a person becomes excessively preoccupied with perceived flaws or defects in their physical appearance. These flaws are often minor or not noticeable to others, but to the individual, they feel significant and distressing. People with BDD may engage in repetitive behaviors such as mirror-checking, excessive grooming, or seeking reassurance, and the condition can interfere with daily functioning, relationships, and overall quality of life. Treatment often involves cognitive-behavioral therapy (CBT) and, in some cases, medication.
Body Image	A person's perception and feelings about their body size, shape, and composition, which may or may not reflect their actual body composition.
Body Positivity	A social movement and mindset that encourages individuals to accept, appreciate, and respect their bodies regardless of size, shape, appearance, or ability. It challenges unrealistic beauty standards promoted by media and culture, and instead emphasizes that all bodies are worthy of dignity, confidence, and care. Body positivity also promotes self-compassion, balanced health behaviors, and the idea that physical appearance should not define a person's value or self-worth.
Bone Marrow	Soft, spongy tissue found inside large bones that produces red blood cells, white blood cells, and platelets. It exists in two forms: *red marrow*, which actively generates blood cells, and *yellow marrow*, which primarily stores fat. It plays a key role in treating blood diseases such as leukemia through bone marrow transplantation.
Bran	The outer protective covering of the seed that is rich in fiber, B vitamins, and trace minerals.
Branched-Chain Amino Acids (BCAAs)	Support muscle growth, recovery, and energy. They enhance protein synthesis, reduce muscle breakdown, and fight fatigue, making them popular in sports nutrition.
Bulimia Nervosa	An eating disorder characterized by cycles of binge eating followed by compensatory behaviors such as vomiting, excessive exercise, or fasting to prevent weight gain, often driven by a fear of gaining weight and a distorted body image.
Cachexia	Severe loss of muscle and fat mass due to disease, leading to unhealthy body composition and weakness.
Caffeine	Caffeine is a natural stimulant that blocks adenosine, increasing alertness, focus, and energy.
Calorie	A unit of energy that measures how much energy food provides when consumed and metabolized.
Calories	Units of energy that measure the amount of energy food provides when consumed and the body uses when performing physical activities. They are essential for fueling the body's functions, including breathing, digestion, and movement.
Cancer	A disease in which abnormal cells grow uncontrollably and can invade or spread to other parts of the body, disrupting normal body functions and potentially leading to serious health complications.
Capillaries	Very small blood vessels that distribute blood to all parts of the body.

Word(s)	Definition
Carbohydrate	Macronutrients that serve as the body's main source of energy, found in foods like grains, fruits, vegetables, and dairy. They include sugars, starches, and fiber, which the body breaks down into glucose for fuel.
Carbon Dioxide	A gas produced during the metabolism of carbohydrates, fats, protein, and acids. During exercise, the body manages increased levels of carbon dioxide by breathing faster. Plants use carbon dioxide to capture energy through photosynthesis, but high levels of carbon dioxide are toxic to the body.
Carbon Monoxide (CO)	A poisonous gas formed when fuels do not burn completely. Because it is invisible and undetectable without a sensor, it is often referred to as a "silent killer."
Cardiac Muscle	A specialized, involuntary muscle found in the heart, responsible for pumping blood throughout the body. It has striated fibers, like skeletal muscle, but functions autonomously, controlled by the autonomic nervous system and pacemaker cells. It is highly fatigue-resistant and works continuously to maintain circulation.
Cardiac Output	The volume of blood pumped by the heart per minute via heart rate and stroke volume.
Cardiometabolic	Refers to health risks (like heart disease and type 2 diabetes) linked to excess body fat, especially visceral fat, in body composition.
Cardiomyopathy	A group of diseases that affect the structure and function of the myocardium (heart muscle), reducing the heart's efficiency and often leading to serious cardiovascular complications.
Cardiorespiratory endurance	Cardiorespiratory endurance is the ability of the heart, lungs, and circulatory system to efficiently supply oxygen to working muscles during sustained physical activity. It is a key component of fitness that enhances overall stamina, reduces fatigue, and improves aerobic performance.
Cardiorespiratory System	The system that circulates blood through the body; consists of the heart, blood vessels and respiratory system. Cardiorespiratory system supports encompasses both cardiovascular and respiratory systems.
Cardiovascular Disease	A group of conditions that affect the heart and blood vessels, including heart disease, stroke, and high blood pressure, often caused by blocked or narrowed blood vessels, leading to reduced blood flow and increased risk of heart attack or stroke.
Cardiovascular System	The system that circulates blood throughout the body and consists of the heart and blood vessels.
Carditis	Inflammation of the heart.
Cartilage	A flexible connective tissue found in joints, providing cushioning and reducing friction between bones.
Cartilage of a Joint	Refers to the specific cartilage (often articular) within a joint that helps absorb shock and enable smooth movement.
Cartilaginous Joints (Amphiarthroses)	Joints connected entirely by cartilage, allowing limited movement.
Catastrophizing	A cognitive distortion in which an individual assumes the worst possible outcome will occur, often blowing a situation out of proportion and expecting disaster even when it is unlikely.

Word(s)	Definition
Central Nervous System (CNS)	The part of the nervous system consisting of the brain and spinal cord, responsible for processing information and controlling most functions of the body and mind.
Cerebral Embolism	A blockage in a brain artery caused by a clot or debris that formed elsewhere in the body and traveled to the brain, cutting off blood flow.
Cerebral Thrombosis	A blood clot that forms directly within a brain artery, gradually blocking blood flow and potentially causing a stroke.
Cerebrovascular Disease (Stroke)	A group of conditions that affect blood flow to the brain, often leading to strokes, brain damage, or other neurological issues, usually caused by blocked or ruptured blood vessels.
Cervical	Relating to the neck region of the spine, which includes seven vertebrae.
Child Abuse	Any act or failure to act that results in a child's harm, potential harm, or threat of harm, including physical, emotional, sexual abuse, or neglect.
Cholesterol	A waxy, fat-like substance that is both produced by the liver and obtained from certain foods.** **
Chronic	A disease or condition that usually lasts for 3 months or longer and may get worse over time.
Chronic Disease Risk Reduction Levels (CDRR)	Nutrient intake targets set to help reduce the risk of diet-related chronic diseases, such as heart disease or type 2 diabetes. They represent the maximum daily intake level for certain nutrients where reducing consumption is expected to lower disease risk.
Chronic Sleep Deprivation	Persistent lack of adequate sleep over an extended period, which can negatively affect health, mood, and cognitive function.
Chronic Stress	Long-term exposure to stressors that persist over weeks, months, or years, often leading to negative health effects.
Chronically High Cortisol Levels	A prolonged state of elevated cortisol in the body, often resulting from ongoing stress, which can negatively affect immune function, metabolism, and mental health.
Circadian Rhythm Sleep-Wake Disorders	Sleep disorders caused by misalignment between an individual's internal clock and the external environment, resulting in disrupted sleep patterns.
Circadian Rhythms	Biological processes that follow a roughly 24-hour cycle, regulating sleep-wake patterns, hormone release, body temperature, and other physiological functions.
Cirrhosis	A progressive liver condition characterized by scarring of liver tissue that interferes with the liver's ability to perform essential functions such as detoxifying the blood, producing proteins, and aiding in digestion.
Cocaine	A central nervous system stimulant that produces short-term pleasurable effects but can lead to serious mental and physical health problems.
Coccygeal	Pertaining to the coccyx or tailbone, the lowest part of the vertebral column.
Coccyx	The small, triangular bone at the base of the spine, commonly referred to as the tailbone.
Coenzymes	Small, organic molecules that work with enzymes to help speed up chemical reactions in the body.

Word(s)	Definition
Cofactors	Non-protein substances, often minerals, that assist enzymes in carrying out chemical reactions. They can be either inorganic ions like zinc or magnesium, or organic molecules called coenzymes.
Cognitive Behavioral Therapy (CBT)	A structured, short-term form of psychotherapy that focuses on identifying and changing negative thought patterns and behaviors to improve emotional regulation and develop healthier coping strategies.
Cognitive Drift	The gradual decline in focus, motivation, or commitment to a goal or behavior over time, often leading individuals to revert to old habits or lose sight of their original intentions.
Cognitive Overload	When the brain is given more information or tasks than it can effectively process at one time.
Cognitive Strategies	Mental techniques used to organize thinking, solve problems, and improve learning or performance.
Cognitive Therapy	A form of psychotherapy that helps individuals identify, challenge, and modify unhelpful or distorted thought patterns that contribute to emotional distress and dysfunctional behavior.
Cohen syndrome	A rare genetic disorder causing developmental delays, vision problems, low muscle tone, distinct facial features, childhood obesity, and low white blood cell count. Symptoms are managed with supportive care.
Collagen	The main protein found in the body's connective tissues, giving strength, structure, and flexibility to the skin, bones, tendons, ligaments, and cartilage.
Community Violence	A type of violence that happens outside the home and typically involves unrelated individuals who may or may not know each other, often occurring in settings like streets, parks, or schools.
Complementary protein pairing	The practice of combining two or more plant-based protein sources to provide all nine essential amino acids. For example, eating rice with beans creates a complete protein.
Complete proteins	Protein sources that contain all nine essential amino acids in sufficient amounts for the body's needs. They are typically found in animal products like meat, fish, eggs, and dairy, as well as some plant sources such as quinoa and soy.
Complex carbohydrates	Long chains of sugar molecules (starches and fibers) found in foods like whole grains, legumes, and vegetables. They provide sustained energy and often contain fiber, which supports digestion and overall health.
Concentric Contraction	When a muscle shortens while generating force, as in lifting a weight. It builds strength, power, and muscle growth in resistance training.
Condyloid Joints	Joints that allow movement in two planes without rotation, such as the wrist joint.
Conjugated Linoleic Acid (CLA)	An omega-6 fatty acid found in meat and dairy, often used for fat loss, muscle retention, and metabolic support. It may aid body composition and has anti-inflammatory properties.
Connective tissue	A type of tissue that supports, connects, or separates parts of the body. It includes ligaments, tendons, cartilage, bone, fat, and blood, and provides structure, protection, and flexibility through proteins like collagen and elastin.
Conscientiousness	A personality trait reflecting organization, responsibility, reliability, and goal-directed behavior.

Word(s)	Definition
Consciousness Raising	The process of increasing awareness and understanding of a behavior or issue to help individuals recognize its impact and motivate change.
Contingency Management	A structured behavioral intervention in which individuals receive rewards or incentives (such as vouchers, privileges, or prizes) for meeting specific behavioral goals, such as attending therapy sessions, submitting negative drug tests, or adhering to medication regimens.
Contraindicated stretches	Stretching exercises that are considered unsafe or potentially harmful, especially when performed incorrectly or by individuals with certain limitations. These stretches may place excessive stress on joints, muscles, or ligaments and increase the risk of injury.
Coordination	Ability to efficiently and smoothly integrate multiple body movements to perform tasks with precision and control. It involves the synchronization of muscles, senses, and motor skills to enhance performance in sports and physical activities.
Coping Mechanisms	Strategies or behaviors individuals use to manage stress, emotions, or challenging situations, which can be healthy (e.g., problem-solving, relaxation techniques) or unhealthy (e.g., avoidance, substance use).
Coronary arteries	A pair of large blood vessels that branch off the aorta and supply the heart muscle with oxygenated blood.
Coronary Artery Disease	A disease in which there is a narrowing or blockage of the coronary arteries (blood vessels that carry blood and oxygen to the heart). Coronary artery disease is usually caused by atherosclerosis (a buildup of fatty material and plaque inside the coronary arteries).
Corticosteroids	Medications that can alter body composition by increasing fat mass (especially visceral fat) and reducing muscle mass when used long-term.
Cortisol	A stress hormone that can influence body composition by promoting fat storage, especially visceral fat, and breaking down muscle when chronically elevated.
Counter Conditioning	The process of replacing unhealthy behaviors or thoughts with healthier alternatives. It involves choosing positive responses to triggers or situations that previously led to negative habits.
CRAP	An acronym that stands for "calorie-rich and processed foods" and/or "carbonated drinks, refined sugars, artificial additives, and processed foods."
Creatine	A natural compound in muscles that helps regenerate ATP, boosting strength, power, and recovery. Commonly supplemented as creatine monohydrate, it enhances performance and muscle growth.
Creatine Phosphate	A molecule that is sotred in muscle cells and used in the immediate energy system to donate a phosphate to make ATP.
Cross-Contamination	The transfer of harmful bacteria from one surface or food to another, often occurring when raw and ready-to-eat foods come into contact without proper cleaning, leading to potential foodborne illness.
Cross-Education	When training one limb increases strength in the untrained limb due to neural adaptations. It aids injury recovery, neuromuscular efficiency, and rehabilitation.
Cultural Wellness	The ability to respect, understand, and engage with different cultural values, beliefs, and traditions, fostering inclusivity, mutual respect, and a sense of belonging in diverse environments.

Word(s)	Definition
Curable	(of a disease or condition) able to be cured.
Cushing's syndrome	Caused by excess cortisol, often from steroid use or a tumor. Symptoms include weight gain, a round face, thin skin, muscle weakness, and high blood pressure. Treatment targets the underlying cause.
Daily Hassles	Minor, everyday irritations or challenges, such as traffic, deadlines, or household chores, that can accumulate and contribute to stress over time.
Daily Values (DVs)	reference amounts of nutrients set by the FDA to help consumers understand the nutrient content of foods in the context of a total daily diet. They are used on Nutrition Facts labels as percentages based on a 2,000-calorie diet.
Defense Mechanisms	A subconscious psychological strategy used by individuals to protect themselves from anxiety, stress, or uncomfortable emotions, often by distorting or avoiding reality.
Degenerative Disc Disease	A condition where intervertebral discs lose flexibility and cushioning, often causing pain.
Dehydration	A condition that occurs when the body loses more fluids than it takes in, leading to an insufficient amount of water to maintain normal bodily functions. It can cause symptoms such as fatigue, dizziness, dry mouth, and impaired physical and cognitive performance, especially during exercise or in hot conditions.
Delusions	Strongly held false beliefs that persist despite evidence to the contrary, often seen in schizophrenia and other psychotic disorders.
Dementia	A group of disorders characterized by a decline in memory, thinking, behavior, and the ability to perform everyday activities, often caused by damage to brain cells.
Denial	A psychological defense mechanism in which a person refuses to acknowledge or accept the reality of a situation, problem, or feeling, often to avoid discomfort, anxiety, or emotional pain.
Department of Health and Human Services (DHHS)	A U.S. federal agency responsible for protecting public health and providing essential human services. It oversees agencies such as the FDA, CDC, and NIH.
Depressants	Substances that reduce arousal and stimulation in the central nervous system.
Depression	A mental health disorder characterized by persistent feelings of sadness, hopelessness, and loss of interest or pleasure in activities, often accompanied by physical symptoms such as fatigue, changes in appetite, and difficulty concentrating.
Detoxification	A medically supervised process that helps individuals safely eliminate addictive substances from the body while managing the physical and psychological effects of withdrawal.
Detraining	The gradual loss of fitness and physiological adaptations that occur when an individual reduces or stops regular exercise. This can lead to declines in cardiovascular endurance, muscle strength, flexibility, and overall performance, depending on the duration and extent of inactivity.
Diabetes	A chronic condition where the body cannot properly regulate blood sugar (glucose) levels due to problems with insulin production or function, leading to high blood sugar and potential long-term health complications.
Diastole	The period of the heart's relaxation.

Word(s)	Definition
Diet	The types and amounts of food and beverages a person habitually consumes to meet their nutritional needs and maintain overall health.
Dietary Approaches to Stop Hypertension (DASH) Diet	An eating plan designed to lower high blood pressure by emphasizing fruits, vegetables, whole grains, lean proteins, and low-fat dairy while reducing sodium, saturated fats, and added sugars.
Dietary cholesterol	Cholesterol found in animal-based foods such as meat, eggs, and dairy products. While it can raise blood cholesterol levels in some people, its effect is generally less significant than that of saturated and trans fats.
Dietary fiber	This refers specifically to the indigestible parts of plant foods—such as fruits, vegetables, grains, and legumes—that help regulate the body's use of sugars, assist in digestion, and contribute to satiety and bowel regularity.
Dietary Folate Equivalents (DFE)	A unit used to account for the differences in bioavailability (how well the body absorbs and uses) between natural folate from food and synthetic folic acid from supplements or fortified foods.
Dietary Guidelines	Science-based recommendations that provide advice on healthy eating patterns to promote health, reduce the risk of chronic diseases, and meet nutritional needs.
Dietary Guidelines Advisory Committee (DGAC)	A group of experts appointed by the U.S. Departments of Agriculture (USDA) and Health and Human Services (HHS) to review nutrition science. Their recommendations help shape the Dietary Guidelines for Americans, updated every five years.
Dietary Guidelines for Americans (DGAs)	Science-based recommendations published every five years by the USDA and HHS. They provide advice on healthy eating patterns to promote health, reduce the risk of chronic disease, and meet nutrient needs.
Dietary pattern	The overall combination of foods and beverages a person regularly consumes. It emphasizes how different foods and nutrients work together to affect health over time.
Dietary Reference Intakes (DRIs)	A set of standards that includes recommended intakes of all essential nutrients, recommendations for balancing intakes of macronutrients, and upper safe limits for selected nutrients.
Dietary Thermogenesis (Thermic Effect of Food)	The increase in energy expenditure that occurs after eating, as the body digests, absorbs, transports, and stores nutrients. It typically accounts for about 5–10% of total daily energy expenditure.
Diffusion	The process by which oxygen moves from the lungs to the blood and carbon dioxide moves from the blood to the lungs; faster breathing concentrates oxygen and decreases carbon dioxide in the lungs and promotes diffusion.
Diffusion Capacity	The amount of oxygen that enters the blood stream from the lungs.
Digestion	The process by which the body breaks down food into smaller components, such as nutrients, that can be absorbed and used for energy, growth, and repair. It involves both mechanical actions, like chewing, and chemical processes, such as enzyme activity.
Digital Wellness	Maintaining a healthy relationship with technology and digital media. It involves using devices, apps, and online platforms in a way that supports your mental, physical, and emotional well-being—rather than disrupting it.
Disaccharides	are carbohydrates made up of two monosaccharide molecules bonded together; common examples include sucrose (glucose + fructose), lactose (glucose + galactose), and maltose (glucose + glucose).

Word(s)	Definition
Disordered Fear	Fear that is excessive, persistent, or maladaptive, interfering with normal daily functioning.
Displacement	A defense mechanism where emotions, like anger, are unconsciously redirected from their original source to a safer, less threatening target.
Distress	A negative form of stress that occurs when demands exceed coping abilities, potentially leading to physical, emotional, or behavioral health problems.
Dramatic Relief	The process of experiencing and expressing strong emotions—like fear, sadness, or hope—in response to learning about a behavior's impact.
Drug Overdose	A toxic and dangerous reaction to a substance (or substances) that overwhelms the body's normal functioning, often leading to serious health complications or death if not treated promptly.
Dual Energy X-Ray Absorptiometry	A medical imaging technique that uses low-dose X-rays to measure bone density and body composition, including the amount of fat, muscle, and bone in the body.
Duration	The length of time a muscle contraction or exercise bout is sustained, influencing energy system use and fatigue development.
Dynamic Constant Training (DCT)	Lifting a constant load throughout a movement, as seen in free weights and machines. It improves strength, muscle mass, and coordination, making it effective for all fitness levels.
Dynamic Contraction	A muscle contraction with movement, including concentric (shortening) and eccentric (lengthening) actions. It enhances strength, power, and muscle control in resistance training.
Dynamic Flexibility	The ability to move joints through their full range of motion during active movements.
Dynamic Progressive Training (DPT)	Gradually increases resistance, weight, or reps to promote strength, muscle growth, and endurance. It follows progressive overload, preventing plateaus and ensuring continuous improvement.
Dynamic Stretching	A form of stretching involving movement to increase flexibility and warm up muscles.
Dynamic Variable Training (DVT)	Adjusts resistance throughout a movement using bands, chains, or machines to match strength curves. It enhances strength, muscle activation, and power, reducing sticking points in lifts.
Dypsnea	commonly known as shortness of breath, is the subjective sensation of uncomfortable breathing, often described as difficult or labored breathing.
Dysfunctional Attitudes	Negative, rigid, and often unrealistic thought patterns that can distort perception, hinder emotional well-being, and interfere with healthy behavior and decision-making.
Dystrophy	The degeneration or weakening of tissue, often due to genetic, metabolic, or nutritional disorders.
E-Cigarettes	Electronic nicotine delivery systems (ENDS) designed to simulate smoking by producing a vapor or aerosol instead of smoke.
Eating Disorders	Mental health conditions characterized by unhealthy and harmful eating behaviors, such as extreme food restriction, binge eating, or purging, often driven by concerns about body image, weight, or control.

Word(s)	Definition
Eccentric Contraction	When a muscle lengthens under tension, controlling movement and absorbing force. Examples include lowering a weight or descending in a squat. They enhance strength, muscle growth, and injury prevention.
Emotional Health	The ability to recognize, understand, and manage one's emotions in healthy and constructive ways, including expressing feelings appropriately, coping with challenges, and maintaining balance during positive and stressful times.
Emotional Wellness	The ability to understand, manage, and express emotions effectively, while maintaining resilience, coping with challenges, and fostering positive relationships.
Empty Calories	calories from foods and beverages that provide little to no nutritional value—meaning they are high in added sugars and/or solid fats but low in essential nutrients like vitamins, minerals, or fiber. Common sources include sugary drinks, candy, pastries, and fried foods.
Endemic	Endemic means a disease that is always present in a population within a geographic area, typically year-round.
Endometriosis	A disorder in which tissue similar to the lining of the uterus grows outside the uterus, often causing pelvic pain.
Endomysium	A thin connective tissue layer that surrounds individual muscle fibers within a fascicle. It provides structural support, facilitates nutrient and oxygen exchange, and helps transmit force during muscle contractions.
Endosperm	The Large center of the seed that provides energy, primarily in the form of complex carbohydrates.
Endothelial Cells	Cells lining the blood vessels.
Energy Balance	The relationship between calories consumed (energy intake) and calories expended (energy output through metabolism, physical activity, and thermic effect of food).
Energy Expenditure	The total amount of energy (calories) the body uses to sustain life and support physical activity. Energy expenditure includes basal metabolic rate (BMR), the thermic effect of food (TEF), and energy used during physical activity.
Energy Intake	The total number of calories consumed from food and beverages. Energy intake provides the fuel needed for basal metabolism, physical activity, and physiological functions.
Energy-dense	Foods that provide a high amount of calories relative to their weight or volume. They are often high in fat and added sugars but low in nutrients, such as fast food, pastries, and fried snacks.
Environmental Reevaluation	The process of recognizing how one's behavior affects others and the environment. It involves understanding the social and environmental consequences of actions, which can motivate change out of concern for others or the greater good.
Environmental Stressors	External conditions or situations in a person's surroundings that cause stress, such as noise, pollution, extreme weather, overcrowding, or unsafe living conditions.
Environmental Wellness	Maintaining a healthy and sustainable relationship with the natural and built environment, including taking actions to protect and preserve the planet while creating safe, supportive, and clean surroundings.
Epidemic	An unexpected increase in the number of disease cases in a specific geographical area.

Word(s)	Definition
Epimysium	The outermost connective tissue layer that surrounds an entire skeletal muscle, providing structural support and protection.
Ergonomics	The study and design of work environments to promote efficiency and reduce strain on the body.
Esophagus	A muscular tube that transports food from the pharynx to the stomach.
Essential Fat	The minimum amount of fat needed for normal body function, including hormone production, nerve function, and protecting organs; part of healthy body composition.
Etiology	The cause or origin of a disease or condition.
Eustress	A positive form of stress that enhances motivation, focus, and performance, often associated with growth and achievement.
Exercise-Associated Hyponatremia	A condition occurring during or after prolonged physical activity in which blood sodium levels drop below 135 mEq/L, typically due to excessive fluid intake outpacing sodium losses.
Exercise:	A planned, structured, and repetitive physical activity performed to improve or maintain physical fitness, health, and overall well-being. It can include activities that enhance cardiovascular endurance, muscular strength, flexibility, and coordination.
Exposure Therapy	A therapeutic technique in which individuals gradually confront feared objects, situations, or memories in a controlled and safe manner to reduce anxiety and avoidance behaviors.
External Lamina	The external lamina is a thin layer of connective tissue surrounding individual muscle fibers. It is composed primarily of collagen and glycoproteins and provides structural support, protection, and a scaffold for muscle regeneration by facilitating satellite cell activity.
Extraversion	A personality trait characterized by sociability, assertiveness, and positive emotionality.
Fascicles	Bundles of muscle fibers grouped together within a skeletal muscle, surrounded by perimysium. They contribute to muscle strength, flexibility, and function, with their arrangement affecting force production and movement efficiency.
Fasciculus	A bundle of muscle fibers surrounded by perimysium, a connective tissue layer.
Fast-Twitch Muscle Fibers	Muscle fibers that generate quick, powerful movements but fatigue rapidly; in body composition, they contribute to lean mass and athletic performance.
Fat (triglycerides)	The most common type of fat in the body and food, consisting of three fatty acids attached to a glycerol backbone. They serve as a major energy source and are stored in adipose tissue for later use.
Fat Blockers	Supplements that inhibit fat absorption by blocking lipase enzymes, reducing calorie intake.
Fat Distribution Patterns	The way body fat is stored in the body, such as android (apple-shaped, around the abdomen) or gynoid (pear-shaped, around hips and thighs), which influences health risks and overall body composition.
Fat Mass (FM)	The total amount of fat tissue in the body, including both essential fat needed for normal body functions and non-essential fat stored for energy.

Word(s)	Definition
Fat-Free Mass (FFM)	The total weight of all body components excluding fat, including muscles, bones, organs, fluids, and tissues.
Fat-soluble vitamins	Vitamins (A, D, E, and K) that dissolve in fat and are stored in the body's fatty tissue and liver. Because they can accumulate, excessive intake may lead to toxicity.
Fatty acids	The building blocks of fats, made up of chains of carbon and hydrogen atoms with a carboxyl group at one end. They can be classified as saturated, monounsaturated, or polyunsaturated, depending on their chemical structure.
Faulty Conceptualization	The inaccurate or mistaken interpretation of a situation, symptom, or problem, often leading individuals to downplay or misattribute serious issues—such as viewing early signs of illness as harmless—thereby delaying appropriate action or change.
Fear	An emotional response to an immediate, real, or perceived threat that prepares the body for action.
Female Athlete Triad	A medical condition involving three interrelated components: low energy availability (with or without disordered eating), menstrual dysfunction, and low bone mineral density. It is commonly seen in physically active females and can lead to serious long-term health issues if not properly addressed.
Fentanyl	A synthetic opioid analgesic that is 50 to 100 times more potent than morphine.
Fiber	A type of carbohydrate that the body cannot digest or absorb. It passes through the digestive system largely intact and plays a vital role in maintaining digestive health.
Fiber Recruitment	The process by which the nervous system activates muscle fibers to generate force. Efficient fiber recruitment enhances strength, power, and endurance, and is improved through progressive overload and neuromuscular training.
Fiber Supplements	Products designed to increase dietary fiber intake, aiding in digestion, gut health, and regularity. Commonly used for constipation relief, blood sugar control, and weight management.
Fibromyalgia	A chronic condition characterized by widespread musculoskeletal pain, fatigue, and tender points.
Fibrous Joints (Synarthroses)	Joints connected by dense connective tissue, allowing little or no movement.
Fight-or-Flight Response	The body's automatic physiological reaction to a perceived threat, preparing an individual to either confront or escape danger. It involves increased heart rate, rapid breathing, heightened alertness, and the release of stress hormones such as adrenaline.
Financial Wellness	The ability to effectively manage your financial resources, meet current and future financial obligations, and feel secure and confident about your financial stability.
Firearm Violence	The threatened or actual use of a gun to cause harm, intimidate, or exert power over others.
FITT Principle	Guides exercise programming with four key factors: frequency, intensity, time, and type.
FITT-VP Principle	Guides exercise programming with six key factors: Frequency (how often), Intensity (effort level), Time (duration), Type (exercise mode), Volume (total workload), and Progression (gradual increase for improvement).

Word(s)	Definition
Five-Factor Model	A widely accepted framework for describing personality using five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism.
Fixators	Stabilizing muscles that prevent unwanted movement, providing a stable base for prime movers. They aid in balance, posture, and injury prevention.
Flat Affect	A severe reduction or absence of emotional expression, often observed in schizophrenia and other mental health disorders.
Flavonoids	A group of naturally occurring plant compounds with antioxidant and anti-inflammatory properties. They are found in foods like fruits, vegetables, tea, and dark chocolate, and may help protect against chronic diseases.
Flexibility	The ability of a joint or group of joints to move through their full range of motion (ROM) without pain, discomfort, or restriction. It depends on the length and elasticity of muscles, tendons, and ligaments, as well as joint structure and nervous system function. Flexibility is essential for efficient movement, injury prevention, and overall physical function.
FOMO (Fear of Missing Out)	Anxiety or worry that others are having rewarding experiences without you, often fueled by social media or comparisons, which can increase stress and reduce life satisfaction.
Food and Drug Administration (FDA)	A U.S. federal agency responsible for protecting public health by regulating food, drugs, medical devices, and dietary supplements. It ensures the safety, effectiveness, and accurate labeling of these products.
Force	The amount of tension produced by a muscle during contraction; it depends on motor unit recruitment, firing rate, and muscle cross-sectional area.
Free radicals	Unstable molecules with unpaired electrons that can damage cells, proteins, and DNA through oxidative stress. They are produced naturally in the body and can also come from external sources like pollution, smoking, and radiation.
Frequency	Frequency refers to how often a muscle group or exercise is trained within a given period, typically measured in workouts per week. Frequency should be balanced with intensity, volume, and recovery to maximize strength gains while preventing over-training.
Frost bite	Cold-related injury that occurs when skin and underlying tissues freeze due to prolonged exposure to extreme cold temperatures. It commonly affects extremities such as fingers, toes, ears, and the nose, leading to numbness, discoloration, and potential tissue damage.
Frost-nip	A mild form of frostbite that occurs when the skin is exposed to cold temperatures, causing temporary numbness and redness without permanent tissue damage. It typically affects extremities like fingers, toes, ears, and the nose, and can be reversed by gradually warming the affected area.
FTO Gene	A gene linked to body composition that can increase the likelihood of higher body fat levels and obesity by influencing appetite and energy balance.
Gallbladder	A small, green organ beneath the liver that stores and releases bile into the small intestine.
Gallbladder Disease	Conditions that affect the gallbladder, such as gallstones, inflammation (cholecystitis), or infection, often cause pain, digestive issues, and in some cases, require surgical removal of the gallbladder.
Gender Dysphoria	Psychological distress resulting from a mismatch between an individual's gender identity and their assigned sex at birth.

Word(s)	Definition
Gender Identity	A person's deeply held internal sense of their own gender, which may be male, female, a blend of both, neither, or something else entirely. It is how individuals perceive themselves and what they call themselves, which may or may not align with the sex assigned to them at birth.
Gene-Environment Interaction	How genetic factors (like those affecting fat storage or muscle growth) and lifestyle factors (such as diet, physical activity, and stress) work together to shape body composition.
General Adaptation Syndrome (GAS)	A model describing the body's three-stage response to prolonged stress: alarm, resistance, and exhaustion.
Generalized Anxiety Disorder (GAD)	A mental health condition characterized by excessive, persistent worry and fear about various aspects of daily life, often accompanied by symptoms like restlessness, fatigue, difficulty concentrating, irritability, muscle tension, and sleep disturbances.
Germ	A part of the plant seed from which a new plant can sprout that provides fatty acids, vitamin E, B vitamins, and antioxidants.
Ghrelin	A hormone that increases hunger and food intake; it influences body composition by promoting fat storage when energy intake exceeds energy use.
Glucose	A simple sugar that serves as the body's primary source of energy for cells, tissues, and organs. It is obtained from carbohydrates in food and transported in the blood as blood sugar.
Gluten Free	A diet or food product that does not contain gluten, a protein found in wheat, barley, and rye, commonly followed by individuals with celiac disease or gluten sensitivity.
Glycemic index (GI)	A measure of how quickly a carbohydrate-containing food raises blood glucose levels compared to pure glucose. Foods with a high GI cause rapid spikes in blood sugar, while low-GI foods lead to slower, steadier increases.
Glycogen	A stored form of glucose found primarily in the liver and muscles, serving as a key energy reserve for the body. Glycogen is replenished through carbohydrate consumption after depletion.
Golgi Tendon Organs (GTOs)	Sensory receptors in tendons that detect changes in muscle tension and help prevent injury.
Goniometers	Instruments used to measure the range of motion in a joint.
Gout	A type of arthritis caused by the buildup of uric acid crystals in the joints, leading to sudden episodes of severe pain, swelling, redness, and stiffness, most often in the big toe.
Green Tea Extract	A concentrated form of bioactive compounds from green tea leaves, rich in antioxidants, especially catechins like EGCG (epigallocatechin gallate). It is known for its benefits in metabolism, fat oxidation, heart health, and cognitive function.
Gynoid Shape	A fat distribution pattern where more fat is stored in the hips and thighs; in body composition, it's generally linked to lower health risks than abdominal (android) fat storage.
Hallucinations	Perceptions of sights, sounds, or sensations that are not present in reality, commonly associated with psychotic disorders.
Hallucinogens	Substances that profoundly alter a person's sensory perception, emotional state, and consciousness, often causing visual or auditory hallucinations, distorted sense of time, and altered thinking or reality.

Word(s)	Definition
Heart Rate	The number of times your heart beats per minute (bpm).
Heart Rate Reserve	The difference between maximum heart rate and resting heart rate; used in one method for calculating target heart rate zone.
Heat cramps	Painful, involuntary muscle spasms that occur due to excessive loss of fluids and electrolytes through sweating, often during intense physical activity in hot conditions. They are an early sign of heat-related illness and can be relieved by rehydration and rest.
Heat exhaustion	A heat-related illness caused by prolonged exposure to high temperatures and inadequate fluid intake, leading to symptoms such as heavy sweating, dizziness, nausea, weakness, and rapid pulse. If untreated, it can progress to heat stroke, a life-threatening condition.
Heat stroke	Heat stroke is a severe, life-threatening heat-related illness that occurs when the body's temperature regulation system fails, causing core body temperature to rise above 104°F (40°C). Symptoms include confusion, loss of consciousness, rapid heartbeat, and hot, dry skin, requiring immediate medical attention to prevent organ damage or death.
Helping Relationships	Supportive connections with others that encourage and assist in behavior change. These relationships provide emotional support, accountability, and motivation, often through friends, family, mentors, or support groups.
Hemorrhagic	Relating to or involving bleeding; in the stroke context, it refers to a stroke caused by a ruptured blood vessel leaking blood into or around the brain.
Herniated or Ruptured Discs	A condition where the inner nucleus pulposus protrudes through the outer annulus fibrosus, potentially compressing spinal nerves.
Heroin	A powerful, illegal opioid that rapidly affects the brain, producing intense feelings of euphoria and pain relief, but also leading to tolerance, dependence, and addiction.
High Intensity Interval Training (HIIT)	A workout style alternating short bursts of intense exercise with recovery periods; it improves body composition by reducing fat mass and preserving or increasing lean muscle.
High-density lipoprotein (HDL) cholesterol	Often called "good" cholesterol because it helps remove excess cholesterol from the bloodstream and transports it to the liver for excretion. Higher HDL levels are linked to a lower risk of heart disease.
High-Density Lipoproteins (HDL)	It is sometimes called the "good" cholesterol because it carries cholesterol from other parts of your body back to your liver. Your liver then removes the cholesterol from your body.
High-Intensity Interval Training (HIIT)	A training technique that involves short bursts of intense exercise alternated with periods of low-intensity recovery.
Hinge Joint	A joint that permits movement in one direction, such as the elbow or knee.
Holistic approach to healthy eating	This approach considers not only the nutritional content of food but also how dietary choices impact overall well-being, including physical, mental, social, and environmental health. This approach emphasizes balance, variety, and moderation, while also taking into account factors like cultural preferences, food sourcing, lifestyle habits, and the enjoyment of food as part of a healthy, sustainable lifestyle.
Homeostasis	The process by which an organism automatically regulates its internal conditions (such as temperature, pH, and chemical balance) to maintain stability despite changes in the external environment.

Word(s)	Definition
Homeostatic Sleep	The body's natural process of regulating sleep intensity and duration based on prior wakefulness, ensuring balance between sleep and wakefulness.
Hydrostatic Weighing	A method of measuring body composition by determining body density through underwater weighing, where a person's weight on land and underwater are compared to estimate body fat percentage.
Hyperglycemia	A term for high blood glucose (blood sugar).
Hypermobility	A condition where joints move beyond the normal range of motion, often due to genetic factors.
Hypertension	A condition characterized by consistently high blood pressure, which forces the heart to work harder to pump blood and increases the risk of heart disease, stroke, kidney problems, and other health issues.
Hypervitaminosis	A condition that occurs when a person has excessive levels of one or more vitamins in the body, typically as a result of over-supplementation rather than food intake. This buildup can lead to toxic effects and interfere with normal body functions.
Hypoglycemia	Abnormally low blood sugar levels, which can cause symptoms resembling a stroke (confusion, weakness, dizziness) but are reversible with glucose restoration.
Hypogonadism	A medical condition characterized by reduced production of sex hormones (such as testosterone in males or estrogen in females).
Hyponatremia	A medical condition characterized by abnormally low sodium concentration in the blood, typically resulting from excessive fluid intake, excessive sodium loss (such as through prolonged sweating), or a combination of both. In exercise settings, it most often occurs when an individual consumes large amounts of fluid without adequate electrolyte replacement, leading to dilution of blood sodium levels and potential impairment of nerve, muscle, and brain function.
Hypothalamic-Pituitary-Adrenal (HPA) Axis	A complex system involving the hypothalamus, pituitary gland, and adrenal glands that controls the body's stress response and regulates cortisol production.
Hypothermia	A dangerous condition that occurs when the body loses heat faster than it can produce it, causing core body temperature to drop below 95°F (35°C). Symptoms include shivering, confusion, slowed heart rate, and loss of coordination, and if untreated, it can lead to unconsciousness and death.
Hypothyroidism	A condition where the thyroid makes too much hormone, causing weight loss, fast heartbeat, nervousness, and heat intolerance. It's treated with medication, radioactive iodine, or surgery.
Immediate ("Explosive") Energy System	The system that supplies very short bursts of energy to muscle cells through the breakdown of cellular stores of ATP and creatine phosphate (CP).
Immunosuppressant	Any substance or factor that reduces or inhibits the effectiveness of the immune system, often increasing susceptibility to infections or disease.
Inactivity-Mobility Cycle	is a self-reinforcing pattern in which reduced physical activity leads to decreased joint mobility and flexibility, which in turn makes movement more difficult and uncomfortable. As mobility declines, individuals tend to become even less active, further worsening mobility. This cycle can contribute to muscle stiffness, joint pain, and a decline in overall physical function and quality of life.
Inclinometers	Devices used to measure the angle of joint movement or spinal curvature.

Word(s)	Definition
Incomplete proteins	Protein sources that lack one or more of the nine essential amino acids. They are typically found in plant-based foods such as grains, nuts, seeds, and vegetables.
Individual Differences, Principle of	The concept that flexibility programs should be tailored to an individual's unique body structure, capabilities, and needs.
Infectious Agent	A microbe or pathogen that can invade a host and cause disease.
Insertion	The movable attachment of a muscle, where force is applied to create movement. It is typically distal to the origin and moves toward it during contraction.
Insoluble fiber	A type of dietary fiber that does not dissolve in water and adds bulk to stool, helping prevent constipation. It is found in foods like whole grains, nuts, seeds, and the skins of fruits and vegetables.
Insomnia	A sleep disorder characterized by difficulty falling asleep, staying asleep, or obtaining restorative sleep, despite adequate opportunity.
Instrumental Activities of Daily Living (IADLs)	Are more complex tasks that enable individuals to live independently in a community. They go beyond basic self-care (ADLs) and involve activities like managing finances, transportation, and meal preparation.
Intellectual Wellness	Actively engaging in lifelong learning, critical thinking, creativity, and the pursuit of knowledge to expand skills, challenge the mind, and foster personal growth.
Intensity	The level of effort or difficulty at which a physical activity is performed. It is typically categorized as low, moderate, or vigorous and can be measured using heart rate, perceived exertion, or other physiological markers to ensure appropriate workout effectiveness and safety.
Intermittent Fasting	An eating pattern that cycles between periods of eating and fasting, focusing on when you eat rather than what you eat, and is often used for weight management and potential health benefits.
Intervertebral Discs	Cushion-like pads between the vertebrae that absorb shock and allow movement in the spine.
Intimate Partner Violence (IPV)	Physical, sexual, psychological, or emotional abuse, stalking, or economic control by a current or former partner or spouse.
Intracerebral Hemorrhage	Bleeding that occurs directly within the brain tissue itself, typically from a ruptured blood vessel, causing rapid pressure buildup and brain damage.
Inverse Myotatic Reflex	A protective reflex that causes a muscle to relax when there is excessive tension, often mediated by the Golgi tendon organs.
Irrational Anxiety	Persistent worry or apprehension that is disproportionate to the actual likelihood or severity of a threat.
Irrational Fear	An excessive or unreasonable fear of a situation or object that poses little or no actual danger.
Ischemic	Relating to insufficient blood supply to tissue; an ischemic stroke occurs when a blockage prevents adequate blood flow to part of the brain.
Isokinetic Training (IKT)	A type of resistance training where muscle contractions occur at a constant speed throughout the range of motion, regardless of the force applied.

Word(s)	Definition
Isometric Contraction	A type of muscle contraction where the muscle generates tension without changing length or causing joint movement. It helps build strength, endurance, and stability by maintaining a static position.
Isometric Training (IMT)	A resistance training method where muscles generate force without changing length or causing joint movement. It enhances strength, endurance, and stability by maintaining static muscle contractions.
Isotonic Contraction	A type of muscle contraction where the muscle changes length while generating constant tension.
Isotonic Training	A type of resistance exercise where muscles generate force while changing length, maintaining constant tension throughout the movement.
Joint	A location where two or more bones meet, allowing for varying degrees of movement.
Joint Capsule	A fibrous tissue envelope that encloses a synovial joint, providing stability while allowing movement.
Joint Structure	The anatomical features of a joint, including bones, cartilage, ligaments, and the joint capsule, that influence movement and flexibility.
Ketogenic Diet	A high-fat, very low-carbohydrate diet that shifts the body into a state of ketosis, where it burns fat for energy instead of carbohydrates, commonly used for weight loss and managing certain medical conditions.
Kidney Disease	A condition where the kidneys are damaged and cannot properly filter waste and excess fluids from the blood, which can lead to fluid buildup, waste accumulation, and other serious health problems.
Kilocalorie (kcal)	The amount of energy needed to raise the temperature of 1 kilogram of water by 1°C. In nutrition, it is the standard unit used to measure the energy content of foods, and it is often referred to simply as a “Calorie.”
L-Carnitine	Naturally occurring amino acid derivative that plays a crucial role in fat metabolism and energy production. It transports fatty acids into mitochondria, where they are converted into ATP through beta-oxidation.
L-Glutamine	Conditionally essential amino acid involved in muscle recovery, immune function, and gut health. It serves as a key fuel source for rapidly dividing cells, including immune and intestinal cells. It also supports protein synthesis, nitrogen balance, and energy production.
Lactic Acid	A byproduct of anaerobic metabolism, produced when the body breaks down glucose for energy in low-oxygen conditions, such as intense exercise.
Large Intestine (Colon)	Includes ascending, transverse, descending, and sigmoid sections; responsible for water absorption and forming feces.
Learned Helplessness	A condition in which repeated exposure to uncontrollable or adverse events leads an individual to believe they have no control over outcomes, often resulting in passive behavior and feelings of resignation.
Legumes	A group of plants that include beans, lentils, peas, and chickpeas, valued for their high protein, fiber, and nutrient content. They are an important source of plant-based protein and can help support heart and digestive health.
Ligaments	Strong bands of connective tissue that connect bones at joints and provide stability.

Word(s)	Definition
Linoleic acid (18:2)	An essential omega-6 fatty acid that the body cannot produce and must obtain from food. It is found in vegetable oils, nuts, and seeds, and plays a key role in cell structure and normal growth.
Lipids	A group of fats and fat-like substances, including triglycerides, phospholipids, and sterols, that are insoluble in water but essential for energy, cell structure, and hormone production. They provide more than twice the energy per gram compared to carbohydrates or proteins.
Lipogenesis	the metabolic process by which the body converts excess carbohydrates and proteins into fatty acids, which are then stored as fat. This primarily occurs in the liver and adipose tissue.
Lipoproteins	They are complex particles composed of lipids (fats) and proteins that transport lipids throughout the bloodstream. They play a crucial role in the metabolism and distribution of fats in the body.
Liver	A large organ located on the upper right side of the abdomen; it produces bile for fat digestion.
Long-Term Stressors	Stressful events or conditions that persist over an extended period, often weeks, months, or even years. They can have ongoing effects on physical and emotional health and may contribute to chronic stress, anxiety, or other mental health concerns.
Low Body Composition	Having a low percentage of body fat and a higher proportion of lean mass (muscle, bone, and other fat-free tissues), which is generally associated with better physical fitness and health when maintained within healthy ranges.
Low-Density Lipoproteins (LDL)	A type of cholesterol that is often referred to as "bad" cholesterol. It is a lipoprotein, which means it is a combination of fat (cholesterol) and protein
Low-Density Lipoprotein Cholesterol (LDL)	Often called “bad” cholesterol because high levels can lead to plaque buildup in arteries, increasing the risk of heart disease and stroke. It carries cholesterol from the liver to the body’s cells.
Lumbar	Refers to the lower back region of the spine, consisting of five vertebrae.
Lymph Nodes	Bean-shaped structures that filter lymph fluid, trap pathogens, and house immune cells.
Lymphocytes	Small white blood cells critical for immune defense.
Macronutrients	Nutrients the body needs in large amounts to provide energy and support basic functions: carbohydrates, proteins, and fats. Water is also considered a macronutrient, though it does not provide calories.
Macrosomia	A condition where a baby is born significantly larger than average, a risk that maternal physical activity during pregnancy can help reduce.
Maladaptive Coping Strategies	Unhealthy or ineffective methods of managing stress, emotions, or challenges, such as substance use, avoidance, or denial, which may provide temporary relief but worsen long-term mental health.
Male Athlete Triad (MAT)	a syndrome observed in male athletes that involves three interrelated components: low energy availability, low testosterone levels, and decreased bone mineral density.
Malignant tumor	A malignant tumor,** **also known as cancer, is an abnormal growth of cells that can invade and spread to other parts of the body.

Word(s)	Definition
Marijuana	A drug made from the dried leaves, flowers, stems, and seeds of the cannabis plant, containing THC and other cannabinoids that alter brain function, affecting mood, perception, and behavior.
Maslow's Hierarchy of Needs	A five-tier model of human needs, ranging from basic survival (physiological and safety) to social, esteem, and self-actualization.
Maximal Oxygen Consumption or VO_2 max	The highest rate of oxygen consumption an individual is capable of during maximum physical effort, reflecting the body's ability to transport and use oxygen; measured in milliliters if oxygen used per kilogram of body weight per minute.
Medication	Prescribed drugs used to manage symptoms of mental health conditions, such as depression, anxiety, bipolar disorder, or schizophrenia, by balancing brain chemistry and improving emotional and cognitive functioning.
Mediterranean Diet	A dietary pattern based on the traditional eating habits of countries bordering the Mediterranean Sea, emphasizing fruits, vegetables, whole grains, legumes, nuts, olive oil, fish, and moderate wine consumption, while limiting red meat and processed foods.
Melatonin	A hormone produced by the pineal gland that helps regulate sleep-wake cycles and signals the body when it is time to sleep.
Menstrual Dysfunction	Any abnormality in the menstrual cycle, such as absent, irregular, heavy, or painful periods, often caused by hormonal, lifestyle, or medical factors.
Mental Health	A person's overall psychological, emotional, and social well-being, influencing how they think, feel, and behave, as well as their ability to manage stress, maintain relationships, and make decisions.
Mental Health Disorders	A group of conditions that affect a person's thinking, mood, behavior, or overall psychological well-being, often interfering with daily life, relationships, and the ability to cope with stress.
Mental Illness	A wide range of mental health conditions that affect a person's thinking, mood, behavior, or overall functioning, often causing significant distress or impairment in daily life.
MET	A unit of measure that represents the body's resting metabolic rate - that is, the energy requirement of the body at rest.
MET-minute	A measure of training volume equal to exercise intensity expressed in METs times the total exercise time (METs x time).
Metabolic rate	The rate at which the body uses energy (calories) to carry out these metabolic processes, including at rest and during physical activity.
Metabolic Syndrome	A cluster of conditions — including high blood pressure, high blood sugar, excess abdominal fat, and abnormal cholesterol levels — that occur together, increasing the risk of heart disease, stroke, and type 2 diabetes.
Metabolism	The body's process of converting food into energy; in body composition, metabolism affects how efficiently calories are used for maintaining muscle, storing fat, and supporting overall energy balance.
Metastasis	The spread of cancer cells from their original (primary) site to other parts of the body.
Methamphetamine	A synthetic stimulant drug that causes a rapid and intense high, followed by dangerous physical and psychological effects.

Word(s)	Definition
Micronutrients	Vitamins and minerals that the body requires in small amounts for proper growth, development, and overall health. They help regulate processes like metabolism, immunity, and bone health.
Mindful Eating	The practice of paying full attention to the experience of eating, including the taste, texture, and smell of food, as well as recognizing hunger and fullness cues, to promote healthier eating habits and improve the relationship with food.
Mineral toxicity	Occurs when the body accumulates excessive amounts of a mineral, leading to harmful effects on health. It is usually caused by high-dose supplements or overexposure rather than food sources.
Minerals	Inorganic nutrients the body needs in small amounts to support vital functions such as building strong bones, transmitting nerve signals, and maintaining fluid balance. Examples include calcium, iron, potassium, and zinc.
Mitochondria	Membrane-bound organelles known as the powerhouses of the cell, responsible for producing ATP (adenosine triphosphate) through aerobic respiration. They play a key role in energy metabolism, especially in muscle cells, which require high energy for contraction. Mitochondria also contribute to cell signaling, apoptosis (cell death), and oxidative stress regulation.
Mitral Valve	The heart valve that lies between the left atrium and left ventricle that prevents the back flow of blood into the left atrium.
Mobility Exercises	Dynamic movements designed to improve joint range of motion, muscle flexibility, and movement quality.
Mode of Transmission	The way in which an infectious agent is transferred from an infected person or animal (source) to a susceptible host (new person or animal).
Monogamous	Having or involving a sexual relationship with only one partner at a time.
Monosaccharides	They are the simplest form of carbohydrates, consisting of a single sugar molecule such as glucose, fructose, or galactose.
Monounsaturated fats	Healthy fats that have one double bond in their chemical structure and can help reduce bad cholesterol levels. They are found in foods like olive oil, avocados, and many nuts and seeds.
Mood Disorders	A category of mental health conditions that primarily affect a person's emotional state, causing persistent feelings of sadness, emptiness, or excessive elation.
Motivational Drift	The gradual loss of motivation or drive to maintain a behavior or goal, often occurring when initial excitement fades, progress plateaus, or the behavior becomes routine without ongoing reinforcement.
Motivational Enhancement Therapy (MET)	- **Neglect**: The chronic failure to meet an individual's basic physical, emotional, medical, educational, or safety needs, especially when the person is unable to meet those needs themselves.
Motor Neuron	A nerve cell that originates in the central nervous system and sends signals to muscle fibers, causing them to contract. A single motor neuron and all the muscle fibers it innervates form a motor unit.
Motor Unit	Consists of a motor neuron and all the muscle fibers it innervates. It functions as a single unit to produce muscle contractions.

Word(s)	Definition
Mouth	The entry point where food is ingested and mechanical digestion (chewing) begins.
Multicomponent Physical Activity	A comprehensive exercise approach that combines aerobic, muscle-strengthening, and balance exercises, particularly beneficial for older adults to address multiple aspects of health and functional ability and reduce the risk of falls
Muscle dysmorphia	A subtype of body dysmorphic disorder in which an individual becomes excessively preoccupied with the belief that their body is too small or insufficiently muscular, even if they have above-average muscle size. It is sometimes called “bigorexia” or “reverse anorexia.” People with muscle dysmorphia may engage in compulsive weightlifting, strict dieting, or use of anabolic steroids to increase muscle mass. This condition can negatively affect physical health, mental well-being, social relationships, and daily functioning.
Muscle Endurance	the ability of a muscle or group of muscles to sustain repeated contractions or to maintain a submaximal contraction over an extended period of time without fatigue.
Muscle Fibers	Muscle fibers are elongated muscle cells responsible for contraction. They contain myofibrils with actin and myosin filaments.
Muscle Force	The amount of tension or strength a muscle generates when it contracts to move or stabilize a body part. It is influenced by factors such as muscle size, fiber type, neural activation, and the type of contraction (isometric, concentric, or eccentric). Muscle force is essential for all physical movements, from simple daily tasks to high-intensity athletic performance.
Muscle Hyperplasia	The increase in muscle mass due to the formation of new muscle fibers (cells), rather than the enlargement of existing ones (as in hypertrophy).
Muscle Hypertrophy	The increase in muscle size due to the growth of muscle fibers, primarily from resistance training or mechanical overload. Hypertrophy is driven by progressive overload, adequate nutrition (especially protein intake), and recovery.
Muscle Learning	The process by which repeated practice improves coordination, timing, and efficiency of muscle activation patterns.
Muscle Power	The ability of a muscle or group of muscles to exert force rapidly, combining both strength and speed. It reflects how quickly muscular force can be generated to perform an action.
Muscle Spindles	Sensory receptors within muscles that detect changes in length and help regulate muscle contraction.
Muscle Strength	the maximum amount of force a muscle or muscle group can generate against a resistance in a single effort.
Muscular endurance	The ability of a muscle or group of muscles to sustain repeated contractions or maintain a contraction over an extended period of time. It is essential for activities requiring prolonged effort, such as cycling, running, or high-repetition resistance training.
Muscular strength	Muscular strength is the maximum amount of force a muscle or muscle group can generate in a single effort.
Musculotendinous Junction	The transition area where a muscle connects to a tendon. This region is crucial for force transmission from muscle contractions to the skeletal system, enabling movement.
Myocardial infarction (MI)	A myocardial infarction (MI), commonly known as a heart attack, occurs when blood flow to the heart muscle decreases or stops in one of the coronary arteries, causing tissue death (infarction).

Word(s)	Definition
Myofascial Pain	Pain that originates from the muscle and connective tissue (fascia), often due to trigger points.
Myofibrils	Long, threadlike structures within muscle fibers (muscle cells) composed of repeating units called sarcomeres, which are the functional units of muscle contraction. They are essential for muscle function and are responsible for the striated appearance of skeletal and cardiac muscle.
Myoglobin	An oxygen-binding protein found in muscle tissue that stores and transports oxygen to muscle cells, facilitating aerobic respiration and energy production. It is structurally similar to hemoglobin but has a higher oxygen affinity, allowing muscles to sustain activity, especially during prolonged or intense exercise.
Myopathies	A group of neuromuscular disorders characterized by muscle weakness, dysfunction, or degeneration due to abnormalities in muscle fibers. Symptoms often include muscle weakness, fatigue, and, in some cases, pain or stiffness.
Myosin Myofilaments	Thick protein filaments in muscle fibers that play a key role in muscle contraction. They are composed of myosin proteins, which have heads that attach to actin filaments to form cross-bridges, generating force through the sliding filament mechanism.
Narcolepsy	A neurological disorder that causes excessive daytime sleepiness, sudden sleep attacks, and, in some cases, muscle weakness triggered by strong emotions.
Natural Killer (NK) Cells	A type of immune cell that identifies and destroys virus-infected or cancerous cells without prior exposure.
Negative Energy Balance	When the body burns more calories than it consumes, leading to weight loss as the body uses stored fat for energy.
Neuromotor Exercise	Exercise that involves motor skills such as balance, coordination, gait, and agility (e.g., Tai Chi, yoga). It is primarily relevant for older adults
Neuromuscular Adaptation	Early improvements in strength and performance resulting from changes in the nervous system, such as increased motor unit recruitment, firing frequency, synchronization, and reduced inhibitory signaling, rather than muscle hypertrophy.
Neuromuscular Junctions	The specialized synapse where the axon terminal of a motor neuron meets a muscle fiber. At this junction, the neurotransmitter acetylcholine is released, triggering the muscle fiber to contract.
Neuroticism	A personality trait associated with emotional instability, anxiety, moodiness, and susceptibility to stress.
Neurotransmitters	Chemical messengers in the brain and nervous system that transmit signals between neurons, influencing mood, behavior, and bodily functions.
Neutral Energy Balance	When the number of calories consumed equals the number of calories the body burns, resulting in weight maintenance.
Neutral Spine	A posture where the natural curves of the cervical, thoracic, and lumbar spine are maintained in proper alignment.
Nicotine	A stimulant drug that affects the central nervous system, producing short-term pleasurable effects like alertness and relaxation, while also causing dependence and addiction with repeated use.

Word(s)	Definition
Nicotine Replacement Therapies (NRT)	A tobacco cessation aid that delivers controlled amounts of nicotine to the body to ease withdrawal symptoms and support quitting, while breaking the behavioral habit of smoking or chewing tobacco.
Nitric Oxide	A gas released by the endothelial cells to promote blood flow. The capacity of these cells to release nitric oxide is an important marker of good health.
Non-Alcohol Fatty Liver Disease	A condition where excess fat builds up in the liver of people who drink little or no alcohol, potentially leading to liver inflammation, scarring, and liver damage over time.
Non-Exercise Activity Thermogenesis (NEAT)	The calories burned through daily movements outside of structured exercise (like walking, fidgeting, or doing chores); it contributes to energy expenditure and influences body composition by affecting fat gain or loss.
Non-oxidative Energy System	The system that supplies energy to muscle cells for highly intense exercise of short duration by breaking down muscle stores of glucose and glycogen; called the anaerobic system because chemical reactions take place without oxygen and produce lactic acid.
Non-REM (NREM) Sleep	The portion of the sleep cycle characterized by slower brain waves, physical restoration, and memory consolidation, divided into stages 1 through 3.
Noradrenaline (Norepinephrine)	A hormone and neurotransmitter similar to adrenaline that plays a role in alertness, attention, and the body's stress response by increasing heart rate and blood flow to muscles.
Nucleus Pulposus	The soft, gel-like center of an intervertebral disc that helps absorb compressive forces.
Nutrient-dense	Foods that provide a high amount of vitamins, minerals, and other beneficial nutrients relative to their calorie content. Examples include fruits, vegetables, whole grains, lean proteins, and legumes.
Nutrient-rich	Foods that supply abundant vitamins, minerals, and other beneficial nutrients with relatively few calories. They support overall health and are often whole, minimally processed foods like vegetables, fruits, and lean proteins.
Nutrients	Substances in food that are essential for the body's growth, development, and overall functioning. Nutrients include carbohydrates, fats, proteins, vitamins, minerals, and water, which are the compounds required for growth and survival that must be obtained from food.
Obesity	A medical condition characterized by excessive accumulation of body fat that increases the risk of health problems such as heart disease, diabetes, and certain cancers. It is commonly defined by a body mass index (BMI) of 30 or higher.
Occupational Wellness	Finding personal satisfaction and fulfillment in work, balancing responsibilities, and aligning career goals with values, while maintaining a healthy work-life balance.
Omega-3	Essential polyunsaturated fats that support heart, brain, and immune health. They are found in fatty fish, flaxseeds, chia seeds, walnuts, and canola oil.
Omega-6	Essential polyunsaturated fats that help with growth, brain function, and normal development. They are found in vegetable oils, nuts, and seeds, but excessive intake compared to omega-3s may promote inflammation.
Opioids	Natural, synthetic, or semi-synthetic substances that interact with opioid receptors in the brain to reduce pain and produce pleasurable effects.

Word(s)	Definition
Origin	The fixed, proximal attachment of a muscle to a bone, typically the more stable and less movable part during contraction. It serves as the anchor point from which the muscle pulls to create movement at its insertion.
Osteoarthritis	A degenerative joint disease where the cartilage that cushions the ends of bones wears down over time, leading to pain, stiffness, swelling, and reduced joint mobility.
Osteoporosis	A disease characterized by weakened bones and reduced bone density, increasing the risk of fractures. It often develops with aging and is influenced by factors like low calcium intake, hormonal changes, and lack of physical activity.
Outbreak	A sudden increase in the number of disease cases in a particular place and time, beyond what is normally expected.
Overgeneralizing	A cognitive distortion where a person draws broad, sweeping conclusions based on a single event or limited evidence, often leading to negative thinking patterns and reinforced anxiety or self-doubt.
Overlearning	The practice of continuing to study or rehearse material even after it has been initially mastered, which can improve retention and performance under stress.
Overtraining	A condition that occurs when an individual exceeds their body's ability to recover from intense or excessive exercise, leading to decreased performance, fatigue, increased risk of injury, and other negative physiological and psychological effects. It results from inadequate rest, poor nutrition, or excessive training volume and intensity.
Overweight	A condition where a person has more body weight than is considered healthy for their height, typically defined by a body mass index (BMI) between 25 and 29.9.
Oxidative (Aerobic) Energy System	The system that supplies energy to cells for long periods of activity through the breakdown of glucose, glycogen, and fats; called the aerobic system because its chemical reactions require oxygen.
Oxytocin	A hormone and neurotransmitter involved in social bonding, trust, and stress regulation.
Paleo Diet	A dietary pattern based on eating foods presumed to have been available to early humans, focusing on meat, fish, fruits, vegetables, nuts, and seeds, while avoiding processed foods, grains, dairy, and legumes.
Pancreas	A yellow, elongated organ that secretes digestive enzymes and bicarbonate into the small intestine.
Pancreatitis	The inflammation of the pancreas, a gland that helps with digestion and blood sugar regulation, causing symptoms such as abdominal pain, nausea, vomiting, and digestive problems. It can be acute (sudden) or chronic (long-lasting).
Pandemic	An epidemic that spreads globally.
Panic Disorder	A mental health condition characterized by recurring, unexpected panic attacks—intense episodes of fear or discomfort—often accompanied by physical symptoms such as rapid heartbeat, sweating, shortness of breath, and a fear of losing control or impending doom.
Parasympathetic Nervous System	The division of the ANS that promotes relaxation, recovery, and energy conservation, often referred to as the "rest-and-digest" system.

Word(s)	Definition
Partially hydrogenated oils (PHOs)	Oils that have been chemically altered to make them more solid and extend shelf life, creating trans fats in the process. Because trans fats raise LDL (“bad”) cholesterol and lower HDL (“good”) cholesterol, PHOs are no longer generally recognized as safe for use in food.
Passive Forces	External forces that assist in stretching a muscle, such as gravity, a partner, or equipment.
Passive Stretching	A type of stretching in which an external force is used to help stretch the muscle.
Passive-Aggressive Behavior	Indirect expression of anger or resentment through subtle, obstructive, or nonverbal actions rather than openly addressing the issue.
Pathogens	Microorganisms or infectious agents that can cause disease.
Peer Pressure	The social influence from peers that encourages an individual to adopt certain behaviors, beliefs, or actions, often to gain acceptance or avoid rejection.
Perceived Control	The belief that one can influence outcomes and events in one's life.
Percent Body Fat	The proportion of total body weight made up of fat mass compared to fat-free mass; a key measure of body composition used to assess health and fitness.
Percent Daily Values (%DV)	- **Pharynx**: The passage connecting the mouth to the esophagus; involved in swallowing.
Perfect Use Effectiveness	- **Portal of Entry****: **The route or pathway through which an infectious agent, such as a virus, bacterium, or parasite, gains access to the body of a host.
Perimysium	Is the connective tissue sheath that surrounds and groups muscle fibers into bundles called fascicles. It provides structural support, allows the passage of nerves and blood vessels, and helps distribute force during muscle contraction.
Perinatal Depression	A type of depression that occurs during pregnancy or within the first year after childbirth, affecting emotional well-being and daily functioning.
Periodization	A structured approach to training that involves dividing a workout program into specific cycles or phases to optimize performance, recovery, and progression. It typically includes variations in intensity, volume, and exercise focus to prevent plateaus, reduce injury risk, and enhance overall fitness gains.
Peripheral Nervous System (PNS)	The network of nerves outside the brain and spinal cord that connects the CNS to the rest of the body, transmitting signals to and from organs, muscles, and sensory receptors.
Persistent Depressive Disorder (Dysthymia)	A chronic form of depression characterized by a consistently low mood lasting for at least two years, often with less severe but long-lasting symptoms compared to major depression.
Personality	The enduring patterns of thoughts, feelings, and behaviors that characterize an individual and influence how they interact with the world.
Personality Traits	Consistent characteristics or qualities that influence an individual’s thoughts, emotions, and behaviors across situations.
Phobia	An intense, irrational fear of a specific object, situation, or activity that leads to avoidance behavior.

Word(s)	Definition
Physical activity	Any movement of the body that requires energy expenditure, including daily activities such as walking, household chores, and recreational or structured exercise. It plays a key role in maintaining overall health, improving fitness, and reducing the risk of chronic diseases.
Physical fitness	A set of physical attributes that allows the body to respond or adapt to the demands and stress of physical effort.
Physical training	A structured and planned regimen of physical activities designed to improve specific aspects of fitness, such as strength, endurance, flexibility, or agility. It involves progressive overload, consistency, and variation to enhance overall performance and health.
Physical Violence	The use of physical force with the intent to harm, control, intimidate, or punish another person. It includes actions that cause bodily pain, injury, or physical suffering.
Physical Wellness	Maintaining a healthy body through regular exercise, proper nutrition, adequate sleep, and proactive management of health to enhance overall physical functioning and quality of life.
Phytochemicals	Naturally occurring compounds in plants that are not essential nutrients but provide health benefits, such as reducing inflammation and lowering disease risk. They are abundant in fruits, vegetables, whole grains, legumes, and tea.
Phytosterols	Plant-based compounds structurally similar to cholesterol that can help lower LDL (“bad”) cholesterol levels by reducing its absorption in the intestine. They are naturally found in foods like vegetable oils, nuts, seeds, and whole grains.
Pivot Joints	Joints that allow rotation around a single axis, such as the joint between the first and second cervical vertebrae.
Plane (Gliding) Joints	Joints that allow sliding or gliding movements, typically found in the wrists and ankles.
Plant-based protein	Protein that comes from sources such as beans, lentils, nuts, seeds, soy, and whole grains. While some are incomplete proteins, combining different plant foods can provide all essential amino acids.
Plethysmography	A method used to measure changes in volume within an organ or the whole body, often used in body composition testing (such as air displacement plethysmography) to determine body fat percentage by assessing body density through air pressure changes.
Polycystic Ovary Syndrome (PCOS)	A hormonal disorder that often affects body composition by increasing fat mass (especially abdominal fat) and making it harder to maintain or build lean muscle.
Polyphenols	A large group of plant compounds with antioxidant and anti-inflammatory properties that may protect against chronic diseases. They are abundant in foods such as berries, tea, coffee, red wine, and dark chocolate.
Polyunsaturated fats	Healthy fats that contain two or more double bonds in their chemical structure and help reduce LDL (“bad”) cholesterol levels. They are found in foods like fatty fish, walnuts, flaxseeds, and vegetable oils.
Portal of Exit	The route through which an infectious agent leaves the body of an infected individual
Portion Size	The amount of food or drink a person chooses to consume at one time, which may be more or less than a standard serving size.
Positive Energy Balance	When a person consumes more calories than their body uses, leading to weight gain as the excess energy is stored as fat.

Word(s)	Definition
Positive Psychology	The scientific study of strengths, virtues, and factors that enable individuals and communities to thrive, focusing on enhancing well-being, happiness, and fulfillment rather than solely addressing problems or disorders.
Post-Traumatic Stress Disorder (PTSD)	A mental health condition triggered by experiencing or witnessing a traumatic event, characterized by symptoms such as intrusive memories, flashbacks, avoidance of reminders, negative changes in mood or cognition, and heightened arousal or reactivity.
Postvention	A set of organized responses and support activities that occur after a suicide to aid survivors in grief, prevent suicide contagion, and stabilize the affected community.
Potassium	An essential mineral and electrolyte that helps regulate fluid balance, nerve signals, and muscle contractions. It is found in foods like bananas, potatoes, beans, and leafy greens.
Power	The ability to generate force quickly, combining strength and speed to produce explosive movements. It is essential for activities like sprinting, jumping, and Olympic lifting, and is improved through strength and plyometric training.
Power Naps	Short naps, usually 10–30 minutes, intended to restore alertness, improve mood, and enhance cognitive performance without causing sleep inertia.
Prader-Willi Syndrome	A genetic disorder causing poor muscle tone, insatiable appetite, obesity, developmental delays, and behavioral issues. It has no cure, but symptoms can be managed.
Prime Mover	The primary muscle responsible for generating a specific movement. It works with synergists (assistive muscles) and against antagonists (opposing muscles) for controlled motion.
Progression	The gradual increase in intensity, duration, frequency, or difficulty of a workout over time to continually challenge the body and improve fitness levels. It is a key principle in training to ensure continuous improvement while minimizing the risk of injury or overtraining.
Progressive overload	The gradual increase of stress placed on the body during exercise to stimulate muscle growth, strength, and endurance improvements. This can be achieved by increasing weight, repetitions, intensity, or training volume over time to continually challenge the muscles and promote adaptation.
Projection	A defense mechanism where individuals attribute their own unacceptable thoughts, feelings, or traits to others.
Proprioceptive Neuromuscular Facilitation (PNF) Stretching	An advanced form of flexibility training involving both stretching and contracting the muscle being targeted.
Proprioceptors	Sensory receptors that provide information about body position and movement.
Protective Factors	Strengths, supports, or resources that decrease the likelihood of harmful outcomes and increase a person's ability to cope with challenges or stress.
Protein Powder	A dietary supplement made from various protein sources, such as whey, casein, soy, pea, or hemp, designed to support muscle growth, recovery, and overall protein intake. It is commonly used by athletes, bodybuilders, and individuals with increased protein needs. Protein powders come in different forms, including concentrates, isolates, and hydrolysates, each varying in protein content and digestion speed.
Proteins	Macronutrients made up of amino acids that build and repair tissues, support immune function, and serve as enzymes and hormones. They are found in both animal and plant-based foods.

Word(s)	Definition
Psychological Aggression	The use of communication or behavior to inflict emotional pain, exert control, or undermine a person's sense of self-worth or safety.
Psychological Stressors	Internal or cognitive factors that create stress, including worry, fear, perfectionism, low self-esteem, or negative thinking patterns.
Psychoneuroimmunology (PNI)	The interdisciplinary study of how psychological factors, the nervous system, and the immune system interact and influence overall health.
Psychotherapy	A therapeutic process in which a trained mental health professional uses evidence-based techniques to help individuals explore thoughts, feelings, and behaviors, address mental health concerns, and develop healthier coping strategies.
Psychotic Disorders	Severe mental health conditions that affect thinking, perception, and awareness of reality. Individuals may experience hallucinations, delusions, or disorganized thought patterns.
Pulmonary Circulation	The part of the circulatory system that moves blood between the heart and lungs; controlled by the right side of the heart.
Pulmonary Valve	The heart valve between the left ventricle and the aorta that prevents the back flow of blood into the left ventricle.
Range of Motion (ROM)	The full movement potential of a joint, usually its range of flexion and extension.
Rating of Perceived Exertion (RPE)	A system of monitoring exercise intensity by assigning a number to the subjective perception of target intensity.
Rational Anxiety	A normal, proportionate reaction to a stressful or challenging situation that motivates problem-solving or caution.
Rational Fear	A reasonable and appropriate response to a real, identifiable danger.
Rationalization	A defense mechanism where individuals justify unacceptable behaviors or feelings with logical or socially acceptable explanations to avoid guilt or discomfort.
Reaction Formation	A defense mechanism where individuals unconsciously act in a way opposite to their true feelings to hide or suppress unacceptable emotions or desires.
Reaction time	Reaction time is the amount of time it takes for the body to respond to a stimulus. It is a crucial component of athletic performance, especially in sports requiring quick reflexes, such as sprinting, boxing, or tennis.
Reciprocal Inhibition	A neuromuscular response where the contraction of one muscle leads to the relaxation of its opposing muscle.
Recommended Dietary Allowance (RDA)	The average daily nutrient intake level sufficient to meet the needs of nearly all (97–98%) healthy individuals in a specific age and sex group. It is used as a goal for planning and assessing diets.
Recreational Drugs	Psychoactive substances used voluntarily for enjoyment or leisure, rather than for therapeutic or medical purposes.
Rectum	The final section of the large intestine, where feces are stored before elimination.
Regression	A defense mechanism where individuals revert to earlier developmental behaviors to cope with stress or anxiety.

Word(s)	Definition
Reinforcement Management	Using rewards to encourage healthy behaviors and reducing the rewards or benefits of unhealthy behaviors. It helps strengthen positive habits through motivation and accountability.
REM Sleep	A sleep stage marked by rapid eye movement, vivid dreaming, increased brain activity, and critical roles in emotional regulation and memory processing.
Repetition (Rep)	Refers to one complete movement of an exercise, including both the lifting (concentric) and lowering (eccentric) phases. Multiple reps make up a set, and the number of reps performed influences strength, endurance, and muscle growth.
Repetition Maximum (RM)	The maximum number of repetitions a person can perform of a given exercise at a specific weight before reaching failure. For example, a 1RM (one-rep max) is the heaviest weight that can be lifted once with proper form, while a 10RM is the heaviest weight that can be lifted 10 times before failure.
Repression	A defense mechanism where distressing thoughts or memories are unconsciously pushed out of awareness to reduce anxiety.
Reservoir	A place or environment where an infectious agent (such as a virus, bacterium, or parasite) can live and multiply.
Resistance Training	A form of physical activity that involves working muscles against an external force—such as weights, resistance bands, or body weight—to improve muscular strength, endurance, and size.
Respiratory System	The lungs, airways (like the trachea and bronchi), and the muscles that control breathing, supplies oxygen to the body and removes carbon dioxide.
Resting Metabolic Rate	The number of calories the body burns at rest to maintain basic functions; it plays a key role in body composition by influencing how easily someone gains or loses fat and muscle.
Resting Metabolic Rate (RMR)	The amount of energy the body uses at rest to perform basic functions such as breathing, circulation, and maintaining body temperature. It is slightly higher than the basal metabolic rate (BMR) because it is measured under less strict conditions.
Restless Leg Syndrome (RLS)	A neurological condition causing uncomfortable sensations in the legs and an irresistible urge to move them, often interfering with sleep.
Retinol Activity Equivalents (RAE)	This unit is used to measure vitamin A activity from both preformed vitamin A (like retinol from animal sources) and provitamin A carotenoids (like beta-carotene from plants). Because the body converts plant-based carotenoids less efficiently than animal-based retinol, RAE helps standardize the amount of usable vitamin A regardless of the source.
Reversibility	Reversibility is the principle that fitness gains and physiological adaptations from exercise are lost when training stops or is significantly reduced. This decline in strength, endurance, and flexibility can occur within weeks of inactivity, emphasizing the importance of consistent physical activity.
Rheumatoid Arthritis	An autoimmune disorder causing chronic inflammation of joints, leading to pain and potential joint deformity.
Risk Factors	Any attribute, exposure, or situation that raises the probability of a negative health or behavioral outcome.
S.M.A.R.T. Goal	A clearly defined objective that is Specific, Measurable, Achievable, Relevant, and Time-bound, designed to enhance focus and increase the likelihood of success.

Word(s)	Definition
Sacral	Pertaining to the sacrum, the triangular bone at the base of the spine, formed by five fused vertebrae.
Sacrum	A large, triangular bone at the base of the spine that connects to the pelvis.
Saddle Joints	A type of synovial joint where the articulating surfaces of the bones are shaped like a saddle—concave in one direction and convex in the other. This unique structure allows movement in two planes: flexion/extension and abduction/adduction, making the joint biaxial.
Salivary Glands	Located near the mouth, these glands secrete saliva to moisten food and begin the breakdown of carbohydrates.
Sarcomere	The basic contractile unit of striated muscle fibers, composed of actin (thin) and myosin (thick) filaments arranged in a repeating pattern. It is the structural and functional unit of muscle contraction.
Sarcolemma	the specialized cell membrane that surrounds a muscle fiber (muscle cell). It plays a crucial role in conducting electrical signals (action potentials) and in regulating the exchange of ions, which are essential for muscle contraction.
Sarcopenia	An age-related loss of muscle mass, strength, and function, typically beginning around the age of 30 and accelerating with advancing age. It can lead to reduced mobility, increased risk of falls, and decreased quality of life if not addressed through regular physical activity and proper nutrition.
Satiety	The feeling of fullness after eating that reduces the urge to eat; it helps regulate calorie intake and influences body composition by affecting fat gain or loss.
Saturated fatty acids	Fats in which all carbon atoms are fully “saturated” with hydrogen, containing no double bonds. They are found mainly in animal products and some tropical oils, and high intake is linked to increased LDL (“bad”) cholesterol and heart disease risk.
Schizophrenia	A chronic mental health disorder characterized by disruptions in thought processes, perceptions, emotional responsiveness, and social functioning, often including symptoms such as hallucinations, delusions, disorganized thinking, and impaired cognitive abilities.
Sciatica	Pain that radiates along the sciatic nerve, typically from the lower back through the hip and down the leg, often caused by nerve compression.
Scoliosis	A lateral curvature of the spine that can lead to imbalance and back pain.
Seasonal Affective Disorder (SAD)	A type of depression that occurs at a specific time of year, typically during fall and winter, when there is less natural sunlight, and is characterized by symptoms such as low energy, sadness, changes in sleep and appetite, and difficulty concentrating.
Sedentary	In general, sedentary behavior refers to any waking behavior characterized by a low level of energy expenditure (less than or equal to 1.5 METs) while sitting, reclining, or lying.
Self-actualization	The process of realizing and fulfilling one’s potential, talents, and abilities to achieve personal growth, purpose, and the highest level of self-fulfillment.
Self-Compassion	The practice of treating oneself with kindness, understanding, and patience during times of difficulty, rather than engaging in self-criticism, to improve emotional resilience and mental wellness.
Self-efficacy	An individual’s belief in their ability to successfully perform tasks, achieve goals, and manage challenges in specific situations.

Word(s)	Definition
Self-esteem	An individual's overall sense of self-worth or personal value, encompassing confidence in one's abilities and respect for oneself.
Self-liberation	The process of committing to behavior change based on the belief that change is possible. It involves making a firm decision to act, often supported by goal setting, self-belief, and personal accountability.
Self-Reevaluation	The process of reflecting on how a behavior aligns with one's values, identity, and goals. It helps individuals see how changing a behavior supports the person they want to become, increasing motivation for change.
Set	A group of consecutive repetitions (reps) of an exercise performed without rest. Multiple sets are typically performed with short rest periods in between to improve strength, endurance, or muscle growth.
Sexual Violence	Any sexual act, attempt to obtain a sexual act, or other act directed against a person's sexuality using coercion, force, threats, manipulation, or when the victim is unable to consent.
Sexually Transmitted Infections (STIs)	Infections that are primarily spread through sexual contact, including vaginal, anal, or oral sex. They are caused by bacteria, viruses, or parasites and can affect anyone who is sexually active.
Short-Term Stressors	Stressful events or situations that are temporary and typically resolved quickly. They may cause immediate physical or emotional reactions, such as increased heart rate, tension, or worry, but usually subside once the situation is over.
Shoulder Flexibility Test	An assessment that measures the range of motion in the shoulders.
Simple Carbohydrates	sugars made up of one or two sugar molecules that are quickly digested and absorbed by the body. They provide a rapid source of energy and are found naturally in fruits, milk, and some vegetables, as well as in processed foods like candy, soda, and baked goods with added sugars.
Sit-and-Reach Test	A common test to measure flexibility in the hamstrings and lower back.
Skeletal Muscle	A type of striated, voluntary muscle attached to bones via tendons, enabling movement, posture, and stability. It contracts through signals from the nervous system and functions using the sliding filament mechanism. Skeletal muscles also play a role in metabolism and heat production.
Skinfold Analysis	A method of estimating body fat percentage by measuring the thickness of skin folds at specific sites on the body using calipers, based on the assumption that the thickness of subcutaneous fat is proportional to total body fat.
Skinny-Fat	A body composition where a person has a normal or low body weight but a high body fat percentage and low muscle mass, increasing health risks despite appearing thin.
Sleep Apnea	A sleep disorder where a person's breathing repeatedly stops and starts during sleep, leading to poor sleep quality and low oxygen levels, often causing daytime fatigue, snoring, and increased risk of health problems.
Sleep Deprivation	A condition resulting from insufficient sleep, leading to cognitive, emotional, and physical impairments.
Sliding Filament Theory	Explains muscle contraction as actin filaments sliding past myosin filaments, shortening the sarcomere. This process, powered by ATP and regulated by calcium, generates muscle force through cross-bridge cycling.

Word(s)	Definition
Slow-Twitch Muscle Fibers	Muscle fibers that are fatigue-resistant and support endurance activities; in body composition, they contribute to lean mass and help with fat metabolism during prolonged exercise.
Small Intestine	– A long, coiled tube where most nutrient absorption occurs; it lies between the stomach and the large intestine.
Smokeless Tobacco	Tobacco products that are consumed without combustion, typically by chewing, sucking, or sniffing, and are absorbed through the lining of the mouth or nose.
Smooth Muscle Tone	Refers to the continuous, low-level contraction of smooth muscle tissue, which helps maintain organ function and blood vessel diameter. Smooth muscle remains partially contracted even at rest, allowing for sustained control over processes such as blood pressure regulation, digestion, and airway constriction. This tone is regulated by the autonomic nervous system, hormones, and local physiological conditions.
Social Anxiety Disorder	A mental health condition characterized by an intense fear of social or performance situations, where individuals worry about being judged, embarrassed, or humiliated, often leading to avoidance and significant distress.
Social Liberation	The process of recognizing and using social or environmental supports that encourage healthy behavior change. It involves becoming aware of societal shifts, policies, or resources that make positive change easier and more accepted.
Social Stressors	Stress arising from relationships or interactions with others, such as conflict with friends or family, social isolation, peer pressure, or workplace challenges.
Social Wellness	The ability to build and maintain healthy, supportive relationships, effectively communicate, and contribute to a connected and positive community.
Socioeconomic status (SES)	A person's social and economic standing, which influences body composition through access to nutritious food, opportunities for physical activity, healthcare, and education about healthy habits.
Sodium	An essential mineral and electrolyte that helps regulate fluid balance, nerve function, and muscle contractions. However, excessive intake is linked to high blood pressure and increased risk of heart disease and stroke.
Soluble fiber	A type of dietary fiber that dissolves in water to form a gel-like substance, helping slow digestion and regulate blood sugar and cholesterol levels. It is found in foods like oats, beans, apples, and citrus fruits.
Specific Phobias	Intense, irrational fears of specific objects, animals, or situations that lead to avoidance and distress.
Specificity	Principle that training should be tailored to target specific fitness goals, movements, or muscle groups to achieve optimal performance improvements. It means that adaptations in strength, endurance, or skill development are directly related to the type of exercise performed.
Speed	The ability to move the body or a specific body part quickly from one point to another. It is a crucial component in athletic performance and can be improved through sprint training, strength development, and neuromuscular efficiency.
Spinal Stenosis	A narrowing of the spinal canal that can compress nerves, leading to pain, numbness, or weakness.

Word(s)	Definition
Spine	Also called the vertebral column or backbone, is the central support structure of the body. It is made up of 33 individual bones called vertebrae, which are stacked in a column and separated by intervertebral discs. The spine protects the spinal cord, supports the head and torso, and allows for a wide range of movement while maintaining stability.
Spiritual Wellness	A sense of purpose, meaning, and connection to something greater than oneself, often involving values, beliefs, or practices that promote inner peace and harmony.
Spleen	The largest lymphatic organ, containing white blood cells that fight infection.
Spondylolisthesis	A condition in which one vertebra slips forward over the vertebra below it, often causing back pain.
Spot Reduction	The belief, and common misconception, that exercising a specific body part will selectively reduce fat in that area.
Sprain	An injury to a ligament caused by overstretching or tearing.
Stalking	A course of conduct directed at a specific person that would cause a reasonable person to feel fear or distress.
Static Flexibility	The ability to hold a stretch at the end of a joint's range of motion.
Static Stretch	A stretch that is held in a challenging but comfortable position for a period of time.
STD (Sexually Transmitted Disease)	Refers to the condition that develops when an STI causes noticeable symptoms or complications.
Steatosis	The build-up of fat in the liver cells, which can impair liver function and, over time, lead to inflammation, fibrosis, and potentially cirrhosis or liver failure.
STI (Sexually Transmitted Infection)	Refers to the presence of a virus, bacterium, parasite, or fungus in the body. A person can have an STI without symptoms.
Stimulants	Substances that speed up the body's systems, especially the central nervous system, leading to increased heart rate, blood pressure, and energy levels.
Stimulus Control	The process of modifying your environment to support healthy behaviors and reduce triggers for unhealthy ones. It involves adding cues that promote positive habits and removing those that encourage negative ones.
Stomach	A J-shaped organ where food is mixed with digestive juices and broken down into chyme.
Storage Fat	Body fat stored in adipose tissue for energy reserves; includes subcutaneous fat under the skin and visceral fat around organs, both contributing to overall body composition.
Straight Leg Test (SLT)	is a flexibility assessment used to measure the flexibility of the hamstring muscles (the muscles located at the back of the thigh).
Strain	An injury to a muscle or tendon caused by overstretching or tearing.
Stress	The body's physical, mental, and emotional response to external pressures or demands. In the context of exercise, stress can be beneficial in promoting adaptations and growth, but excessive stress without adequate recovery can lead to fatigue, injury, or overtraining.

Word(s)	Definition
Stress Response	The body and mind's reaction to a stressor, involving physiological, emotional, and behavioral changes. This response prepares an individual to face or adapt to challenges, often triggering increased heart rate, heightened alertness, rapid breathing, and the release of stress hormones such as cortisol and adrenaline.
Stress-Management	The use of techniques and strategies to control, reduce, or cope with stress, enhancing overall well-being and resilience in challenging situations.
Stressors	Events, situations, or demands that challenge an individual's ability to cope, potentially causing physical, emotional, or mental strain. Stressors can be short-term, long-term, or recurring, and may include things like exams, work deadlines, major life changes, or interpersonal conflicts.
Stretch Reflex or Myotatic Reflex	An automatic muscle contraction in response to stretching within the muscle.
Stroke	When blood flow to the brain is blocked, or there is sudden bleeding in the brain.
Stroke Volume	The amount of blood the heart pumps with each beat.
Subarachnoid Hemorrhage	Bleeding into the space between the brain and the surrounding membrane (subarachnoid space), most often caused by a ruptured aneurysm.
Subcutaneous Fat	Fat stored directly under the skin; it is part of total body composition and less harmful than visceral fat, though excess amounts still affect health and appearance.
Sublimation	A defense mechanism where unacceptable impulses are transformed into socially acceptable behaviors or activities.
Substance Use Disorders	Medical conditions in which the recurrent use of alcohol, drugs, or other substances leads to significant impairment, distress, or health risks. They are characterized by symptoms such as cravings, loss of control, tolerance, withdrawal, and continued use despite negative consequences.
Suicide	The intentional, self-inflicted death of an individual. It is typically associated with overwhelming psychological pain, hopelessness, or the belief that life is no longer worth living.
Superfood	A term used to describe nutrient-dense foods that are especially rich in vitamins, minerals, antioxidants, and other compounds believed to promote health and reduce the risk of disease. Examples include foods like blueberries, salmon, kale, and chia seeds.
Suppressed Anger	The conscious or unconscious inhibition of expressing anger, which can lead to stress, resentment, or negative health outcomes.
Susceptible Host	A person who is vulnerable to infection and can be easily affected by a disease.
Sympathetic Nervous System	The division of the ANS that prepares the body for rapid action in stressful or threatening situations, often called the "fight-or-flight" response.
Synergist	A muscle that assists the primary mover (agonist) in performing a movement by providing additional force or stabilizing the joint. Synergists help refine motion, reduce unnecessary movement, and enhance overall efficiency.

Word(s)	Definition
Synovial Fluid	A thick, slippery fluid found within synovial joints. It is produced by the synovial membrane and serves several important functions: lubricating the joint to reduce friction between the articulating bones, supplying nutrients to the cartilage, and acting as a shock absorber to protect the joint during movement. This fluid is essential for maintaining healthy, pain-free joint motion.
Synovial joints (Diarthroses)	The most common and most movable type of joint in the human body. These joints are characterized by a fluid-filled joint cavity enclosed by a joint capsule, which allows for smooth movement between the articulating bones. The synovial fluid within the cavity reduces friction, nourishes the cartilage, and absorbs shock. Examples of synovial joints include the knee, shoulder, elbow, and hip, each allowing varying types and ranges of motion depending on their structure.
Synthetic Cannabinoids	Laboratory-created drugs that interact with the same brain receptors as THC but often in stronger and more unpredictable ways, leading to severe health risks.
Systemic Circulation	The part of the circulatory system that moves blood between the heart and the rest of the body; controlled by the left side of the heart.
Systole	The period of the heart's contraction.
Target Heart Rate Zones	the range of heart rates that should be reached and maintained during cardiorespiratory endurance exercise to obtain optimal training effects.
Tend	-and-Befriend****:** A stress response, often observed in females, involving nurturing behaviors and seeking social support as a coping strategy.
Tendons	Strong, fibrous connective tissues that attach muscles to bones, enabling movement by transmitting the force generated by muscles. They are composed primarily of collagen, making them highly resistant to tension while maintaining flexibility. Tendons play a crucial role in stability, mobility, and overall musculoskeletal function.
Testosterone Boosters	Supplements designed to naturally increase testosterone levels in the body. They typically contain ingredients like D-aspartic acid, fenugreek, ashwagandha, tribulus terrestris, and zinc, which may support hormone production, improve muscle growth, enhance libido, and boost energy levels.
The Transtheoretical Model (TTM)	Explains behavior change through six stages: pre-contemplation, contemplation, preparation, action, maintenance, and termination.
Thermic Effect of Food (TEF)	The energy (calories) expended by the body to digest, absorb, transport, and metabolize nutrients from food.
Thermogenic Blends	Formulations of ingredients designed to increase the body's metabolism, enhance fat oxidation, and promote heat production (thermogenesis). These blends often include stimulants like caffeine, green tea extract, capsaicin, and other metabolism-boosting compounds. They are commonly found in weight loss supplements and pre-workout formulas to help improve energy expenditure and fat burning.
Thoracic	Pertaining to the middle section of the spine, consisting of twelve vertebrae connected to the ribs.
Thymus	A small organ located behind the breastbone where T-cells mature.
Tidal Volume	the amount of oxygen entering the lungs with each breath
Time	In the context of the FITT principle for weight training, TIME refers to the duration of each workout session or the amount of time spent performing the exercise.

Word(s)	Definition
Time Management	The practice of planning and organizing how one allocates time to tasks and responsibilities.
Tobacco	A plant in the Nicotiana genus, most commonly Nicotiana tabacum, whose leaves are harvested, cured, and processed for use in various products, including cigarettes, cigars, pipe tobacco, and smokeless tobacco
Tolerable Upper Intake Levels (ULs)	The maximum daily amounts of nutrients unlikely to cause harmful effects for most people. Consistently exceeding the UL increases the risk of toxicity and adverse health effects.
Tolerance	The body's reduced response to a drug or alcohol after repeated use, requiring higher doses to achieve the desired effect (e.g., euphoria, pain relief, intoxication).
Transactional Model of Stress	A framework that explains stress as a dynamic process resulting from the interaction between an individual and their environment, emphasizing how personal appraisal of a situation influences the stress response.
Transient Ischemic Attack (TIA)	A brief, temporary episode of stroke-like symptoms caused by a short-lived blockage in blood flow to the brain, with no lasting damage; often called a "mini-stroke" and a warning sign of future stroke risk.
Traumatic Brain Injury (TBI)	A disruption in normal brain function caused by an external force, such as a blow or jolt to the head, which can result in cognitive, emotional, and physical impairments.
Tricuspid Valve	The heart valve between the right atrium and the right ventricle that prevents the back flow of blood into the right atrium.
Triglycerides	The most common type of fat in the body and food, made of three fatty acids attached to a glycerol backbone. They store energy for later use, but high blood levels can increase the risk of heart disease.
Trunk Rotation Test	A test used to assess the rotational flexibility of the torso and spine.
Type	In reference to the FITT principle, "type" identifies the mode or style of resistance used to develop muscular fitness. This refers to the form of resistance training chosen to improve muscular strength, endurance, or power, and the specific exercises selected to target desired muscle groups.
Type A Individuals	People who are competitive, ambitious, impatient, and prone to high stress and urgency.
Type B Individuals	People who are relaxed, patient, easygoing, and less prone to stress-related behaviors.
Type C Personality	Individuals who tend to suppress emotions, especially negative ones, and may exhibit a high need for approval and compliance.
Type D Personality	Individuals characterized by high negative emotions (e.g., worry, irritability) and social inhibition, often linked to increased health risks.
Type I Muscle Fibers	Also known as slow-twitch fibers, are skeletal muscle fibers specialized for endurance and sustained, low-intensity activity. They contract slowly, generate less force, and resist fatigue due to their high mitochondrial density and reliance on aerobic metabolism. These fibers are well-suited for activities like long-distance running, cycling, and maintaining posture.
Type II Diabetes Mellitus	A chronic condition where the body becomes resistant to insulin or doesn't produce enough insulin, leading to elevated blood sugar levels and increasing the risk of heart disease, kidney problems, nerve damage, and other health complications.

Word(s)	Definition
Type II Muscle Fibers	Also known as fast-twitch fibers, are skeletal muscle fibers that contract quickly and generate high force but fatigue faster than Type I (slow-twitch) fibers. They are further divided into Type IIa (fast oxidative-glycolytic) and Type IIb (fast glycolytic) fibers. These fibers are essential for explosive movements like sprinting, jumping, and heavy lifting.
Type IIa Muscle Fibers	Also known as fast-twitch oxidative-glycolytic fibers, are a hybrid between Type I (slow-twitch) and Type IIb (fast-twitch) fibers. They contract quickly and generate moderate to high force but have greater endurance than Type IIb fibers due to their ability to use both aerobic and anaerobic metabolism. This makes them well-suited for activities requiring both power and endurance, such as middle-distance running and repeated resistance training.
Type IIb Muscle Fibers	Also known as fast-twitch glycolytic fibers, are a type of skeletal muscle fiber that generate high force and contract rapidly but fatigue quickly. They rely primarily on anaerobic metabolism, using stored glycogen for energy, making them well-suited for short bursts of intense activity like sprinting or heavy lifting. However, they have low endurance due to limited oxygen efficiency and a high rate of lactic acid production.
Typical Use Effectiveness	- **Vaccination**: Treatment with a vaccine to produce immunity to a particular infectious disease or pathogen.
U.S. Department of Health and Human Services (USDHHS)	A U.S. government department responsible for public health. It publishes guidelines like the Physical Activity Guidelines for Americans.
Ultra-Processed Foods (UPFs)	Industrially manufactured foods that contain ingredients rarely found in home kitchens, including additives, preservatives, artificial flavors, and sweeteners.
Underweight	A body weight that is considered too low to be healthy, typically defined as having a Body Mass Index (BMI) below 18.5.
United States Department of Agriculture (USDA)	A federal agency responsible for developing and executing policies on farming, food, and nutrition. It oversees programs like MyPlate, school meals, and food safety regulations.
Unsaturated fats	Healthy fats that contain one or more double bonds in their chemical structure, making them typically liquid at room temperature. They include monounsaturated and polyunsaturated fats, found in foods like olive oil, nuts, seeds, and fatty fish.
Veins	Vessels that carry blood to the heart.
Venae	Cavae**: The large veins through which blood is returned to the right atrium of the heart.
Ventricle	One of the two lower chambers of the hear from which blood flows through arteries to the lungs and other parts of the body.
Vertebrae	The individual bones that make up the spinal column.
Vertebral Column	Also known as the spine or spinal column, is a series of interconnected bones called vertebrae that extend from the base of the skull to the pelvis. It supports the body's weight, protects the spinal cord, and allows for flexible movement. The vertebral column is divided into five regions: cervical, thoracic, lumbar, sacral, and coccygeal.
Visceral Fat	Fat stored deep in the abdomen around internal organs; in body composition, it is linked to higher risks of heart disease, type 2 diabetes, and other metabolic disorders.
Vitamin D	A fat-soluble vitamin that helps the body absorb calcium and phosphorus, supporting bone and immune health. It can be made in the skin through sunlight exposure and is also found in foods like fatty fish and fortified milk.

Word(s)	Definition
Vitamins	Organic compounds that the body needs in small amounts to regulate metabolism, support growth, and maintain health. They are classified as fat-soluble (A, D, E, K) or water-soluble (B-complex, C).
Volume	The total amount of work performed in a training session or over a specific period. It is typically calculated as the product of sets × repetitions × weight for resistance training or frequency × duration for aerobic exercise, influencing overall training load and progression.
Water	An essential nutrient that supports nearly every body function, including hydration, temperature regulation, nutrient transport, and waste removal. It is the most abundant substance in the human body and must be consumed regularly for survival.
Water-soluble vitamins	Vitamins that dissolve in water and are not stored in large amounts in the body, so they must be consumed regularly. They include the B-complex vitamins and vitamin C.
Weight Management	The process of adopting long-term lifestyle habits—such as healthy eating, regular physical activity, and behavior changes—to achieve and maintain a healthy body weight. It includes strategies for losing, gaining, or maintaining weight in a way that supports overall health and well-being.
Wellness	Wellness is a balanced approach to physical, mental, emotional, and social well-being, achieved through intentional choices like staying active, eating well, and managing stress.
Whole grains	Grains that retain all three parts of the original kernel, the bran, germ, and endosperm, after processing. Because these parts are left intact, whole grains are rich in fiber, vitamins, minerals, and beneficial plant compounds.
Withdrawal	The body's response to the absence of a drug on which it has become physically or psychologically dependent
Yerkes-Dodson Law	A principle stating that there is an optimal level of arousal for performance, with too little or too much stress impairing effectiveness.

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