



Health and Exercise Wellbeing

Department of Health and Exercise Studies (HES)
North Carolina State University

EIGHTH EDITION



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Health and Exercise Studies Courses

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HESF 101	Fitness and Wellness	DAN 234	Country Dance	DAN 264	Ballet
HESF 102	Fitness Walking	HESS 235	Karate	DAN 265	Ballet II
HESF 103	Water Aerobics	HESF 237	Weight Training	HESF 265	Softball
HESF 104	Swim Conditioning	HESS 239	Self Defense	HESF 266	Ultimate Frisbee
HESF 105	Aerobics and Body Conditioning	DAN 240	Social Dance	HESF 267	Flag Football
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HESA 226	Skin and Scuba Diving I	HESF 259	Intermediate Rock Climbing	HESS 295	Special Topics in Physical Education
HESA 227	Scuba Diving II	HESS 260	Intermediate Equitation	HESF 296	Independent Study in Physical Education
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HESA 229	Scuba Leadership	HESF 262	Introduction to Whitewater Canoeing		
DAN* 230	Horton Dance Technique				

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HESM 202 Coaching Basketball	HESM 208 Coaching Track & Field/ Cross-Country	HESM 381 Athletic Training
HESM 203 Coaching Football	HESM 209 Coaching Volleyball	HESM 477 Coaching Concepts
HESM 204 Coaching Golf	HESM 211 Coaching Strength Training and Conditioning	HESM 478 Principles of Sport Science
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HESM 285 Personal Health		
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SPORTS SCIENCE		
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HESF 102 Fitness Walking	HESS 245 Golf	HESM 477 Coaching Concepts
HESF 104 Swim Conditioning	HESR 249 Tennis I	HESM 478 Exercise Physiology and Sports Science
HESF 105 Aerobics and Body Conditioning	HESO 277 Mountain Biking	HESM 479 Sport Management
HESF 107 Run Conditioning	HESF 279 Yoga I	HESM 284 Women's Health Issues
HESF 109 Step Aerobics	HESF 282 Advanced Aerobics and Leadership	HESM 285 Personal Health
HESA 221 Intermediate Swimming	HESM 202 Coaching Basketball	HESM 286 Nutrition, Exercise, and Weight Management
HESF 237 Weight Training	HESM 211 Strength Training and Conditioning	

*DAN courses are also included as other core activity courses that NC State offers.

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chapter 1



Introduction to Health and Wellness

by Sarah Ball, Ph.D., Peggy S. Domingue, M. Ed., and Jeong Dae Lee, Ph.D.

What Is Health?

Individuals with optimum health are considered to exhibit excellent levels of the components of physical fitness, including cardiorespiratory endurance, musculoskeletal strength and endurance, flexibility, and body composition, as well as they are more resilient to the stresses encountered in daily living. They can do the activities they choose with less challenge than those who make less than optimum physical health choices. A strong physique, invulnerable immunity, good mental health, environmental adaptability, or a combination of all these traits are often used to measure overall health (Edlin & Golanty, 2019). The World Health Organization (2022) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” In general, the term “healthy” has been broadly used to refer to one’s state of being where health issues can be discussed and considered as people strive to work on their bodies. Specifically, physical fitness, nutrition, chronic and infectious diseases, mental health, stress management, substance use, aging, and others are often addressed in health discussions.

However, as many different behaviors, attitudes, or even cultures can be contextualized, health should be discussed in a broader sense to determine more holistic aspects of health. Health status is a continuum ranging from irreversible health problems to optimum robustness of one’s state of being, with some individuals making a certain health status on the continuum their end goal instead of a referential or directional point of an ongoing process. Over time, health status can exist at different points on the continuum and can be either positive or negative. Depending on the tendency of current behavior to build either positive or negative health habits, health statuses could switch between positive and negative points in the future. Concurrently, one’s interpretations of one’s feelings, mood, energy level, and sense of well-being could also determine the holistic sense of one’s health status. Overall, health can be perceived

1

Chapter One

as an ongoing process. People attempt to comprehend the dynamics that determine health and how to hold themselves accountable for their choices and assessment of their health status (Rath & Harter, 2010).

What Is Wellness?

The term wellness is frequently used interchangeably with health; however, it can be regarded as a conceptually different approach to the health state. The concept of wellness may cover more expansive areas of the health state as it emphasizes multi-paced balancing actions and processes throughout an individual's life (Sartorius, 2006). In other words, removing a disease may not be considered the sole purpose or product of one's health endeavors, but the notion of wellness, process, adaptation, or balance is more deliberately focused as it contextualizes one's attitudes, values, perspectives, choices, or interpretations over one's health state. Recognizing the concept of wellness puts an "actively purposed goal" into focus. In this sense of wellness, individual responsibilities become important factors as one's health state must be assessed by one's choices, potential, or the meaningfulness of behaviors rather than only external or uncontrollable factors such as age, family history, or socioeconomic status (VanderWeele, 2017; VanderWeele et al., 2019). Similar people on the health continuum may measure their wellness statuses very differently. It has been found that individuals with severe illnesses or impairments may have a strong sense of well-being while living up to their own wellness potential as wellness can be determined by an individual's decisions about how to live with vitality and meaning (Liguori & Carroll-Cobb, 2021). For example, a person with diabetes can often be physically ill, but still feels well because of the support from friends and family members that keeps the person with diabetes mentally strong and happy. People with a disease issue can be medically compromised, however given the correct choices from medical data can function well and achieve a level of health beyond their diagnosis.

Dimensions of Wellness

The definition of wellness can be better understood by knowing the various dimensions of wellness. The six dimensions of wellness commonly addressed are physical, social, emotional, intellectual, spiritual, and environmental. The increase of anxiety and depression

which can be attributed to social isolation is an ongoing situation given recent global health events. Although some additional dimensions of wellness, such as occupational or financial wellness, could have been included in this discussion, this chapter focuses on only six dimensions of wellness as it intends to look at health-related content during college years.

- **Physical wellness** refers to physical statuses such as physical appearance, strength, stamina, energy, and absence of diseases. It is important to maintain one's physical health to stay physically fit enough to move one's body without undue fatigue. Physical wellness is concerned with maintaining a strong and healthy body for people to feel physically fit. Related questions to determine physical wellness include: Do you have strength and flexibility to perform movements better? Are you often sick? Do you have a healthy body mass index?
- **Emotional wellness** refers to psychological or mental status. People can deal with many emotional changes or challenges that alter their moods, motivations, and/or anxiety levels. One's mental state is often ascribed to neurochemicals, but self-esteem, locus of control, or anxiety also affects emotional wellness. Some questions regarding emotional wellness include: Are you aware of your emotions? Do you cope with anxiety well? Do you express your emotions well?
- **Social wellness** is another important aspect of a health-conscious lifestyle among all other dimensions of wellness. Significant others like family members, school friends, or coworkers influence people's actions, behavior, and how they relate to one another. As for a health-conscious lifestyle, people communicate with others daily, not only to share information, belief systems, or resources but also to share a sense of community, support, trust, belonging, or acceptance. Social wellness can be determined by social interactions and connections between people. Questions to ask include: Do you have good relationships with your significant others, family, or friends? Do you feel accepted by a group of people with whom you think you belong? Are you dealing with social biases that hinder your relationships with others?

- **Intellectual** wellness involves decision-making or problem-solving. Depending on how behaviors are selected, the degree to which one lives healthily or well may vary. To make a better decision or solve an issue more properly, one will need to improve one's knowledge, critical thinking skills, and intellectual potential. Given an optimal level of intellectual wellness, one could make healthier choices, safer solutions, and more in-depth analyses of health behaviors. Some related questions include: Are you able to read food labels correctly? Are you able to recognize the differences in cholesterol, HDL, and LDL? Is your exercise routine appropriate to meet your fitness goals safely and effectively? Can you evaluate the effectiveness of your coping strategies to handle stressors?
- **Spiritual** wellness is addressed with an inner sense or guidance beyond external knowledge, mind, or will. Spiritual well-being includes the ability to create or recognize the purpose of one's life, give meaning to one's existence, or even an awareness of a supreme being. As spiritual wellness fulfills one's inner sense of who one is, spiritual wellness often steers behaviors or attitudes towards a lifestyle that may or may not affect one's health or wellness status. For spiritual wellness, questions to ask include: Do the choices you make every day reflect the meaning of your life? Are you able to identify your personal values and beliefs? Do your behaviors conflict with your values?
- **Environmental** wellness is associated with the awareness of external circumstances (e.g., air, temperature, weather, trails, wilderness, animals, outdoor activities), living space, recycling, neighbors, and other environmental concerns. This dimension is an essential part of living that must be considered to live a healthier life as many environmental issues are not visible, but they can contribute to a healthy state. At times, dirty air, unclean water, poisonous soil, or unpleasantly noisy neighbors may play negative roles in one's life. The lack of nature preservation can also be problematic as it may affect the quality and patterns of one's life. Questions to ask include: Do you live in an area with clean air? Are you aware of the global weather changes? Do you know the benefits of recycling?

Knowing these aspects of multiple wellness dimensions, one can also think about the importance of maintaining balance. If one or more wellness dimensions are not properly maintained, other dimensions could be affected. For example, one's physical wellness is initially maintained with optimal levels of physical fitness, but one's relationship with school peers may not be optimal due to conflict. As these conflicts in relationships with peers affect social wellness, one may find oneself socially ill or impaired with a sense of isolation or loneliness despite one's physical wellness. Without properly integrating the dimensions of wellness, it may not be possible to determine overall wellness. Losing one of these various dimensions of wellness is like missing one of the spokes in a bicycle wheel; it may soon result in a lack of well-being. There are indications that chronic conditions are increasing in younger populations, therefore requiring an increased focus on earlier prevention for younger people.

Health Issues in the U.S.

Chronic diseases such as cardiovascular diseases, cancer, and diabetes are commonly addressed as major health issues that many Americans face (**Figure 1-1**). Data from the National Vital Statistics Reports (Xu et al., 2021) supports that heart diseases are the leading cause of mortality in the U.S., with cancer, dementia-related diseases, lung diseases, diabetes, and influenza being other common causes of death among the U.S. population. Unhealthy food choices, physical inactivity, poor stress management, or toxic environments can be thought of as contributors to poor health among the U.S. population, hence the importance of having a balance in one's wellness domains.

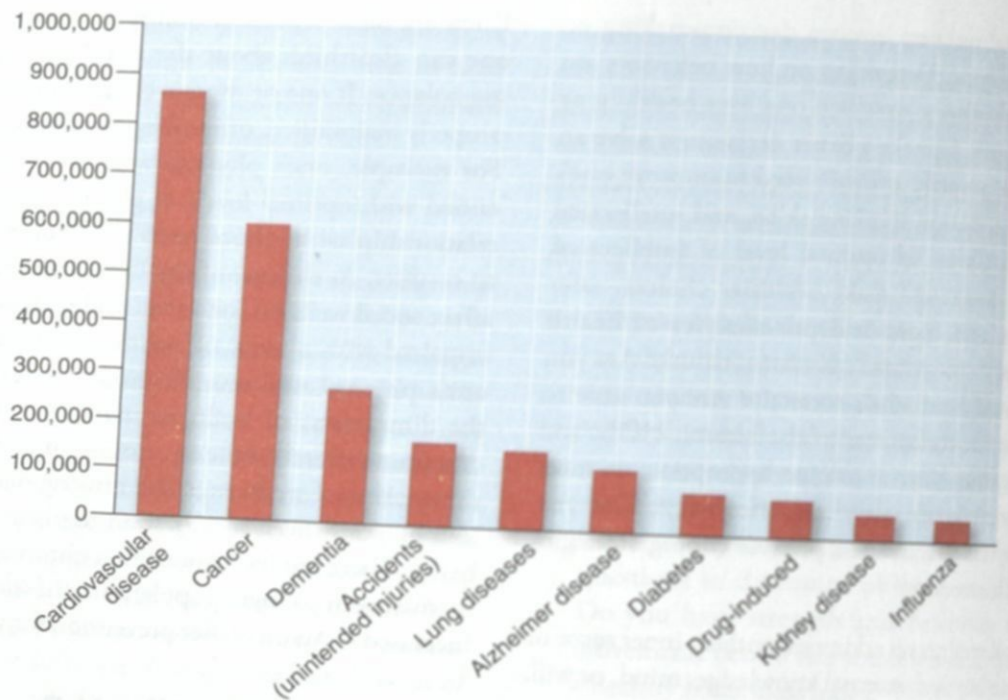


FIGURE 1-1. Leading Causes of Death in the U.S., 2019.

Meanwhile, what is happening to college students in the U.S. regarding their health issues? In general, traditional college students are young and considerably more energetic while experiencing minor or short-term illnesses, mostly in interspersed periods. However, according to the National Vital Statistics Reports (2021), the leading causes of death among young Americans are accidents involving unintentional injuries, firearm injuries, suicide, drug-related incidents, and homicidal assaults,

as well as several common chronic diseases among all populations such as cancer, cardiovascular diseases, and diabetes (Figure 1-2). Compared to the general U.S. population, these trends indicate that young Americans are more likely to engage in risky behaviors such as reckless driving leading to car accidents, depression, drug addiction, and violent actions. These issues may relate to their social, emotional, and/or intellectual wellness rather than physical wellness.

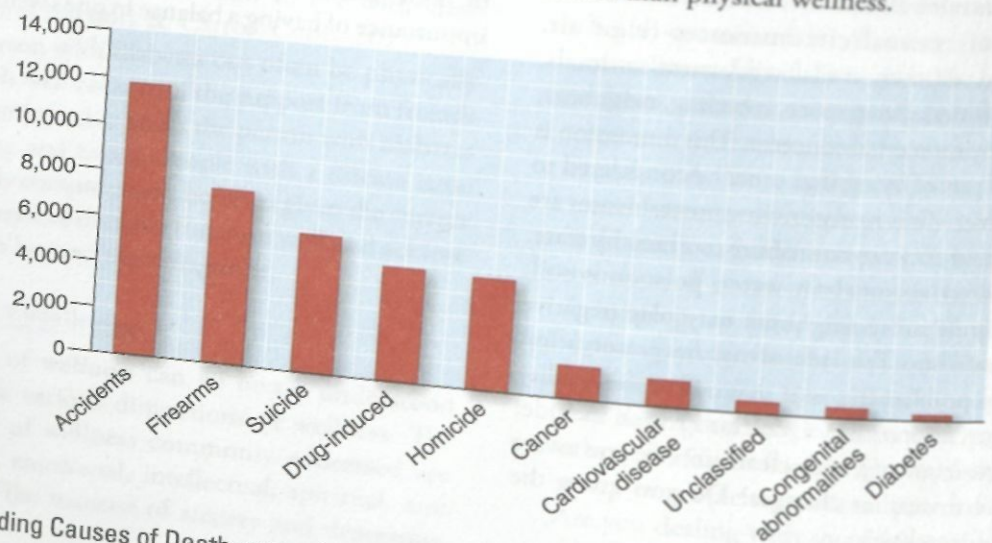


FIGURE 1-2. Leading Causes of Death among Young Adults in the U.S.

These health trends in the U.S. speak for themselves. To better evaluate health and wellness, one must consider health as a broad spectrum of the state of being and wellness as a combination of physical, mental, social, intellectual, spiritual, and environmental aspects. The absence of any dimension of wellness can lead one to a less than optimum health status.

Behavior Change

Knowledge can be powerful and in the case of this textbook, can provide one with best practices and recommendations for engaging in certain health behaviors. While this information can help one make decisions about engaging in health behaviors, understanding why some may or may not engage in certain behaviors is another topic to understand. The following are some concepts and theories that can help explain why some engage in certain health behaviors and some do not.

Motivation

Individuals are driven to do what they do for various reasons; this drive can be called motivation. Most likely these reasons can be broken down into intrinsic and extrinsic motivators (**Table 1-1**). Intrinsic motivators can be described as those reasons that are internal to the individual (e.g., an individual engages in group fitness classes because they enjoy exercising in that type of setting with other participants for socialization). An extrinsic motivator can be described as a reward that is external to the individual (e.g., an individual participates in a specific sport to win a trophy or an award). Amotivation is when an individual has no drive at all (e.g., an individual has no drive to engage in exercise).

Table 1-1. Examples of Motivators for Engaging in Physical Activity

INTRINSIC MOTIVATORS	EXTRINSIC MOTIVATORS
Ability to do more physical work	Trophy/Win
Relieves stress	Reward/Prize
Enjoy learning new skills	Recognition from others
Enjoy the socialization	Approval from others
Enjoy the personal challenge	Affiliation to a group

Self-Determination

A human motivation theory that describes motivation in relation to an individual being autonomous in their actions to achieve personal growth is called the Self-Determination Theory (Deci & Ryan, 1985). This theory states that individuals have three psychological needs that drive motivation: relatedness (e.g., the need to feel belonged therefore an individual participates in group fitness classes), competence (e.g., experiencing mastery in an activity), and autonomy (e.g., feeling that one has a choice in selecting the physical activity that they would like to engage in). Understanding these needs can help explain why someone may or may not participate in certain health behaviors.

Health Belief Model

A widely accepted theoretical framework describing how an individual's beliefs can predict their health-related behaviors is the Health Belief Model (HBM) (Glanz, Rimer, & Viswanath, 2008). The HBM has six constructs that can help determine one's beliefs and likelihood to engage in any given health behavior (Table 1-2).

Table 1-2. Health Belief Model

HBM CONSTRUCTS	EXAMPLES RELATED TO PHYSICAL ACTIVITY
Perceived Susceptibility	I believe that there is a possibility of me acquiring a preventable health condition if I do not engage in recommended amounts of physical activity.
Perceived Severity	If I do not engage in the recommended amounts of physical activity, I could negatively affect my fitness levels which can impact my athletic performance.
Perceived Benefits	If I engage in the recommended amounts of physical activity, I will have good fitness levels.
Perceived Barriers	I do not have enough time or money to engage in physical activity.
Self-Efficacy	I feel confident in my ability to engage in physical activity.
Cues to Action	My low physical fitness levels have impacted my ability to engage in my hobbies, therefore I am prompted to engage in the recommended amounts of physical activity to improve my fitness levels.

Transtheoretical Model

A widely used theoretical model used to describe behavior change is called the Transtheoretical Model (Prochaska & Velicer, 1997) which indicates that individuals proceed through six construct stages of change, with a relapse from any reached stage to a former stage possible (Table 1-3).

Table 1-3. Transtheoretical Model

PRECONTEMPLATION	Not serious about changing in the next six months.
CONTEMPLATION	Know change is important and intend to change within six months.
PREPARATION	Change appears to be possible and plans are made to make a change. This is likely a stage where goals are made.
ACTION	Have made and sustained change(s) for about six months.
MAINTENANCE	Continue to practice new habits successfully for six months or more.
TERMINATION	New habits have been established and efforts to change are complete.

Goal Setting

Goals motivate. Goal setting is a critical component of any exercise program. Knowing what you want to achieve can focus your time and attention on the necessary steps to take you where you want to go. Goal setting directs effort and gives one a sense of purpose. This can serve to motivate people who may otherwise lose interest in an activity or exercise program. Most people make statements that they would like to be in “better shape” or “lose weight” and become discouraged when they do not see results. Setting goals can help provide realistic expectations for change and keep one focused on the task, providing the motivation to continue. Goal setting that results in improved performance does so because it directs attention to important elements of a skill, mobilizes efforts, encourages prolonged persistence and promotes the development of new learning strategies (Locke & Latham, 1985). In addition, goal setting is effective when certain conditions are met. Simply setting goals is not the answer. Goals must be well-planned, personal, written, idealistic, short- and long-term, measurable, time specific, monitored, and evaluated (Hoeger & Hoeger, 2000). Other keys to setting effective and appropriate goals follow.

Before goals are set, individuals must recognize which behaviors they want to change or maintain. Goals serve to facilitate growth toward a desired outcome and many times that outcome involves change. The decision to change behaviors and to maintain that change is positively impacted through the goal-setting process. One can evaluate if goals were met through data collection.

Seven Key Steps to Effective Goal Setting

Locke and Latham (1990) propose a seven-step process to maximize the effectiveness of goal setting.

1. Set appropriate goals.

The first step in setting appropriate goals is to assess needs. Before goals can be set, one needs to know what their needs are. In addition, the function of the goal needs to be defined. Knowing the focus of the goal, the type of goal, and the goal difficulty will aid in setting appropriate goals.

2. Develop goal commitment.

People need to be committed to goal achievement. Goal achievement can be enhanced when people participate in the goal setting process, when social support is provided, and rewards for goal achievement are available.

3. Evaluate barriers to goal attainment.

Potential barriers to goal attainment need to be identified. Then, strategies on how to overcome these barriers are necessary.

4. Construct an action plan.

Setting goals without having a plan on how to implement them is a plan to fail. Goal setters must put an action plan in place for their goals to be effective. Knowing how to get to where you are going is critical. An action plan tells you how to get where you want to go.

5. Obtain feedback.

Feedback that contains information about how one is progressing toward goals is an important step to effective goal setting. Feedback can come from several sources. One possible source of feedback is the method of evaluation an individual chooses when goals are initially established.

6. Evaluate goal attainment.

Goal attainment and increased motivation is more likely when goals are periodically evaluated. A method of evaluation must be established when goals are set. There should be an organized method to evaluate where one is as they work toward their goals.

7. Reinforce goal achievement.

Goal setters are encouraged to repeat the goal-setting process regardless of whether or not a goal was reached. Setting new goals enhances motivation and increases goal attainment.

Principles of Goal Setting

There are several goal-setting principles throughout the literature. The following eleven principles are commonly found to be important components for a successful goal-setting program (Weinberg & Gould, 2003).

1. Set Specific Goals

To simply set out to "do-your-best" is not enough when change is necessary. Goals should be specific and measurable and stated in terms that are very well-defined. Specific goals are most effective and easy to track and measure.

2. Set Moderately Difficult but Realistic Goals

Goals that are difficult enough to be challenging, but realistic enough to be achieved are the most effective goals. When goals are too difficult, frustration and a lack of confidence can result. On the other hand, goals that are very easily attained are generally of little value.

3. Set Short- and Long-Term Goals

Both short-term and long-term goals are important and must be set. In addition, short- and long-term goals must be linked to each other. Goals should progress logically according to predetermined objectives. Being able to meet short-term goals that lead to long-term goals can stimulate confidence and motivation.

4. Set Performance, Process, and Outcome Goals

Performance goals focus on achieving certain successes based on an individual's previous performance. With performance goals, one is more concerned with making comparisons with one's self and not with other people. Performance goals measure one's progress against one's self regardless of what others are doing or have done. Process goals, on the other hand, focus the attention on criteria that must be met during the performance so that performance goals can be met. Correctly executing an exercise (process goal) can result in the ability to lift more weight or run a longer distance (performance goal) thus winning a competition or race (outcome goal). Outcome goals focus on the result of an event and can create motivation to succeed on process and performance goals. However, too much focus on outcome goals can create anxiety.

5. Set Practice and Competition Goals

When an individual chooses to compete, goals for practice and competition must be set. For most, more time is spent practicing for a competition and having specific goals for that practice time can help maintain motivation. Practice goals should complement competition goals so that goals are more likely to be achieved.

6. Record Goals

Goals should be recorded and posted. The method of recording is whatever one determines to be most practical. The purpose is to be reminded of set goals, focus on those goals, and promote accountability.

7. Develop Goal Achievement Strategies

Goal achievement strategies should indicate specifically how much, how often, how many, etc. The purpose of developing goal achievement strategies is to define specifically how a goal is to be achieved. This is similar to constructing the action plan mentioned above.

8. Consider Personality and Motivation

Knowing one's self will help determine how to set goals. For some, time restraints and schedules affect the method of how goals are to be achieved or maintained. Personality characteristics can also affect the structure and intensity of goal-setting efforts.

9. Foster Individual Goal Commitment

As mentioned earlier under the seven steps to effective goal setting, one must be committed to a goal before they can hope to achieve it. When people are allowed to set their own goals they take ownership in that goal and are more committed to it.

10. Provide Goal Support

Enlisting the support of family and friends makes goal setting more effective. Educating those around you about your goals and the efforts you are making to achieve them can encourage support. This support is very important in progressing toward goals.

11. Provide Goal Evaluation and Feedback

When goals are set there must be a method put in place to evaluate those goals. This is done at the start of the goal-setting process. Being able to adequately

measure progress can provide feedback. This feedback must contain specific information relative to the progress, or lack thereof, in the effort to reach defined goals. Evaluation is critical and can provide the information needed to alter goals.

Common Problems in Goal Setting

The following six problems are often found in goal setting (Weinberg & Gould, 2003; Cox, 2007):

1. Poorly Written Goals

Goals should be written so they are specific, measurable, achievable, realistic, and timely (SMART) (Table 1-4). When goals are vague, lack direction, cannot be measured, and are unrealistic people are not motivated to strive to attain them. There is no motivation to attain goals that have no purpose or intent to change behavior. Writing goals in a specific manner will serve to motivate and facilitate change.

2. Setting Too Many Goals Too Soon

People anxious to see change many times set too many goals too soon and become discouraged. A few realistic goals are better than several unrealistic goals. Having the time to realistically implement and monitor set goals is important to the effectiveness of goal setting.

3. Failure to Devise a Strategy

One of the goal-setting principles is to develop a goal-setting strategy or action plan. The purpose of this strategy is to plan how one will achieve this goal. Not having a strategy or plan on how to achieve a goal results in certain failure for the goal-setting process.

4. Failure to Monitor Progress

Knowing where one is in the process of attaining a goal is critical to not only achieving the goal, but also staying motivated to attain the goal. Well-defined goals can be easily monitored. Having the ability to monitor progress will allow necessary adjustments to be made and will provide direction for future efforts.

5. Failing to Adjust Goals

Being aware of the possibility that goals may need to be adjusted can eliminate disappointment when changes need to be made.

6. Not Planning for Evaluation

When evaluation is planned for, then one understands that periodic evaluation will occur and the effort to stay on task is encouraged. The lack of evaluation is a major reason for failure in goal-setting programs. When there is no follow-up, there is no way to assess progress.

Steps to Designing a Goal-Setting System

The following are three basic steps to design a goal-setting system:

1. Preparation and Planning

Before setting goals, one must assess abilities and needs. An integral part of assessment is identifying areas that need improvement or change. When needed changes are identified, a plan for how to achieve that change begins to take shape. Using the seven steps to effective goal setting and the principles of goal setting will provide direction on setting goals and formulating a plan to achieve them.

2. Set Appropriate Goals

As mentioned earlier, goals must be challenging but realistic. They must be well-planned, personal, written, realistic, short- and long-term, measurable, time specific, monitored, and evaluated (Hoeger & Hoeger, 2000). What is appropriate for one person may not be appropriate for another. Setting the appropriate goals is the foundation for meeting those goals.

3. Evaluate Goals

From the start, a plan on how to evaluate the goals you set must be established. When the goal is set, there should be an evaluation plan that corresponds to that goal. Knowing that there will be an evaluation motivates one to stay on task. Accurate evaluations provide necessary information so that one knows if and when to adjust goals along the way. More importantly, evaluating goals and progress toward a goal makes the probability of achieving that goal a reality.

Summary Questions

1. Describe the different wellness domains and how they relate to your life.
2. Identify the leading causes of death in the U.S.
3. Describe commonly used health behavior models and theories as well as explain how they can relate to an individual engaging in any given health behavior.
4. Think of one health behavior you would like to change. List the stages of change and decide which one applies to your target health behavior.
5. Describe eleven commonly found components in a successful goal-setting program.
6. Summarize six common problems in goal setting.
7. Identify methods of behavior change, barriers to change, stressors, and indicators of relapse.

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Useful Websites

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chapter 2



Cardiorespiratory Fitness

by Macy Kalb, M.S. and Brenda Watson, Ph.D.

Physical Fitness

Physical fitness means that the various systems of the body are healthy and function efficiently so one can engage in activities of daily living, recreational pursuits, and leisure activities without unreasonable fatigue.

Being physically fit is critical to our overall health and well-being. Physical fitness is directly associated with one's health. According to the American College of Sports Medicine, health-related fitness is divided into five components: 1) cardiorespiratory fitness, 2) muscular strength, 3) muscular endurance, 4) muscular flexibility, and 5) body composition. These five components will be addressed throughout this textbook.

The latest government health-related physical activity guidelines recommend that adults need at a minimum 2.5 hours of moderate-intensity activity each week. However, at least 5 hours, half of which is in vigorous-intensity mode, is best for optimal health-related fitness benefit. Brisk walking, jogging, running, swimming, strength training, calisthenics (push-ups, sit-ups, pull-ups) done in various levels of intensity and forms (sports-related activity) combined with a healthy diet will help you realize your full potential.

2

Chapter Two

If you're inactive (rarely active)

increase daily activities at the base of the pyramid.

- Walk whenever you can.
- Make leisure time as active as possible.

If you're sporadic (active some of the time, but not regularly)

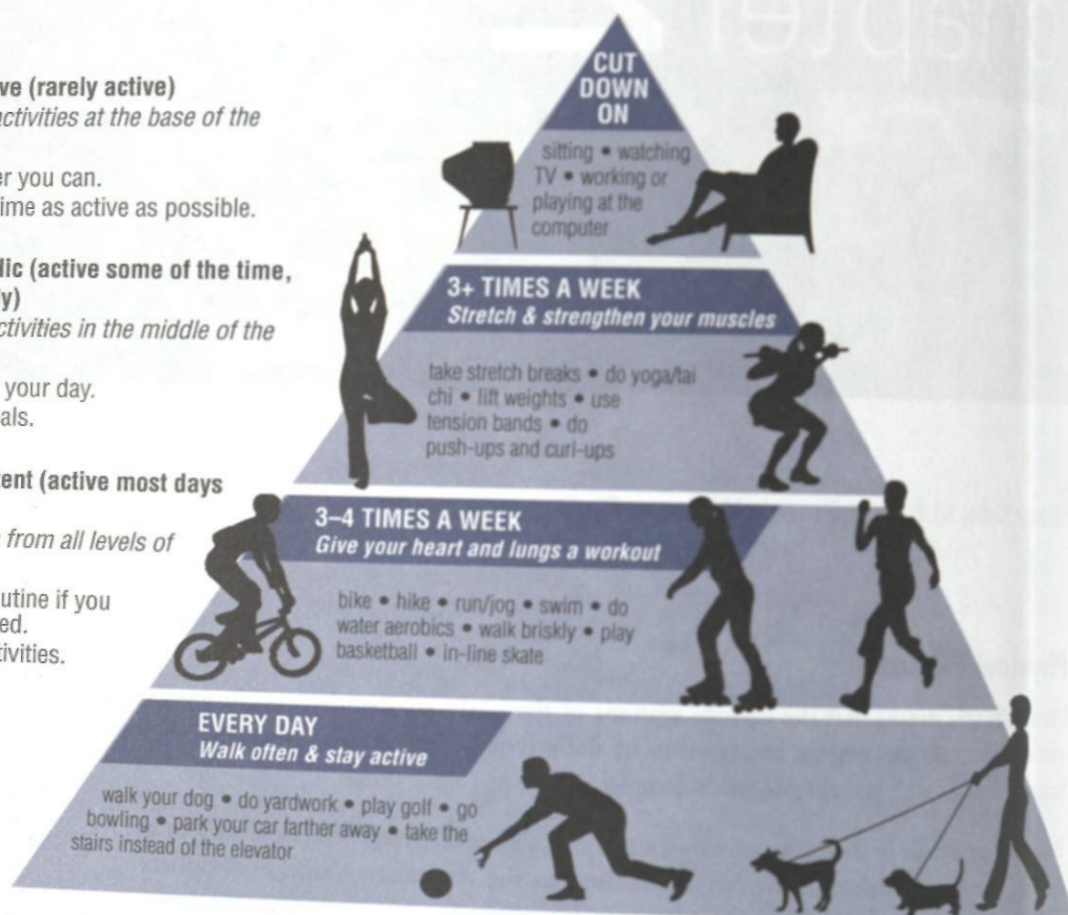
increase daily activities in the middle of the pyramid.

- Plan activity in your day.
- Set realistic goals.

If you're consistent (active most days of the week)

choose activities from all levels of the pyramid.

- Change your routine if you start to get bored.
- Explore new activities.



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Cardiorespiratory Fitness

Cardiorespiratory fitness is the ability to perform moderate- to high-intensity dynamic exercise involving large muscle groups for prolonged periods of time. It is sometimes referred to as cardiorespiratory endurance, aerobic fitness, or aerobic capacity. The body's circulatory and respiratory systems function together to supply oxygen to the working muscles to produce energy. Cardiorespiratory fitness is the efficiency with which the body is able to transport, absorb, and use oxygen.

Improved Cardiorespiratory Fitness

To improve one's cardiorespiratory fitness, an individual needs to engage in activities that place added stress on the circulatory and respiratory systems at intensities that result in physiological adaptations. These adaptations enable the muscles to produce and use more energy during exercise and therefore the muscles can work more intensely and for a longer duration. The charts below identify some of the physiological adaptations and health benefits from improved cardiorespiratory fitness.

PHYSIOLOGICAL ADAPTATIONS	
Increased	Decreased
• Heart volume • Resting and maximum stroke volume • Maximum cardiac output • Total blood volume • Lactate threshold • Maximal ventilation • Maximum oxygen consumption • Capillary density to exercised muscles • Mobilization and utilization of fat • Insulin sensitivity	• Resting heart rate

HEALTH BENEFITS	
Increased	Decreased
• Aerobic work capacity • HDL ("good") cholesterol • Heart function • Immune function • Sense of well-being	• Fatigue in daily activities • Body fat stores • Risk for Type-2 diabetes • Blood pressure to normal levels • Risk of certain cancers • Risk of mortality from all causes • Rate of osteoporosis • Symptoms of anxiety/tension/depression

Types of Activities to Improve Cardiorespiratory Fitness

The American College of Sports Medicine (ACSM) places cardiorespiratory activities into three groups categorized according to skill demands. The chart below provides information about the three groups of cardiorespiratory activities.

	SKILL DEMANDS	CARDIORESPIRATORY ACTIVITIES	TRAINING EFFECT ON CARDIORESPIRATORY FITNESS
Group 1	Require very little skill and provide a constant intensity level.	Jogging, running, walking, cardio equipment	Generally the most ideal for maintenance and improvement of cardiorespiratory fitness.
Group 2	Require more skill than Group 1 activities. The intensity is dependent on the skill of the individual.	Swimming, aerobic dance, cycling on a real bicycle (not a stationary bike), skating, skiing	Can be as effective as Group 1 activities for maintenance and improvement of cardiorespiratory fitness provided that the individual exercising is skilled enough in that activity to maintain the minimum exercise intensity.
Group 3	Incorporates a large variety of skill requirements and intensity levels. Generally more fun than activities in Groups 1 and 2 and are good ways to make cardiorespiratory fitness more enjoyable.	Basketball, soccer, racket sports	Mostly effective for maintenance of cardiorespiratory fitness rather than improvement since there is less control over the intensity levels.

Exercise Prescription for Cardiorespiratory Fitness

Much like a drug prescription for an illness, exercise can be prescribed in varying dosages. The exercise dose, or quantity and intensity of exercise needed for the desired effect, will vary depending on the desired response. The interaction of the variables frequency, intensity, duration and type of activity all determine the dose of exercise. This is called the FITT principle and is used to establish an individualized exercise prescription.

Table 2-1. Cardiorespiratory Fitness Guidelines (ACSM, 2011). The American College of Sports Medicine (ACSM) recommends the following exercise prescription to improve and maintain cardiorespiratory fitness (for apparently healthy adults of all ages).

FITT PRINCIPLE	MODERATE-INTENSITY EXERCISE	VIGOROUS-INTENSITY EXERCISE	COMBINED	WEIGHT LOSS
Frequency: How Often (days per week)	≥ 5×/week	≥ 3×/week	3–5×/week	5–7×/week
Intensity: How Hard (load/resistance)	50–60% HRR, 60–75% MHR	≥ 60% HRR	Moderate or Vigorous	Moderate
Time: How Long (length of training session)	≥ 30 min/day	≥ 20 min/day	≥ 20 min/day	50–60 min/day
Type: Aerobic or Anaerobic Exercise	Aerobic	Aerobic	Aerobic	Aerobic
Volume: Accumulated Total of Activity	≥ 150 min/week	≥ 75 min/week	≥ 75 min/week	300 min/week

- Intermittent activities in 10-minute sessions have the same health benefits as continuous activities (but not necessarily the same fitness benefits).
- Adults engaging in competitive sports or activities with higher fitness demands can benefit from more advanced training than the ACSM exercise prescription for cardiorespiratory fitness.

Aerobic and Anaerobic Activities Defined

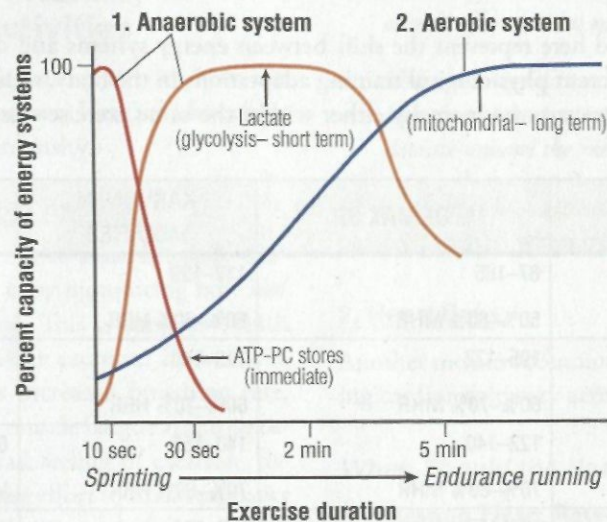
Aerobic Activities: Use large muscle groups in a rhythmic, continuous manner, keeping heart rate consistently elevated for an extended period of time. The intensity allows the body to supply enough oxygen for the activity to continue for long periods. Jogging, lap swimming, fitness walking.

Anaerobic Activities: Explosive, start-and-stop activities in which the heart rate fluctuates. Intensity is so great that the body is unable to deliver the oxygen that is demanded of the activity for it to continue for long periods. Weight training, sprinting activities, most sports.

Aerobic and Anaerobic Energy Systems Defined

The body needs energy to perform physical activities. The energy is supplied to the body through one of three energy systems, which are either aerobic or anaerobic:

1. Anaerobic system—ATP-PC
2. Anaerobic system—Lactate/Glycolysis
3. Aerobic system



With an overlap of energy systems, the anaerobic system provides the working muscles with ATP from ATP-PC stores and the lactate or glycolysis path. The aerobic system provides ATP from mitochondria which require oxygen to burn carbohydrates and fats.

The shift between energy systems depends on the intensity and the duration of an activity. Short, intense bursts of exercise rely mainly on the anaerobic systems while lower intensity longer durations of exercise use mostly the aerobic system.

The three substrates of stored carbohydrates (glycogen), fat, and protein (breakdown of muscle tissue) contribute varying percentages during different intensities of these three energy systems:

Energy Substrate	At Rest	Light- to Moderate-Intensity Exercise	High-Intensity Endurance Exercise	High-Intensity Sprint-Type Exercise
Protein	2-5%	2-5%	5-8%	2%
Carbohydrate	35%	40%	70%	95%
Fat	60%	55%	15%	3%

Note: For fat loss, Calories burned is the key—not the energy substrate used; otherwise, “At Rest” would seem to be the best intensity to lose fat, which is not true. The highest Calorie burn for the same duration would be high-intensity sprint-type exercise, which burns the least fat.

Training Zones

The Training Zones designated here represent the shift between energy systems and different intensities. Different training intensities lead to different physiological training adaptations in the body, so to improve overall cardiorespiratory fitness, it is important to vary the intensity either within the same exercise session or for different workouts during the week:

	% OF MAX HR	KARVONEN MODIFIED	VO2 MAX	RPE SCALE
Zone 1 (Recovery, aerobic)	87–105 50%–60% MHR	117–129 50%–60% HRR		2–4
Zone 2 (Endurance, aerobic)	105–122 60%–70% MHR	129–140 60%–70% HRR		4–5
Zone 3 (Stamina, aerobic)	122–140 70%–80% MHR	140–152 70%–80% HRR	60–65% VO2 max	5–7
Zone 4 (Economy, anaerobic)	140–157 80%–90% MHR	152–163 80%–90% HRR	80% VO2 max	7–9
Zone 5 (Speed, anaerobic)	157–175 90%–100% MHR	163–175 90%–100% HRR	100% VO2 max	9–10
Max HR	175	175	>100%	10

Zone 1: Comfortable and easy, warm-up

Zone 2: Challenging but comfortable

Zone 3: Aerobic zone, challenging and uncomfortable

Zone 4: Anaerobic Threshold Zone, breathless—not maximum—but winded

Zone 5: Redline Zone, used mostly during interval training

Methods to Assess Intensity of Cardiorespiratory Activities

While engaging in a cardiorespiratory activity, how can intensity be assessed by the exerciser? Here are a few common methods used to assess intensity.

1. RPE—Rating of Perceived Exertion

A simple method for an exerciser to assess intensity during cardiorespiratory activity is by monitoring how his/her body feels during exercise. This is subjective with the exerciser “perceiving” his/her exertion. By focusing on bodily sensations such as increased breathing rate, increased heart rate, sweating, muscle fatigue and appraising these together as an overall feeling of exertion, the exerciser can increase or decrease effort to adjust intensity of the activity. The Borg Scale (Borg, 1982) and RPE Scale (Modified Borg RPE) provides more guidance to assess intensity. These scales have been validated against measures of heart rate.

Some findings from studies on the RPE Scale are as follows:

- Men tend to underestimate initially until more familiar with the scale.
- Women tend to overestimate initially until more familiar with the scale.

BORG SCALE 6–20	RPE SCALE 0–10 MODIFIED BORG SCALE
6	0 Nothing at all
7 Very, very light	0.5 Very, very weak
8	1 Very weak
9 Very light	2 Weak
10	3 Moderate
11 Fairly light	4 Somewhat strong
12	5 Strong
13 Somewhat hard	6
14	7 Very strong
15 Hard	8
16	9
17 Very hard	10 Very, very strong
18	*Maximal
19 Very, very hard	
20	

- *Athletes often misinterpret the scale by not focusing on overall effort but on muscle fatigue.*
- *There is a significant learning curve for the exerciser, but after becoming more familiar with the scale, values deviate toward the mean.*

RPE is useful when heart rate cannot be measured accurately, such as when medications affect heart rate.

2. Heart Rate

Another measure commonly used to assess intensity during cardiorespiratory activity is monitoring heart rate.

When Should the Heart Rate Count be Taken?

- **Resting Heart Rate**—A “true” resting heart rate is taken in the morning before rising from bed. The count should be for a full minute. After rising, the heart rate will increase possibly 10–20 beats per minute. If awakened by an alarm clock, the count can still be taken after resting quietly for several minutes.
- Fluctuations in heart rate may be due to: lack of sleep, medications, emotional stress, hydration level, food intake, caffeine, illness, environmental temperature, or humidity.
- **Exercise Heart Rate**—Most exercisers take a heart rate immediately post-exercise, but there are reasons to take the heart rate at other times: pre-exercise, during exercise, immediately post-exercise, and within a few minutes post-exercise.
 1. Pre-exercise—This count provides a relative base to compare the exercise heart rate. An unusually high pre-exercise heart rate may be due to one of the factors listed above for “fluctuations.”
 2. During exercise—The heart rate will plateau (rise during the warm-up and stay consistent through the aerobic phase, then drop during the cooldown); therefore, if the intensity remains the same, it will not matter when during the aerobic phase of the workout that the heart rate is measured.

3. Immediately post-exercise—The post-exercise heart rate will be consistent with the aerobic phase heart rate, right before starting the cooldown. The heart rate needs to be measured within 15 seconds of reducing the activity level. After this, the heart rate will slow down (due to decreased activity and decreased need for oxygenated blood to the working muscles), entering a recovery phase.
4. A few minutes post-exercise—This recovery heart rate can be an indicator of fitness level. The more fit individual will have a faster recovery in returning to the pre-exercise heart rate.

How Many Seconds Should the Heart Rate Count Be?

- **Resting Heart Rate**—60 seconds
- **Exercise Heart Rate**—10 seconds preferred (x 6 = beats per minute). Within 15 seconds of reducing the intensity of exercise, the heart rate will begin to slow down; therefore, a longer count would be inaccurate due to the heart rate lowering. (Note: Some people prefer a 6-second count, because the exerciser only needs to add a "zero" to the count to have the beats per minute count. This is fine, but the concern is that if a beat or two is missed, it is then magnified by ten. For example, a 6-second heart rate count of 12 = 120 beats per minute. If one beat was missed, it actually should be 13 = 130 bpm or two missed beats, 14 = 140 bpm. This is a significant difference.)

What Is a "Good" Resting Heart Rate?

Resting heart rate will vary greatly among individuals and is primarily dependent upon age and fitness level. Check **Table 2-2** for resting heart rate norms:

Table 2-2. YMCA Norms for Resting Heart Rate (beats/min)

AGE (YEAR)	18-25		26-35		36-45		46-55	
	GENDER		GENDER		GENDER		GENDER	
Excellent	49-55	54-60	49-54	54-59	50-56	54-59	50-57	54-60
Good	57-61	61-65	57-61	60-64	60-62	62-64	59-63	61-65
Above Average	63-65	66-69	62-65	66-68	64-66	66-69	64-67	66-69
Average	67-69	70-73	66-70	69-71	68-70	70-72	68-71	70-73
Below Average	71-73	74-78	72-74	72-76	73-76	74-78	73-76	74-77
Poor	76-81	80-84	77-81	78-82	77-82	79-82	79-83	78-84
Very Poor	84-95	86-100	84-94	84-94	86-96	84-92	85-97	85-96

Adapted from: YMCA. *Y's way to fitness*. (3rd.Ed.) as printed in Nieman (1995). Reprinted with permission from the YMCA of the USA.

For Target Heart Rate Zone calculation, see Karvonen Formula (Appendix 2.1).
For a simple prediction of maximum heart rate, here are some calculations. (Note: These are just a few of the many different predictive equations.)

1. $MHR = 220 - \text{age}$
2. Men: $MHR = 214 - (0.8 \times \text{age})$ Women: $MHR = 209 - (0.9 \times \text{age})$ Multiply by intensity %
3. Men: $MHR = 214 - \text{age}$ Women: $MHR = 209 - \text{age}$ Multiply by intensity %

How To Assess Heart Rates

An exerciser can count his/her pulse by using the index and middle fingers of one hand (the thumb has its own pulse and should not be used) at an artery site. The most common sites for assessing pulse where arteries lie close to the surface of the skin are the radial artery (found on the wrist, thumb-side) and the carotid (found in the groove on the neck to the side of the larynx). The fingers should be pressed lightly at the carotid artery because pressing too hard may shut off some of the blood supply to the brain causing light-headedness. Another concern is that the carotid artery has baroreceptors that will signal the brain to slow the heart rate if the fingers press too firmly and this could also result in the exerciser becoming light-headed or even losing consciousness.

Monitors

There are many varieties of heart rate monitors, wrist bands, and sport watches that can provide real-time heart rate readings. A common design has electrodes detecting the heart beat and transmitting the signal to a wristwatch for the exerciser to view. A more recent design has LED technology detecting blood flow and transmitting this information to a wrist band that interprets the heart rate. Many of these monitors have additional features such as stopwatch functions, setting of target heart rate zones, recording splits, GPS, and connectivity for online analysis and graphs of activity and heart rates over time.

3. VO₂ max

VO₂ max or volume of maximal oxygen consumption is the gold standard when assessing cardiorespiratory fitness. VO₂ max is determined by the cardiac output (the maximal amount of blood the heart pumps per minute) and the arterial-venous oxygen difference (the amount of oxygen utilized by the exercising muscles). As exercise intensity increases, the volume of both oxygen consumed and carbon dioxide exhaled also increase. With VO₂ there is a maximum level of oxygen consumption the exerciser will reach and not exceed even with increased exercise intensity. Since VO₂ max is the measure of the body's ability to use oxygen to generate energy, training zones for the exerciser can be based on this measure.

Submaximal Tests

There are simpler ways than a stress test to approximate VO₂ max. Submaximal testing generally uses a treadmill or bike protocol in which heart rate response can be determined by one or more workloads during the test and then VO₂ max can be predicted. The accuracy of the VO₂ max prediction can be affected by factors affecting the exerciser's heart rate (anxiety, caffeine, medication), by the ability of the exerciser to maintain the testing pace, by the mechanical efficiency of the exerciser with the testing activity, and due to variation of maximal heart rates at given ages.

Other submaximal testing involves measuring performance (Rockport Walk Test, Step Test, Balke Test) of a specific distance, acquiring the performance time and exercise heart rates, then using known correlations to predict VO₂ max. For running, there is the Balke Test which predicts VO₂ max accurate to within $\pm 5\%$. The Balke Test involves having the exerciser run around a track for exactly 15 minutes. The aim is to cover the most distance possible, with advice to hold back on the pace for the first five minutes, to run hard for the next five minutes, and to go all out for the last five minutes. The total distance covered in 15 minutes is then converted into VO₂ max by using the following formula:

$$\text{VO}_2 \text{ max} = (\text{meters run} \times 0.0115) + 10.4$$

An individual's VO₂ max is to a large extent determined by genetic factors, but it can be increased by training. General increases for VO₂ max can be between 5% and 20% with even 60% increase being reported. For a small portion of individuals, training seems to make little difference in VO₂ max.

Stress Tests

The most accurate method to assess cardiorespiratory fitness is to conduct a maximal stress test in a laboratory with a protocol usually for a treadmill or stationary bike. VO₂ max is measured with the exerciser completing the test to exhaustion or some designated endpoint. This requires trained personnel to properly monitor the test (sometimes a physician if concerns for cardiac arrest; also ECG electrodes placed on the exerciser's chest to monitor heart rate) and requires expensive equipment

for gas exchange analysis. The exerciser breathes through a mouthpiece with inhalations and exhalations being captured. The amount of carbon dioxide exhaled at maximum energy output provides a measure of how much oxygen the exerciser is burning, thus converting into energy = $\text{VO}_2 \text{ max}$. Also, the heart rate values from the ECG readings in the stress test matched to rating of perceived exertion (RPE) provide valuable information about the cardiorespiratory fitness of the exerciser.

4. Pace

To assess cardiorespiratory fitness for many activities (running, swimming, walking), pace is a good measure of effort and thus intensity. Due to GPS watches and having known distances, the calculation of time for a given distance allows goals to be set to attain certain paces.

Intensity Threshold

Is there a threshold intensity of exercise to improve cardiorespiratory fitness? In many studies there is evidence of a minimum threshold of intensity for benefit, but not in all studies. The overload principle of training states that below a minimum intensity or threshold, the body will not be challenged sufficiently to result in increased $\text{VO}_2 \text{ max}$ or other physiological adaptations. The lack of consistent findings in these studies for a threshold may be related to the varying initial fitness levels of the subjects and the precise training regimens. For example, well-trained athletes were found to need near maximal (95–100% $\text{VO}_2 \text{ max}$) training intensities to improve, whereas moderately trained athletes improved $\text{VO}_2 \text{ max}$ at training intensities of 70–80% $\text{VO}_2 \text{ max}$. Because of varying fitness levels and individual response variability to training, prescriptions for intensity may need to be monitored and adjusted.

Performance Criteria for Cardiorespiratory Fitness Activities

A combination of factors determines an individual's performance in cardiorespiratory activities:

$$\begin{array}{l} \text{Efficiency of lungs,} \\ \text{heart, and blood in} \\ \text{delivering oxygen} \\ \text{through the body} \\ \text{(VO}_2 \text{ max)} \end{array} \times \begin{array}{l} \text{Efficiency of muscles} \\ \text{translating oxygen} \\ \text{and fuel into energy} \\ \text{(Lactate threshold)} \end{array} \times \begin{array}{l} \text{Efficiency of body} \\ \text{in translating} \\ \text{movement into} \\ \text{speed (Economy)} \end{array} = \text{Performance}$$

Training for Cardiorespiratory Fitness

Precautions for Participation in a Cardiorespiratory Fitness Program

Although participation is beneficial to almost everyone, physical limitations need to be identified first. Individuals over age 35 should complete a physical examination and receive clearance from their physician before participating

in a fitness program, regardless of health status. Individuals having any medical problems should also complete a physical examination and receive clearance from their physician, regardless of age. Over-training should be avoided by progressing slowly and allowing the body time to recover between exercise sessions. It is important to cease exercising if pain is persistent. Terminate the exercise session and consult a physician if experiencing chest pain, dizziness, shortness of breath, or nausea.

Components of a Cardiorespiratory Exercise Session

Below are three basic components of a cardiorespiratory exercise session. They include warm-up, conditioning stimulus, and cooldown.

COMPONENTS	DURATION	CRITERIA
Warm-Up	5–15 minutes Depends upon the age and fitness level of the exerciser (older individuals and those with increased risk of irregular heart events benefit from longer warm-up and cooldown periods).	The warm-up represents a period of metabolic and cardiovascular adjustment from rest to exercise. The most appropriate activities for the warm-up are those that are similar to the conditioning stimulus, performed at 50% of the stimulus intensity
Conditioning Stimulus	Duration depends on training goals	FITT Principle
Cooldown	Depends upon the age and fitness level of the exerciser (older individuals and those with increased risk of irregular heart events benefit from longer warm-up and cooldown periods).	The cooldown represents a period of metabolic and cardiovascular adjustment from exercise to rest. To increase flexibility, stretching activities may be appropriate during the cooldown.

Training Log

Maintaining a training log has many benefits and allows for personal reflection. Many serious exercisers report that they maintain some kind of training log or activity record. Recordings can be maintained via a calendar, chart, log, a diary format, and with online applications. A training log allows an individual to set goals and monitor progress. The log can be a source of motivation and can provide discipline for the exerciser. The log can enhance awareness of physical capabilities and physiological and psychological changes. A training log can also provide an early warning of overtraining, which can lead to overuse injuries.

Training Variations

The benefits of cardiorespiratory fitness have been identified throughout this chapter. It is important to maintain some variety in your workouts if you wish to elevate your fitness level, prepare to race, or simply avoid the boredom of the same old routine. Ideally, a training schedule will alternate hard and easy days rather than consist of a gradual linear progression. When we think of aerobic exercise we often think of the most used methods of running, walking, cycling, or swimming. However, there are other methods of aerobic activity, which include aerobic and water aerobic classes. All of these activities use the large muscle groups in a rhythmic and continuous manner to keep the heart rate elevated for an extended period of time. Here are “The Big Six” types of training that can help you add some variety to your cardiorespiratory sessions. Specific examples are given for those relevant to your type of activity.

1. Fartlek Training

Fartlek is a Swedish term for “speed play.” This “speed play” is just how it sounds—play! The exerciser has complete freedom to structure the workout how he/she chooses. Many runners have “lost” the watch for a day, gone out for a 4–5 mile loop, and gotten involved in speed play by doing pick-ups from one light pole to the next with jog recovery between repetitions. The distance traveled or time involved on the hard phase doesn’t always have to be of concern. Although unstructured sessions can allow the exerciser to think and be creative, some may choose to have a well-thought-out fartlek session prior to beginning.

Fartlek training helps to train specific muscle groups and the lungs for a variety of paces.

Here are some examples of a fartlek session for different activities. Remember, “speed play” requires that you maintain the creativity so it is truly “play”:

25 Minute Fartlek Run

3 minute jog followed by 4 minute up-tempo pace; then 4 minute jog recovery, 3 minute up-tempo pace; then 3 minute jog recovery, 2 minute up-tempo pace followed by 2 minute recovery, 1 minute fast pace followed by 1 minute jog recovery; 2–3 minute jog cooldown

Fartlek Swim

Following an adequate warm-up session, swimmer will do a 30 minute continuous swim with frequent

pace changes; 25 yd easy followed by 25 yd fast swim followed by 25 yd easy; 25 yd sprints could be mixed in but be careful to keep moving during those active recovery phases otherwise it may become an interval session.

2. Interval Training

These are the most structured of all workouts. Intervals involve repetition training that alternates intense segments ranging from 30 seconds to 5 minutes followed by a recovery period. The following are all positive physiological benefits seen from interval training.

- Improves VO₂ max.
- Helps improve speed.
- Helps improve overall conditioning.
- Helps your body, legs, lungs, and heart adapt to higher demands being placed on them.
- Faster pace is good final race preparation.

Examples for swimmers

Self-paced Intervals (used in early program training; consist of short distances, easy paces, and liberal recovery times selected by the swimmer):

- *Swim 50-yd repeats at choice pace; recover until ready for next interval*

Strict Intervals (used when intensity of workouts need to be increased; distances remain relatively short, paces become moderate to fast, and recovery times are determined by the pace clock):

- *Swim 25-yd repeats with a "go time" of :40 (swim time and recovery are included in the :40; each :40 results in a new repeat)*

Examples for runners

- *6 × 800 meter repeats at 3:00 pace with equal recovery between each interval*
- *3 × 1 mile repeats at 5k race pace with a predetermined amount of recovery between each interval*

Example for cyclists

- *10 × 2 minute fast rides with 2 minute recovery between each*

Example for fitness walkers

- *5 × 30 seconds hard followed by 30 seconds easy; or 5 × 100 m hard/50 m easy*

3. Tempo Work (Runs, Walks, Swims, Rides)

Tempo work is another method used to add intensity to your workout. Tempo could be used as another word for pace. Tempo runs should be faster than your usual training pace. Tempo work is done at a steady intensity close to race pace. These workouts should be tough but not impossible. Tempo work is also known as lactate threshold pace. **Lactate threshold** is the point during exercise at which muscle lactate concentrations increase abruptly. By exercising at nearly race pace your body begins to adapt to exercising at its upper limit. Here are some examples of tempo work for different activities:

- *For runners: 5 mile run (time-trial) at 10k race pace; or 85–90% of maximum HR*
- *For swimmers: 450 yd time trial swim at high aerobic intensity; 85–90% of max HR*
- *For walkers: 2 mile time trial walk at high aerobic intensity; 85–90% of max HR*
- *For cyclists: 12 mile time trial ride at high aerobic intensity; 85–90% of max HR*

4. Hill Work (Resistance)

Hill work or resistance training is another means to add intensity and variety to your training program. Obviously hill work can be done with runners, walkers, and cyclists but is tough to arrange for swimmers.

Here are some benefits for runners, walkers, and cyclists:

- Builds leg strength.
- Makes you better at climbing those hills during race time.
- Enhances speed by building fast twitch muscle fibers.
- Increases both frequency and length of your stride.

- Strengthens the muscles around the knees helping reduce knee injuries.

Example for runners

- *5 × 200 meter hill climbs; 4 × 100 meter fast strides (flat surface) after completion; jog recovery; 5 × 200 meter downhill runs; 4 × 100 meter fast strides (flat surface) following downhills; jog recovery*

Example for cyclists

- *1 hour ride along hilly terrain; or if riding indoors increase resistance and ride at a slower cadence (70 RPM)*

Example for fitness walkers

- *4 × uphill/downhill = 5 minutes; could also use bleachers, stairs, or any incline that is substantial distance*

Example for swimmers

- *Intervals (repetitions) using paddles; 5 × 100 yd pulls using paddles and buoys to create resistance*

5. High-Intensity Interval Training (HIIT)

High-intensity interval training (HIIT) is another popular type of workout that can improve cardiorespiratory fitness. HIIT is an intense form of exercise where high-intensity (80% to 95% of your maximum heart rate) exercises are performed for 5 seconds to 8 minutes followed by a recovery period of the same period of time at 40% to 50% of the maximum heart rate. The workout can last from 20 to 60 minutes. HIIT improves all aspects of cardiorespiratory fitness and may improve muscular fitness. HIIT can be modified for all fitness levels and special conditions. It can include a variety of modalities such as cycling, swimming, walking, elliptical, and others. The benefit of HIIT is it provides the benefits of a continuous endurance workout in a short amount of time. Because HIIT workouts contain more vigorous moments than the traditional endurance workouts, the excess post-exercise oxygen consumption (EPOC) is greater. EPOC is the time taken for the body to return to its pre-exercise levels. This means the energy expenditure during a HIIT workout could be 6–15% greater than a traditional steady-state endurance workout. Because HIIT workouts are intense, longer recovery periods are needed.

6. Long Slow Distance (LSD)

Long distance work does not add intensity to the workout in the same way that the previously mentioned training methods do, but this type of training is essential to the endurance athlete who is looking to build an aerobic fitness base. These longer training sessions help build and maintain stamina. Longer runs (training sessions) also promote cellular adaptations, which improve the cardiovascular system, spare glycogen, and enhance the use of fat as fuel. This type of training could be called “conversational” because you are able to carry on a conversation with others around you in your training group. These longer sessions are done at 60–75% of your maximum HR.

Long is relative to where you are currently in your training program. As a rule of thumb it is a good idea to never exceed 150% of your regular mid-week mileage/yardage. These longer sessions are done once every week, and for some beginning exercisers it is recommended that the LSD be done once every other week. Typically the LSD training day would fit in best on a weekend morning. However, you can make it fit within your training and racing schedule. Remember, these are aerobic sessions, nothing hard!!

Example run

- *1 hour moderate run at easy but steady pace; 70% of max HR*

Example walk

- *1 hour walk at easy pace; 70% of max HR*

Example swim

- *30–45 minute swim at aerobic pace; 70% of max HR*

7. Easy Day

The easy day is the often overlooked (and sometimes neglected) day that each exerciser needs. It is nearly impossible to go hard every day, and doing so can increase the risk of injury and/or burn-out. Sometimes recovery can be the missing piece to a good training program. Recovery days help the body prepare for harder days. A day off is necessary at times. Two to three days per week would be ideal for easy aerobic activity at a steady pace. These are the easiest training days of the week, but that doesn't mean that they are unimportant. Alternate activities can

provide aerobic training benefits while allowing a specific muscle group to recover from the previous workouts. An example would be for a runner to swim on a cross-training day, or for a swimmer to cycle on a cross-training day.

Cardiovascular Exercise Prescription

Intensity of Exercise

1. Estimate your own maximal heart rate (MHR)

$$\text{MHR} = 220 \text{ minus age } (220 - \text{age})$$

$$\text{MHR} = 220 - \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ bpm}$$

2. Resting Heart Rate (RHR) = $\underline{\hspace{2cm}}$ bpm

3. Heart Rate Reserve (HRR) = $\text{MHR} - \text{RHR}$

$$\text{HRR} = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ beats}$$

4. Training Intensities (TI) = $\text{HRR} \times \text{TI} + \text{RHR}$

$$60\% \text{ TI} = \underline{\hspace{2cm}} \times .60 + \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ bpm}$$

$$70\% \text{ TI} = \underline{\hspace{2cm}} \times .70 + \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ bpm}$$

$$85\% \text{ TI} = \underline{\hspace{2cm}} \times .85 + \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ bpm}$$

5. Cardiovascular Training Zone: The optimum cardiovascular training zone is found between the 70 and 85 percent training intensities. However, individuals who have been physically inactive or are in the poor or fair cardiovascular fitness categories should use a 40–50% training intensity during the first few weeks of the exercise program.

Cardiovascular Training Zone: $\underline{\hspace{2cm}}$ (70% TI)
to $\underline{\hspace{2cm}}$ (85% TI)

Rate of Progression

The recommended rate of progression in an exercise conditioning program depends on the functional capacity, medical health status, age, individual activity preferences and goals, and an individual's tolerance to the current level of training. For apparently healthy adults, the endurance aspect of the exercise prescription has three stages of

progression: initial, improvement, and maintenance. Exercise professionals should recognize that recent physical activity recommendations from the ACSM/CDC and the Surgeon General include 30 minutes of moderate physical activity on most, if not all, days of the week. While some apparently healthy but sedentary individuals may not be able to attain this initial level of activity, they should be encouraged to progress to this goal during the first few weeks of the training program.

ACSM Cardiorespiratory Training Guidelines

1. Three basic components to any exercise conditioning session are warm-up, conditioning stimulus, and cooldown
2. Warm-up and cooldown performed at approximately 50% of stimulus intensity (hold conversation without much difficulty)
3. Warm-up and cooldown may take 5–15 minutes, depending on age & fitness level
4. Accumulate 30 minutes or more of moderate-intensity physical activity on most days of the week (intermittent activities have same health benefits as continuous activities)
5. Frequency: 3–5 days a week
6. Intensity: 50–85% of heart rate maximum ($220 - \text{age} \times .50 \text{ to } .85$) or 60–80% heart rate reserve ($220 - \text{age} - \text{resting heart rate} \times .60 \text{ to } .80 + \text{resting heart rate}$)
7. Time: 20–60 or more minutes per session, continuous or intermittent activity
8. Type: Aerobic (run, brisk walk, swim, cross-country ski, dance, elliptical trainer) Ask fitness expert how to operate equipment with which you are unfamiliar and follow all safety procedures for each activity
9. Enjoyment: preferably enjoyable aerobic activities
10. Three stages of Cardiorespiratory training: Initial, Improvement, Maintenance (See Cardiorespiratory Fitness Prescription Outline)
11. Progression of both intensity and duration in a single session is not recommended. Increase the duration first before increasing the intensity. If you

can complete an exercise session at the upper level of frequency and duration for 2 weeks without signs of excessive fatigue, progress to the next level

12. If training is discontinued, gains in fitness regress by approximately 50% within 4–12 weeks
13. For weight management, frequent, enjoyable exercise periods of low to moderate intensity and relatively long duration result in the largest weekly caloric expenditures
14. Stay within your heart rate range. Monitor through a heart rate monitor or manually (carotid artery on neck or radial artery on thumb side of wrist)

Summary Questions

1. What are some health benefits to improved cardiorespiratory fitness?
2. Explain the FITT Principle. What are the ACSM Guidelines for FITT with moderate-intensity exercise?
3. What are four common methods to assess intensity of cardiorespiratory activities?
4. What are the basic components of a cardiorespiratory exercise session?
5. Name and explain two of “The Big Six” types of training presented within Training Variations.

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Useful Websites

- <http://acsm.org/>
American College of Sports Medicine
- <http://www.cooperaerobics.com>
Cooper Aerobics Center
- <http://www.heart.org>
American Heart Association
- <http://www.strokeassociation.org/>
American Stroke Association
- <http://www.fitness.gov/>
The President's Council on Physical Fitness & Sports
- <http://www.cdc.gov/physicalactivity>
Center for Disease Control Physical Fitness Intensity Guidelines
- <https://www.verywellhealth.com/heart-rate-zones-5214548>

Appendix 2.1 Determining Your Target Heart Rate Zone for Exercise

Determining the appropriate target heart rate (THR) for exercise depends on an exerciser's resting heart rate, age, gender, and fitness level. The Karvonen Formula is preferred over the Maximum Heart Rate formula because it takes into account resting heart rate and gender. Rather than focus on a precise target heart rate (i.e., 140), a zone is calculated (i.e., 136–150). The purpose for achieving and staying within the THR zone is to maintain the appropriate intensity required for improvement of the cardiorespiratory system.

Here is the **Karvonen Formula** calculated for a **20-year-old male, Beginner Fitness Level**, with a **Resting Heart Rate of 68 beats per minute**. Use the second chart below to calculate your Target Heart Rate Zone.

Estimated Maximum Heart Rate (MHR):	MHR	220				MHR
Men = 220	Age -	20				minus age
Women = 226 ¹	PMHR =	200				equals predicted maximum heart rate
Predicted Maximum Heart Rate (PMHR)	RHR -	68				minus resting heart rate
(Age Adjusted)	HRR =	132	132			equals heart rate reserve
Resting Heart Rate (RHR)	Intensity ×	.60	.70	.80	.90	times intensity
Fitness Level:	=	79.2	92.4			equals
Beginner 60–70%	RHR +	68	68			plus resting heart rate
Intermediate 70–80%	=	147.2	160.4			equals
Advanced 80–90%	At 10 seconds +	6	6	6	6	60+6=10 seconds
Target Heart Rate Zone:	Target Heart Rate =	24.5	26.7			beats per 10 seconds
(in this example of a beginner		60%	70%	80%	90%	
= 25–27 beats per 10 seconds)						

NOTE:

For Swimming, MHR=205. This is due to: non-weight bearing activity, horizontal body position, and cooling effect of the water.

¹ Women's hearts are smaller than men's and beat more times per minute.

Use this chart to calculate your Target Heart Rate Zone.

Estimated Maximum Heart Rate (MHR):	MHR					MHR
Men = 220	Age -					minus age
Women = 226 ¹	PMHR =					equals predicted maximum heart rate
Predicted Maximum Heart Rate (PMHR)	RHR -					minus resting heart rate
Resting Heart Rate (RHR)	HRR =					equals heart rate reserve
Fitness Level:	Intensity ×	.60	.70	.80	.90	times intensity
Beginner 60–70%	=					equals
Intermediate 70–80%	RHR +					plus resting heart rate
Advanced 80–90%	=					equals
Target Heart Rate Zone:	At 10 seconds +	6	6	6	6	60+6=10 seconds
_____ to _____ beats per 10 seconds	Target Heart Rate =					beats per 10 seconds
or		60%	70%	80%	90%	
_____ to _____ beats per 60 seconds						

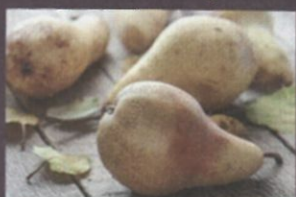
¹ Women's hearts are smaller than men's and beat more times per minute.

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chapter 3



Muscular Strength and Muscular Endurance

by Renee Harrington, Ph.D., Marcus Thompson, Ed.D., and Jerry W. Loflin, Ph.D.

A common question is “who can benefit from resistance training?” As all body movement is the result of muscle contractions, it can safely be argued that most everyone can benefit (U.S. Department of Health and Human Services [HHS], 2018). Stronger muscles are able to function more efficiently and will make all movements easier to perform (Brown, 2017). Although the appropriate level of muscular strength and endurance will vary between individuals depending on their occupational demands and leisure time activities, everyone should develop and maintain a healthy level of muscular strength and endurance throughout their life (HHS, 2018).

This chapter presents basic information regarding the development and maintenance of muscular strength and endurance. The benefits of these components of fitness are reviewed, a simplified overview of the neuromuscular system and how it functions is presented, basic guidelines are discussed with important terms defined, and finally, descriptions of resistance training methods and example exercises are provided.

3

Chapter Three

Benefits of Resistance Training

The benefits of resistance training are widely recognized by the health and medical communities (HHS, 2018; Westcott, 2012) and resistance training has become one of the most prescribed forms of exercise. Listed below are some of the potential benefits of resistance training:

- Improvement or maintenance of muscular strength, endurance, and power
- Improvement or maintenance of bone density
- Increase in the strength of connective tissue (tendons and ligaments)
- Increase in, or maintenance of, lean muscle mass resulting in the potential for improved body composition and helps maintain resting metabolism as we age
- Improvement or maintenance of mobility
- Improved posture
- Enhanced self-image
- Provides a healthy outlet for stress management

With regards to lean muscle tissue, the old adage “use it or lose it” is certainly applicable. Our bodies are adaptable and will lose their muscular strength and endurance if not subjected to a regular form of overload (Haff & Triplett, 2016). As few people have occupations or engage in leisure time pursuits that are physically demanding, it is important to incorporate resistance training into a complete exercise program.

The Anatomy and Physiology of Movement

The science of human movement is complex and requires a strong understanding of biology, anatomy and physiology, biomechanics, and physics. Due to the intended audience of this chapter, a basic introduction to the anatomy and physiology of human movement is provided.

All human motion is the result of muscle contraction, and with exercise, the functional capacity of muscles can be improved (Brown, 2017). For a muscle to contract, two things are required—energy in the form of adenosine triphosphate (ATP) and a stimulus from the central nervous system.

Muscle contractions are complex processes initiated from the central nervous system in the form of an electrical stimulus. Due to their structure and the interaction of various chemical processes, muscle tissue has the unique ability to contract. A cross-sectional view of a skeletal muscle reveals it is composed of thousands of individual muscle cells or fibers. Within each fiber are smaller thread-like strands called myofibrils containing protein filaments (actin and myosin). Actin and myosin enable muscle fibers to contract. Movement occurs when the actin and myosin filaments slide past each other, shortening the fibers. Muscle fibers are grouped into bundles called fasciculi (muscle fiber bundles). Each individual fiber, fasciculi, and muscle are encased in layers of connective tissue (fascia). These layers of connective tissue ultimately tie into the tendons attached to the bones of the skeletal system. Acting as a harness, the force generated in the muscle is transmitted via this connective tissue/tendon to the bone, resulting in movement. The arrangement of the fasciculi determines a muscle's shape and is involved in its ability to generate force.

Each of the thousands of fibers in a muscle is stimulated by a nerve known as a motor neuron. These motor neurons and the muscle fibers they activate are called motor units. The force of a muscle contraction depends in large part on how many fibers are in a motor unit and how many motor units are recruited. This selective recruitment gives us the control necessary to produce movements requiring gradations of force, from the delicate and accurate to the large and powerful. Due to a natural level of inhibition, humans are unable, except perhaps in moments of extreme emotion, to recruit all the available motor units (a built-in safety feature). With exercise, however, humans learn to recruit more motor units. Early strength gains (the first 4 to 6 weeks of resistance training) experienced before muscle tissue has hypertrophied is mostly the result of the nervous system learning to recruit more motor units.

Muscle fibers (or more accurately motor units) are often classified according to their speed of contraction. Over-simplifying, the skeletal muscles' fibers can be classified as either fast twitch or slow twitch. Although all muscles have a mixture of slow- and fast-twitch fibers, typically close to 50 percent of each, all of the fibers in a motor unit are of the same type. Research has shown heredity

largely determines the ratio of fast- and slow-twitch muscle fibers (Hesson, 2012). Due to their inherent qualities, fast-twitch fibers have a greater capacity for anaerobic work (fast and intense) and slow-twitch fibers have a greater capacity for aerobic work (endurance). Thus, for endurance activities (e.g., long distance running), slow-twitch fibers are recruited, and for explosive power movements (e.g., sprinting), fast-twitch fibers are recruited. With training, both slow- and fast-twitch fibers can take on some of the characteristics of the other fiber type, but conversion from one fiber type to the other does not seem to occur (at least not to any appreciable level). Of special interest to the resistance trainer is the fact the body recruits muscle fibers in a set sequence, with slow fibers always the first to be recruited. Resistance training with light resistance will not necessitate recruitment and hence the development of fast-twitch fibers.

Roles of Muscles

Skeletal muscles, which come in a wide variety of shapes, sizes, and fiber compositions, are responsible for every human movement. During a movement in which they are involved, they can function in different roles (Behnke & Plant, 2022). They can act as an:

- **Agonist (prime mover)**—When a muscle is primarily responsible for a movement
Example: the biceps' brachii during elbow flexion such as during a biceps curl
- **Antagonist**—When a muscle produces the opposite action of the agonist (prime mover)
Example: the triceps' brachii during elbow flexion such as during a biceps curl
- **Stabilizer**—When a muscle helps to stabilize the whole body or a particular body part
Example: the erector spinae stabilizes the spine during a biceps curl
- **Synergist**—When a muscle assists the prime mover
Example: the brachioradialis assist elbow flexion such as during a biceps curl

Types of Muscle Contractions

- **Concentric**—A muscle contraction occurring when the muscle exerts a force greater than the resistance and shortens. For example, during a biceps curl when the bar is curled from the straight arm position to the fully flexed position, the biceps are going through a concentric contraction. Resistance trainers often refer to the concentric action as the positive phase of the repetition.
- **Eccentric**—A muscle contraction occurring when the muscle lengthens and exerts less force than the resistance. For example, during the biceps curl exercise as the bar is lowered at a slow, controlled speed from the fully flexed position to the fully extended position, the biceps are going through an eccentric contraction. Resistance trainers often refer to the eccentric action as the negative phase of the repetition. Interestingly, researchers have determined the delayed onset muscle soreness experienced after a workout is largely due to eccentric contractions (Haff & Triplett, 2016).
- **Isometric**—A muscle contraction occurring when the muscle contracts, exerting a force equal to the resistance. Upon equalization, the movement at the joint stops and the muscle neither shortens nor lengthens. Examples include a plank or wall-sit.

Joint Movements

The human body is capable of an infinite variety of movements (Behnke & Plant, 2022). The arrangement of the bones of the skeletal system and how the muscles cross the various types of joints of the body determine the kinds of possible movements. For example, the elbow joint is a hinge joint, allowing for flexion and extension. The biceps and triceps cross the joint on the anterior and posterior side of the joint, respectively, and either flexion or extension will occur when they contract. A ball and socket joint, like the hip, is capable of many more movement patterns (flexion, extension, adduction, abduction, internal rotation, and external rotation). The muscles crossing the hip do so from many angles, and the movement resulting from their contraction is the direct result of how they cross the joint. The fundamental movements are listed and defined below. These movements are defined

from a standardized starting position (standing erect with the feet parallel and close together, with the arms away from the body with the palms facing forward), referred to as the anatomical position. More complex movements are variations and combinations of these fundamental movements.

Major Joint Movements

- **Flexion**—A movement resulting in a decrease of the joint angle. For example, in elbow flexion (e.g., biceps curl) the angle between the forearm and the upper arm is decreased.
- **Extension**—A movement resulting in an increase of the joint angle. In elbow extension (e.g., triceps kickback), the angle between the forearm and the upper arm is increased.
- **Abduction**—A movement away from the midline of the body. Moving the arm away from the body during the start of a jumping jack involves shoulder abduction.
- **Adduction**—A movement toward the midline of the body. Moving the arm toward the side as in the end of a jumping jack exercise involves shoulder adduction.
- **Rotation**—A movement occurring around the vertical axis of the body or around the long axis of a limb. Shaking the head “no” involves rotation of the head. With regard to movement of the limbs (i.e., shoulders and hips), rotation is described as either internal or external rotation. Internal rotation is rotation towards the center of the body. External rotation is rotation away from the center of the body.

Forearm Movements

- **Pronation**—Rotating the forearm so the palm faces either down or backward. Exercisers use a pronated grip when doing the pull-up exercise or reverse biceps curls.
- **Supination**—Rotating the forearm so the palm faces forward or up. Exercisers use a supinated grip when performing a biceps curl.

Scapular Movements

- **Protraction**—During protraction, the scapula move away from the spine and toward the front of your body. Your shoulders should protract when you are reaching forward in space such as when you are reaching for the saltshaker across the dinner table.
- **Retraction**—Retraction is the opposite of protraction. In retraction, your shoulder blades move closer to the spine. This should happen when you are pulling something towards you like when you open a door or reach behind you.
- **Elevation**—In scapular elevation, the whole bone moves directly up (superiorly) toward your ear. You elevate your shoulders when you perform a shrugging motion or when you reach for something on a very high shelf.
- **Depression**—When you depress your scapula, you move the whole bone inferiorly or away from your ear. You depress your shoulder blade when you reach for something down below you.
- **Upward Rotation**—The scapula upwardly rotates when you reach your arm up overhead. During this motion, the inferior angle of the scapula rotates up (superiorly) and to the side (laterally). At the top of your overhead motion, your scapula should be upwardly rotated about 55 degrees.
- **Downward Rotation**—Downward rotation is the opposite of upward rotation. Your scapulae downwardly rotate when you bring your arms down from an overhead position or when you go to reach your hand into your back pocket. During this motion, the inferior angle of the scapula moves closer to the spine.

Ankle Joint Movements

- **Dorsiflexion**—Dorsiflexion occurs at the ankle joint when the toes are moved toward the shin.
- **Plantar flexion**—Plantar flexion occurs at the ankle joint when the toes are moved away from the shin (pointing the toes). Performing the heel raise exercise involves plantar flexion when transitioning to the balls of the foot.

Common Resistance Training Terminology

- **Atrophy**—A loss of muscle and nerve tissue associated with disuse. All lean muscle mass is subject to atrophy.
- **Hypertrophy**—An increase or growth in muscle mass associated with exercise. Hypertrophy is controlled to some degree by the hormone testosterone, so biological males generally see a greater amount of hypertrophy compared to biological females with the same level of training.
- **Muscular Strength**—The maximum amount of force generated by a muscle or group of muscles during a single repetition. Muscular strength is dependent upon many factors, including muscle size, muscle attachments, fiber type, and motor unit recruitment.
- **Muscular Endurance**—The ability of a muscle to generate force for an extended period of time. Strength and endurance, although related, can be thought of as being at opposite ends of a continuum, with each requiring very specific training.
- **Muscular Power**—The ability to produce force rapidly. $\text{Power} = \text{force} \times \text{velocity} = (\text{force} \times \text{distance}) / \text{time}$. Power combines strength and speed and is often the key factor in athletic success.
- **Flexibility**—The ability of a joint to move through its normal, full range of motion (ROM).
- **Repetition (rep)**—One complete movement of an exercise.
- **Set**—A number of repetitions performed consecutively. The number of repetitions in a set is determined by the goals of the trainee.

Types of Resistance Training

- **General Resistance Training**—General resistance training involves the performance of exercises using basic training guidelines such as the number of sets, repetitions, and amount of resistance. General resistance training can trigger specific training adaptations such as improved body composition, muscular strength, muscular endurance, and hypertrophy.
- **Olympic Weightlifting**—Olympic weightlifting is a form of competitive weightlifting in which individuals perform compound, full-body lifting exercises including the clean and jerk and the snatch. Due to the higher movement velocities with heavy resistances, this form of resistance training is an effective way to improve muscular power.
- **Power Lifting**—Power lifting is a form of competitive resistance training in which individuals perform three lifts such as the bench press, squat, and deadlift. This form of resistance training does not require the power associated with Olympic weightlifting. Due to the high forces but relatively low movement speed of an exercise, power lifting is effective for muscular strength production.
- **Body Building**—Body building is a form of competition where the individuals are judged according to the size and symmetrical development of the entire musculature. Individuals who participate in body building often utilize hypertrophy resistance training strategies in which moderate-high training volumes (sets/repetition/resistance) are used to increase muscle size.

Types of Progressive Resistance Training

- **Isometrics**—A form of exercise that employs pulling and pushing against immovable objects where there is no visible lengthening or shortening of the muscle.
- **Isotonics**—A form of exercise characterized by exerting force against moveable objects such as barbells, dumbbells, or resistance training machines where the muscles go through both concentric and eccentric contraction. Due to the lever system formed by the muscles, bones, and joints, the force generated will vary throughout the ROM (Brown, 2017). For example, with elbow flexion during a biceps curl, the biceps can produce maximal force when the elbow joint approaches 100 degrees but are relatively weaker at greater or lesser angles. For this reason, isotonics are subdivided into:
 - *Dynamic constant resistance exercises*—The use of free weights (i.e., barbells and dumbbells) where the resistance remains constant throughout the ROM.

- **Dynamic variable resistance exercises**—The use of machines employing cables, chains, or belts that go around an elliptically shaped cam that varies the resistance throughout the ROM. These machines are designed to match the resistance to the standard force curve for a given movement (i.e., the ability of the user to produce force).
- **Plyometrics**—A form of exercise involving the rapid eccentric loading of a muscle, which activates the stretch reflex, thereby recruiting more motor units. An example is repetitive jumping on and off boxes.
- **Isokinetics**—A type of exercise machine that controls the speed of movement and provides varying resistance throughout the ROM. The resistance the user encounters exactly mirrors the force produced at a constant speed. These machines are expensive and generally are inaccessible by most individuals.
- **Specificity**—The principle of specificity states that specific exercises train the body in specific ways. The body's response to exercise is dependent upon the type of stress and how the stress is applied. The adaptations that occur are specific, so it is important to have goals and know how to train to reach the goals.
- **Reversibility**—The principle of reversibility (often referred to the "use it or lose it" principle) states any progressions achieved through exercise training can and will be lost if overload is reduced and/or stopped.
- **Individuality**—The principle of individuality states exercisers will progress at different rates due to genetics, even when on identical training programs. Since few people ever approach their genetic potential, all people can improve their fitness with proper training, proper nutrition, and adequate rest.

Training Principles

- **Overload**—The principle of overload states that in order for positive adaptations to occur, the body must be subjected to a higher than normal level of stress (exercise is a form of stress). Productive overloading involves the proper use of multiple components of resistance training such as weight/resistance, repetitions, sets, rest, tempo, mode, and frequency.
- **Progression**—The principle of progression states as the body gradually adapts to an exercise program, the exerciser will need to systematically increase overload if adaptations are to continue. This principle implies there is an optimal level of, and time frame for, overloading. A gradual and systematic increase of the workload over time will result in improvement in fitness and reduced risk of injury (Haff & Triplett, 2016). If overload occurs too slowly, improvements take longer. If overload is increased too rapidly, muscle damage or injury could occur. For example, the weekend exerciser generally will not experience the same progressions as an exerciser who trains every other day of the week. The principle of progression also stresses the need for proper rest and recovery. Continual vigorous stress on the body and constant overload will result in exhaustion and injury. Exercisers should not perform vigorous physical activity all of the time, as it increases the risk of overtraining and a possible decrease in fitness (Haff & Triplett, 2016).

Resistance Training Prescription

Every workout should begin with a warm-up. A typical warm-up includes approximately five minutes of whole-body aerobic exercise to gradually increase heart rate, blood flow, and muscle temperature. This is followed by easy whole-body dynamic stretching and then a specific warm-up of the muscles to be exercised (usually light resistance sets) (Haff & Triplett, 2016). Each resistance training exercise should be performed through its full range of motion using a slow, controlled tempo. The resistance should be controlled through both the concentric and eccentric phases of the exercise. It is important to breathe when executing resistance training exercises. The general rule is to inhale during the eccentric phase (typically when lowering the resistance to earth) and exhale during the concentric phase (typically when raising the resistance away from earth).

The FITT (frequency, intensity, time, and type of training) principle can help design and structure a resistance training program and determine the level of improvement and success (American College of Sports Medicine [ACSM], 2021).

Frequency

For general muscular fitness, the American College of Sports Medicine (2021) recommends completing 10 to 12 different exercises for the major muscle groups. A list, including anatomical locations, of the major muscle groups

is presented in **Figure 3-1**. Exercises should be performed 1 to 3 sets of 8 to 12 repetitions and include compound, multi-joint exercises (e.g., bench press, overhead press, rowing exercises, squats, leg presses) (ACSM, 2021). Isolation exercises involving single joints and focusing on smaller muscles should be used to complement resistance training programs (e.g., biceps, triceps, shoulders). Exercises involving large muscle groups and multiple joints should be completed first on resistance training days. If single joint or small muscle group exercises are performed first, these small muscles will become the limiting factor rather than the large muscle groups being exercised (Haff & Triplett, 2016). For instance, performing biceps curls prior to pull-ups will pre-fatigue the biceps and make it difficult to adequately train the larger, stronger muscles of the back.

All exercises should be performed with a controlled movement tempo during all phases (i.e., concentric, eccentric, isometric) of the exercise. The exercises should be performed without the use of momentum and incorporate time under tension ('TUT') (Iversen et al., 2021). Performing an exercise at a slow and controlled tempo during each movement phase would enhance the amount of time a muscle is under contractile tension during a repetition.

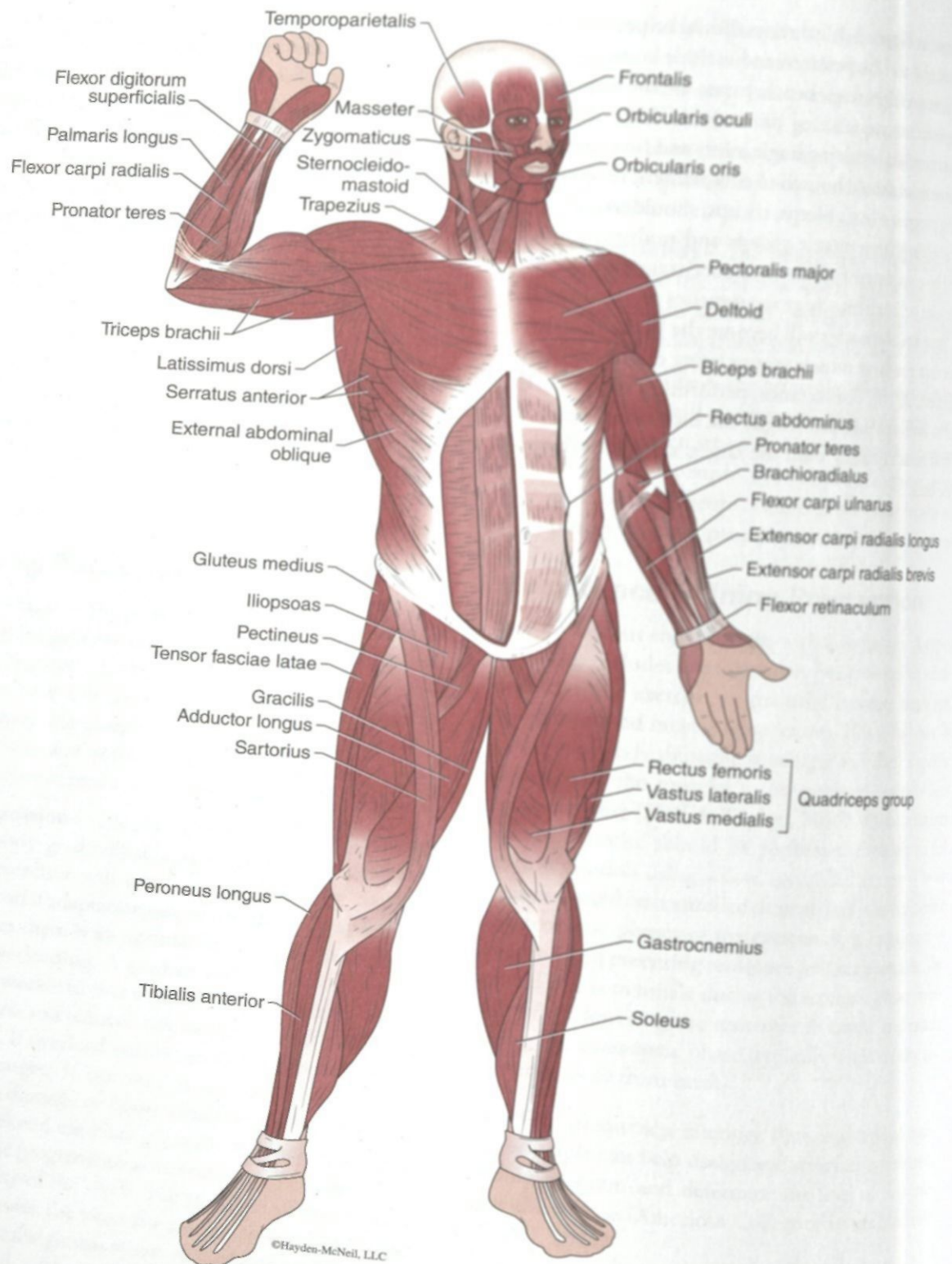


FIGURE 3-1. Muscular System.

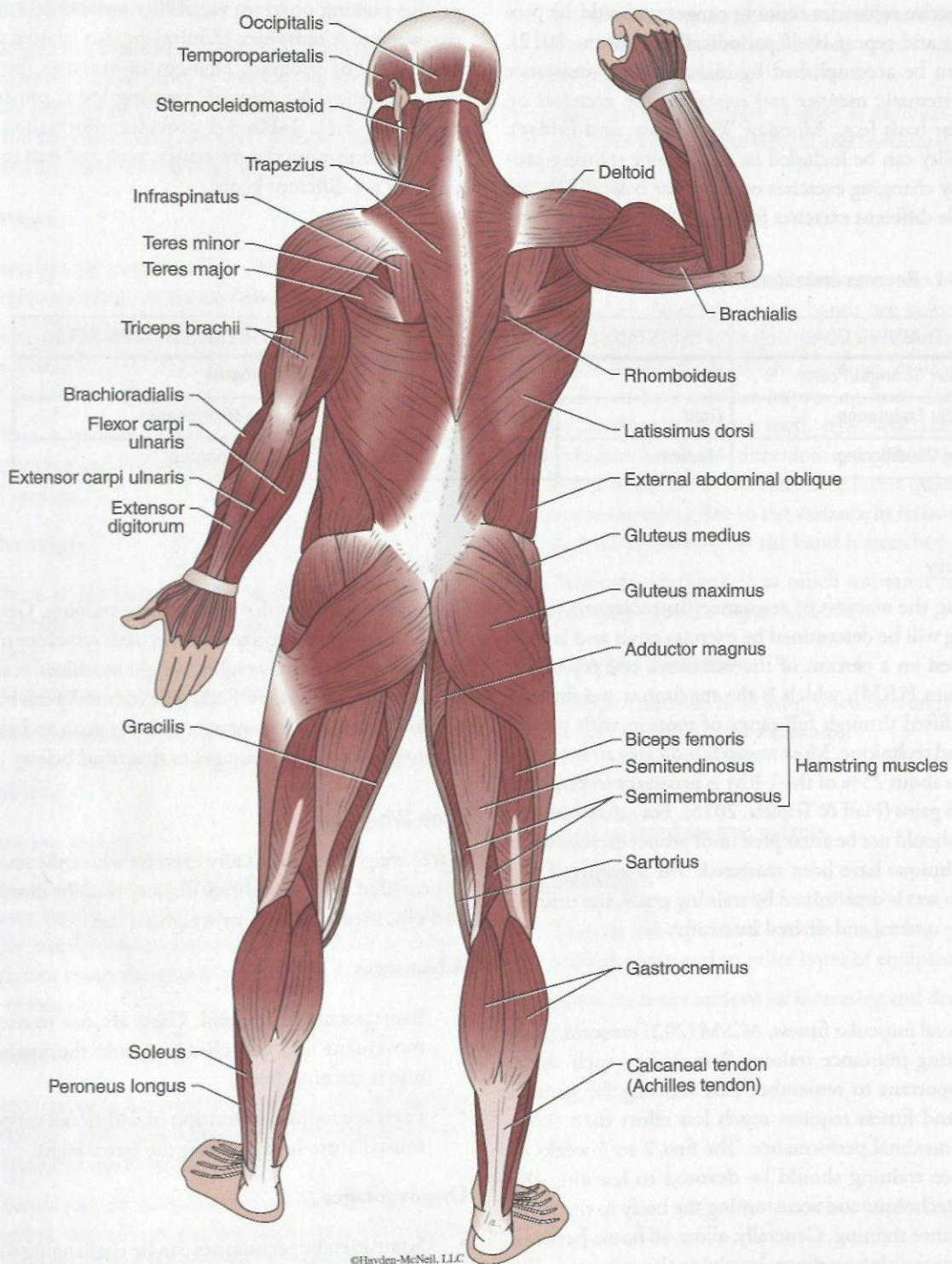


FIGURE 3-1. Muscular System.

An effective resistance training program should be progressive and repeat itself periodically (Hesson, 2012). This can be accomplished by increasing the resistance in a systematic manner and repeating the exercises on a regular basis (e.g., Monday, Wednesday, and Friday). Variability can be included in a resistance training program by changing exercises on a regular basis. There are multiple different exercises for each of the major muscle

groups making program variability a viable and productive option. A resistance training log can be used to help keep track of program changes in exercises, intensity, and frequency. An example training log is provided in **Appendix 3.1**. **Table 3-1** provides information to assist in determining the resistance, sets, and reps to use in training for different goals.

Table 3-1. Recommendations for Training Goals

TRAINING GOAL	RESISTANCE	REPS	SETS	REST BETWEEN SETS
Muscular Strength/Power	Heavy	1 to 6	3 to 5	3 minutes
Muscular Endurance	Light	15 to 25	1 to 3	30 to 60 seconds
General Conditioning	Medium	8 to 12	3	1 to 3 minutes

Intensity

Selecting the amount of resistance (intensity) to use in training will be determined by exercise goals and is usually based on a percent of the exerciser's one repetition maximum (1RM), which is the maximum weight that can be lifted through full range of motion with proper form and technique. Most research indicates an intensity equal to about 75% of the 1 RM is necessary to promote strength gains (Haff & Triplett, 2016). For safety reasons, 1 RMs should not be attempted until proper exercise form and technique have been mastered. The amount of rest between sets is determined by training goals, the utilized training system, and desired intensity.

Time

For general muscular fitness, ACSM (2021) recommends completing resistance training 2 to 3 days each week. It is important to remember that training for general health and fitness requires much less effort than training for maximal performance. The first 2 to 3 weeks of resistance training should be devoted to learning the correct technique and accustoming the body to the stress of resistance training. Generally, allow 48 hours between resistance training workouts involving the same muscles.

Type

There are several modes of resistance training. Generally, the most common ways to perform basic resistance training exercises are with free weights, weight machines, resistance bands, and body weight. Each type (or mode) can be effective in helping reach resistance training goals and each has advantages and disadvantages as described below:

Free Weights

A free weight exercise is any exercise where the resistance is provided by a weighted object, usually dumbbells, barbells, medicine ball, or weighted bar.

Advantages

- Exercises are functional. Users are not restricted in movement and can closely mimic the movements one is training for.
- Exercises require utilization of additional supporting musculature in stabilizing the free weight.

Disadvantages

- Some exercise techniques can be challenging to learn.
- There is a higher potential for injury.
- Exercises may require an additional person to serve as a safety spotter.

Weight Machines

Most weight machines have some type of weighted plates suspended by a cable, belt, or chain (i.e., stack weight). The user places a pin at the desired resistance and performs the movement as controlled by the machine. Other machines are plate loaded (e.g., leg press).

Advantages

- Exercises are easy to learn. With little instruction beginners can perform exercises on machines.
- Exercises are safer. Machines assist in controlling the resistance so there is no danger of weights getting out of control or falling on the user.
- There is greater muscle stimulus due to variable resistance applied through an exercise's full range of motion.

Disadvantages

- There is no variation in movement. Machines generally have a singular path the resistance moves along.
- Machines may not fit all body types.
- Machines assist in stabilizing the resistance resulting in a user not utilizing their own musculature to stabilize.

Resistance Bands

Resistance bands (e.g., resistance bands with handles, flat resistance bands, closed-loop tube bands, loop bands, mobility bands). Resistance bands allow for a variety of workouts using the elastic properties of the bands to create resistance.

Advantages

- Same muscle activity as other types of weight exercises, with reduced chance of injury due to lower amount of force on the joint.
- Greater muscle stimulus due to variable resistance applied through an exercise's full range of motion. The more a band is stretched the greater the resistive force will be applied.

- The constant tension from bands adds an element of required stabilization by the body to maintain form during many exercises.
- There are more exercise options as exercises can be performed in both the vertical and horizontal planes.
- Bands are inexpensive.

Disadvantages

- It is difficult to quantify and compare between workouts. Most resistance bands are color-coded to indicate the strength of the resistance band. With dumbbells or weight machines, exercisers can easily see how they are improving from day to day by tracking resistance used, reps, sets, etc. Using resistance bands, it is difficult to compare the progress across workouts as the resistance is not quantifiable in the same way due to the variance in resistive force depending on how far the band is stretched.
- Bands do not provide as much resistance as heavy free weights and weight machines.

Bodyweight Exercises

Bodyweight exercises entail using one's own body weight to provide resistance (e.g., a pushup).

Advantages

- Same as listed for free weights.

Disadvantages

- Exercise modifications can be made, but they are limited compared to other types of equipment.
- There are fewer options for increasing and decreasing resistance

Resistance Training Systems

There are several systems for determining the number of sets, repetitions, resistance, and order of exercises (Brown, 2017). Not all systems are applicable to all resistance trainers, as some systems require higher frequencies and an advanced level of knowledge and experience. The following outlines a few common resistance training systems with the appropriate level of experience suggested in parentheses.

- **Circuit Training** (all levels)—A system of training where the individual performs a single set of a number of different exercises with a minimum amount of rest in between (Table 3-2). The circuit can then be repeated until the desired number of sets for each exercise is met. This system is time efficient and is effective in developing muscular endurance and general conditioning and in maintaining a certain degree of fitness.

Table 3-2. Example Circuit Training Program

EXERCISE	WEIGHT	REPS
Shoulder Press	Medium; 80% 1RM	10
Bent-Over Rows	Medium; 80% 1RM	10
Standing Dumbbell Curls	Medium; 80% 1RM	10
Triceps Dips	Body weight	15
Chest Push-Ups	Body weight	15
90 Seconds Rest, Repeat as many times as desired		

- **Split Training** (all levels)—A system in which different muscle groups are trained on non-consecutive days within a week (Table 3-3). For example, a 3-day split could include training lower body on Monday, upper body-pushing movements on Wednesday, and upper body-pulling movements on Friday. This type of training allows for adequate rest to occur for muscles between training days.

Table 3-3. Example of Split Training Programs

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
3-Day Total Body	Total Body		Total Body		Total Body		
4-Day Split Push/Pull	Push ¹	Pull ¹		Push	Pull		
4-Day Split Upper/Lower	Upper	Lower		Upper	Lower		
5-Day Split By Body Part	Chest, Shoulders, Triceps	Lower Body	Back, Traps, Biceps		Chest, Shoulders, Triceps	Lower Body	
6-Day Split One Body Part per Day	Chest	Back	Triceps		Shoulders	Biceps	Lower Body
6-Day Split (3-day split repeated)	Chest/Back	Lower Body	Shoulders/Arms		Chest/Back	Lower Body	Shoulder/Arms

1. Note: Push (e.g., chest/triceps); Pull (e.g., back/biceps)

- **Super Set** (intermediate to advanced levels)—Super set training utilizes two exercises targeting opposing muscle groups (e.g., back and front of body or upper and lower body), in rapid succession with a short break between sets (**Table 3-4**). For example, a chest exercise is performed immediately followed by a back exercise then a short rest period before repeating the process. Super-setting is popular when workout time is a factor as it allows for several exercises to be performed quickly and safely.

Table 3-4. Example of Super Set Training

EXERCISES	WEIGHT	REPS
Bench Press	Light, Medium, or Heavy	12–16, 8–10, or 4–6, respectively
Lat Pull Down	Light, Medium, or Heavy	12–16, 8–10, or 4–6, respectively
60 Seconds of Rest, Repeat as many times as desired		

- **Ladder and Pyramid Training** (advanced level)—Ladder training is a system of training where an individual performs a single exercise for 3 or more sets, increasing the resistance and/or reps with each set (**Table 3-5**). This system may also be reversed for a descending ladder. Pyramid training involves use of both ascending and descending ladders together.

Table 3-5. Example of Ladder Training

SET	WEIGHT	REPS
1	Light	12–16
2	Light/Medium	10–12
3	Medium	8–10
4	Heavy	4–6

- **Giant Set** (advanced levels)—Also known as compound set, training with giant sets involves using multiple exercises in succession for the same muscle group (**Table 3-6**). This type of system is often done to failure with a reduction of resistance halfway through as the muscle group fatigues. Giant sets should be utilized sparingly as it can cause significant fatigue and possible delayed onset muscle soreness.

Table 3-6. Example of Giant Set Training

EXERCISE	WEIGHT	REPS
Dumbbell Bench Press	Medium	8–12
Cable Dumbbell Fly	Medium	8–12
Barbell Incline Bench Press	Medium	8–12
Wide Grip Push Up	Body Weight	8–12

- **Eccentric Training** (advanced levels)—Also known as negatives, in this form of resistance training the exerciser focuses on the eccentric contraction of the repetition. During eccentric loading, the weight is lowered slowly (5–7 seconds) paired with a normal concentric speed (**Table 3-7**). Since most exercisers can produce more muscular force during the eccentric contraction compared to the concentric contraction, resistance training intensities used during negatives can range from 105% to 125% of 1 RM. Due the weight being above 1 RM intensities, many exercisers utilizing negatives require one or more spotters to help complete the concentric contraction of the repetition. Compared to regular resistance training repetitions, negatives place a greater emphasis on contracting a muscle while it is being lengthened. The increased emphasis creates more muscle fiber micro-tears, which can lead to greater muscle hypertrophy, fewer training plateaus, and increased delayed onset muscle soreness.

Table 3-7. Example of Eccentric Training

EXAMPLE EXERCISES	WEIGHT	SETS	REPS	REP SPEED
Barbell Bench Press	110% of 1 RM	3	8	2 seconds concentric 5 seconds eccentric
Smith Machine Squats	125% of 1 RM	4	5	2 seconds concentric 6 seconds eccentric
Lat Pulldowns	105% of 1 RM	3	10	1 second concentric 5 seconds eccentric
Leg Extensions	110% of 1 RM	3	10	2 seconds concentric 5 seconds eccentric

- **Drop Set** (advanced levels)—A system of training in which an individual performs as many repetitions as possible to fatigue, immediately drops the resistance 10–15% and again performs as many repetitions as possible to fatigue, repeating for a total of 3–5 sets. Similar to giant sets, this system should generally be used sparingly as it pushes muscles to their absolute maximum capacity, which may cause significant fatigue and overload.

Table 3-8. Example of Drop Set Training

SET	WEIGHT	REP
1	40 lb	To fatigue
2	30 lb	To fatigue
3	20 lb	To fatigue
4	10 lb	To fatigue

Safety

Safety is important at all times when resistance training. The purpose of any physical training is to improve or maintain physical fitness. Injuries due to poor form and training techniques can slow or stop progress. Correct technique should be used to perform each exercise through the proper range of motion in a controlled fashion. Correct technique includes maintaining proper body positioning and alignment, breathing, and moving the joint through its full range of motion utilizing only the appropriate muscles. The spine is strong when its normal curves are maintained (called a neutral spine), and therefore to protect the spine, resistance training exercises should be completed with a neutral spine. Spinal rotation and rounding the lower back during the execution of most exercises should be avoided. It is important to breathe through each repetition.

A spotter, someone to assist in the case the exercise cannot be completed, should be used when training with weights above the body. Collars and/or clips should be used to keep free weight plates securely on bars. Free weight plates sliding and shifting during use can unbalance the bar and result in injury. Weight training facilities are often busy and crowded. Lastly, exercisers should remain aware of their surroundings and any possible exercise hazards.

In addition to ensuring progressive overload, record-keeping can be a motivational tool. Due to the principle of individuality, it is important to remember everyone will progress at different rates even when on the same program. Progress and success will be largely determined by training consistency and training intensity. Therefore, it is important to set goals that are realistic and that promote symmetrical development of all the major muscle groups of the body.

Summary Questions

1. What are two physical and two non-physical benefits of resistance training?
2. Discuss frequency, intensity, time, and type for resistance training.
3. Explain how to implement or perform one of the resistance training systems discussed in this chapter.
4. How does resistance, number of repetitions, and number of sets change according to resistance training goals?
5. What is the function of the agonist, antagonist, synergist, and stabilizer in a resistance training movement?
6. Explain the importance of each of the following training principles: overload, progression, specificity, reversibility, and individuality.

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Useful Websites

<http://www.acsm.org>
American College of Sports Medicine

<http://www.nasca.com>
National Strength and Conditioning Association

<http://www.nata.org>
National Athletic Training Association

chapter 4



Flexibility

by Autumn Mist Belk, M.F.A. and Joan Nicholas-Walker, M.F.A.

Flexibility

Fitness involves five essential components: cardiovascular endurance, muscular endurance, muscle strength, body composition and flexibility. Among these five components flexibility is the most neglected by the general population. Flexibility is defined as the ability to move a joint through its full range of motion (ROM). ROM is important to accomplish day to day activities (turning, reaching, twisting, bending). Stretching, the means by which we increase and maintain flexibility, is used to prepare muscles for workouts, enhance performance, and aid in returning the body to its pre-exercise state. Since flexibility decreases as we age, stretching must be a vital part of a complete exercise program.

Benefits of Increasing and Maintaining Flexibility

- Increased production and retention of lubricants between connective tissue
- Increased neuromuscular coordination
- Improved mobility for daily activities
- Improved joint health and joint mobility
- Decreased muscle stiffness, soreness, and injury
- Improved muscle relaxation and stress relief
- Improved posture, balance, stability, and coordination

4

Chapter Four

Four Methods of Stretching

- **Ballistic**

This form of stretching is characterized by the use of speed and force to produce rapid, repetitive bouncing or jerking movements. Uncontrolled movements via this type of stretching can cause soreness or injury and is not widely recommended. The American Academy of Orthopedic Surgeons (AAOS) and most experts warn against ballistic stretching. This type of stretching may be too forceful and can cause damage to joint soft tissue (i.e., ligaments).

- **Dynamic**

This type of stretching is considered a safe form of the ballistic method. It incorporates gradual and controlled movements to bring muscles through a full range of motion around a joint. The movements imitate the upcoming sport or physical activity in a less intense manner and are widely used during the warm-up phase. This form of stretching is more widely recommended than ballistic stretching.

- **Static**

These stretches are performed by slowly moving into an extended position, holding the position for a period of time, and then returning to a resting length. There is little pain and a low risk for injury. This form of stretching is normally used during the cooldown and is a highly recommended method for effectively developing flexibility.

- **Proprioceptive Neuromuscular Facilitation (PNF)**

This type of stretching consists of alternating an isometric muscular contraction followed by passive stretching. There are various techniques that may be applied when performing this type of stretching, with the most popular being a "contract-relax-contract" method. This method consists of stretching the target muscle, isometrically contracting the muscle for several seconds, then relaxing the muscle and immediately stretching the muscle using gravity or assistance. PNF stretching can be the most effective method of increasing flexibility, but it is time-consuming and usually requires assistance.

As with the other components of fitness, we can use the acronym FITT to follow in developing and maintaining flexibility.

Frequency	2–3 days per week (ideal is 5–7 per week)
Intensity	stretch to mild discomfort
Time	hold for 15–30 seconds/2–4 reps
Type	static, dynamic, PNF

Exercise Warm-Up Phase

The warm-up phase gradually prepares the individual's body for exercise. A proper warm-up should have multiple joints moving taking the body from a resting state into one of moderate to vigorous activity. The primary outcome of the warm-up phase is to increase circulation, increase core temperature, increase ROM, increase performance and prevent injury. The warm-up should be at least 5–10 minutes in length to increase the cardiorespiratory level and include low-intensity movement that can be similar to the upcoming activity or exercise. Execution of the warm-up should take into consideration the individual's age, physical limitations, capabilities, environmental conditions, and the requirements of the upcoming activity or workout.

Stretching does not replace the warm-up phase but is part of it. The focus of stretching is on major muscle groups and is specific to the sport or activity. Research has shown that static stretching and proprioceptive neuromuscular facilitation (PNF) can increase flexibility when incorporated with dynamic stretching as part of a full and complete warm-up phase. Static stretching (15–30 seconds) should be implemented and has a better outcome than stretches held for longer than 60 seconds, which may reduce the ability to generate power during the workout.

Dynamic Stretching

Not all activities need pre-exercise stretching. For example, runners and cyclists have a low risk of acute muscle strain. Therefore, stretching before these activities offers little protection against acute injury. Runners and cyclists can adequately warm up with light/slow jogging or pedaling.

For general fitness activities and selected sports, low-intensity static stretching may be utilized during the

warm-up once the body's core temperature has increased from its resting level (core temperature will rise about half a degree for every five minutes of warm-up). These stretches are performed until mild discomfort is felt and held for 15–30 seconds. Each stretch should be executed in a relaxed, controlled manner. Stretching that results in hyperextension, hyperflexion, or extreme rotation should be avoided. Continued research is needed to clarify the benefits of stretching on performance and its impact related to injury. In addition to muscular stretching, the mobility of the connective tissues in the body contributes to overall flexibility. Deep myofascial release is one type of release therapy that increases flexibility by targeting these connective tissues.

Exercise Cooldown/Recovery Phase

The cooldown phase of exercise is just as important as the warm-up phase. This part of the workout returns the body to its pre-activity resting state. The individual begins with an easy cardiorespiratory phase that allows the heart rate to drop, followed by stretching muscle groups used in the specific workout or activity. A cardiorespiratory cooldown should always be the first part of the total cooldown phase. This is typically a very low intensity version of the exercise routine. For example, if you run for your activity, you will probably choose to cool down with a jog and/or a walk. This gradual decrease in intensity allows the heart to adjust properly. It should be about 3–5 minutes in length, long enough for the heartbeat to return to baseline range and breathing to return to normal.

Once the heart rate and breathing have returned to the pre-activity levels, stretching should always follow the respiratory cooldown/recovery. Stretching should be done long enough to adequately stretch all the major muscle groups used in the activity. Static stretching is the most commonly used and preferred method during post-activity. Each stretch should be held 15–30 seconds with 1–4 repetitions performed for each muscle. All stretches should be performed slowly in a relaxed and controlled manner. It is important to never force a stretch and to spend equal time on each side of the body. Always maintain continuous breathing throughout the stretches and avoid holding the breath at any time.

Stretching after the activity/workout reduces injury as well as muscle soreness. An added benefit of stretching is increased flexibility. This is best accomplished when performed at the end of a workout or activity. At this time the muscles are warm and supple because blood circulation has increased; therefore the muscles are able to attain a maximum stretch. To maintain or improve flexibility, stretching should be completed a minimum of two times a week.

The final phase in the cooldown/recovery phase is to aid in the total release of tension for the individual. Various techniques can be used. Foam rolling and the use of massage sticks are beneficial along with slow breathing exercises. The use of isometric muscle contractions followed by the relaxing of these individual muscle groups have proven to be useful, also.

EFFECTS OF WARM-UP	EFFECTS OF COOLDOWN/RECOVERY
• Increased heart rate • Increased blood flow, stroke volume, and oxygen exchange • Increased muscle and blood temperature • Increased speed and strength of muscle contractions • Decreased muscle soreness, muscle/tendon strains, and muscle/tendon tears • Increased range of motion • Increased muscle, tendon, and ligament elasticity • Decreased muscle tension • Increased psychological preparedness	• Aids in circulatory and metabolic exercise rates returning to normal levels • Decreases muscle cramps • Decreases muscle fatigue • Increases tendon, ligament, and muscle elasticity • Decreases post-exercise muscle soreness • Decreases muscle stiffness • Decreases risk of dizziness and fainting • Prevents a pooling of blood in the veins • Aids in dispersment of lactic acid • Promotes relaxation of the mind and body • Decreases body temperature

Assessing Flexibility

There is no one test that can evaluate an individual's flexibility. Flexibility is defined as the ability to move a joint through its full and complete range of motion; therefore, each joint may have various levels of flexibility with different tests required to measure or evaluate.

Stretching Exercises

The following stretches are common stretches that can be used for both the warm-up and cooldown phase of your exercise program. They focus on the major muscle groups in the body used for many activities. Choose the type of stretches (Static, Dynamic or PNF) that will enhance your exercise program, but remember to never stretch to a point of discomfort.

■ Lateral Head Tilt

- Purpose: To stretch your neck flexors and extensors, and ligaments of the cervical spine.
- Starting position: Keep your head upright with your neck perpendicular to the floor.
- Movement (**Figure 4-1** and **Figure 4-2**): Slowly and gently tilt your head laterally and drop your opposite shoulder gently to increase the stretch as shown in **Figure 4-1**. Hold for 15 to 30 seconds. Return your head to the upright position before stretching to the opposite side. To stretch the back of your neck you may gently drop your chin as shown in **Figure 4-2**.
- Precaution: Damage to the cervical discs may occur if you roll your neck in circles instead of bringing your head to the upright position before stretching in another direction.



FIGURE 4-1. Head Tilt.



FIGURE 4-2. Head Tilt.

■ Shoulder Stretches

Stretch 1

- Purpose: To stretch your shoulders, chest, and upper back.
- Starting position (**Figure 4-3**): Place your left arm across your chest with your right forearm supporting your left arm.
- Movement: With your right forearm, pull your left arm gently toward your right shoulder and hold for 15 to 30 seconds as shown in **Figure 4-3**. Switch arms and repeat stretch to stretch opposite shoulder. Make sure that you keep your shoulder down and away from your ear during the stretch. In **Figure 4-3** the person on your left has her shoulder down (correct); the person on your right is incorrect.

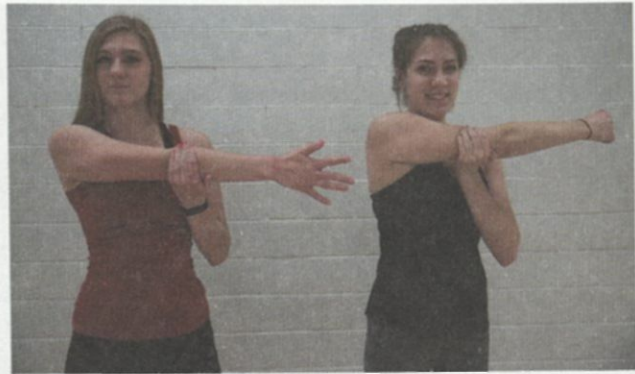


FIGURE 4-3. Shoulder Stretch 1.

Stretch 2

- Purpose: To stretch the shoulders, chest, and upper back.
- Starting position (**Figure 4-4**): Extend your left hand over your left shoulder and reach your right hand up the middle of your back to grasp your left hand as shown on the right. You may use a towel, band or belt to extend your reach if you can't clasp your hands together as shown on the left.
- Movement: Pull downward gently with your lower hand. Breathe in as you stretch downward, holding the stretch for 15 to 30 seconds. Switch arms and hands to stretch your other shoulder. Maintain neutral torso alignment during the stretch. Do not drop the head or allow the ribs or pelvis to protrude as is shown in **Figure 4-5**.



FIGURE 4-4. Shoulder Stretch 2.



FIGURE 4-5. Shoulder Stretch 2.

■ Chest and Shoulder Stretch

- Purpose: To stretch the chest and front of the shoulders.
- Starting position (**Figure 4-6**): Stand perpendicular to a wall with your left hand on the wall (palm facing the wall) at shoulder height as shown in **Figure 4-6**.
- Movement: Gently turn your body away from the wall and your hand to increase the stretch. Hold the stretch for 15 to 30 seconds. Repeat the stretch with the other arm while facing the opposite direction to stretch your other shoulder. Do not allow the elbow to hyperextend. If that is your tendency, maintain a small bend in the elbow of the arm on the wall.



FIGURE 4-6. Chest and Shoulder Stretch.

■ Side Stretch

- Purpose: To stretch your torso.
- Starting position (**Figure 4-7**): Start with your legs crossed and your right arm extended upward, in line with your shoulder. Place your left hand on the ground off of your left hip for support. Lean over slightly toward your left hand (that is on the ground) as shown in **Figure 4-7**.
- Movement (**Figure 4-8**): Twist your stomach so that you look up toward the sky as shown in **Figure 4-8**. Be sure to keep both sit bones on the ground and hold the stretch for 15 to 30 seconds. Switch arms and lean to the opposite side to stretch the opposite side of your torso.



FIGURE 4-7. Side Stretch.



FIGURE 4-8. Side Stretch.

■ Back Stretch

Stretch 1

- Purpose: To stretch your upper and lower back muscles.
- Starting position (**Figure 4-9** and **Figure 4-10**): Soften your knees by bending them slightly, round your spine and keep your head down. Let your hands hang loosely and relaxed by keeping them “heavy” as shown in **Figure 4-9**. A modification of the starting position is to place your hands slightly above your knees so they are supported as shown in **Figure 4-10**.
- Movement: Gently arch your back and lower your shoulders to increase the stretch in your back. Hold the stretch for 15–30 seconds.

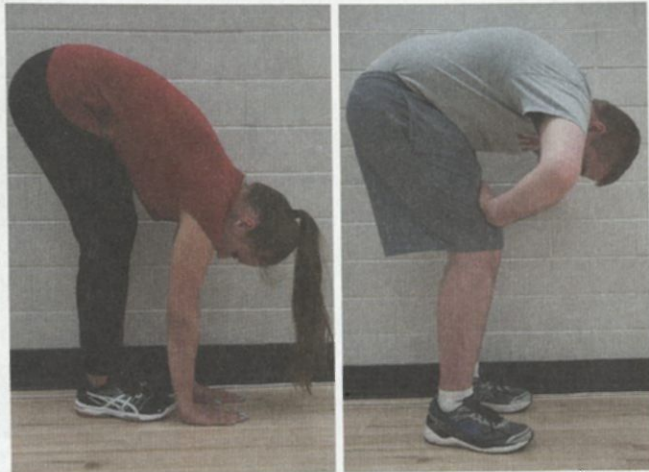


FIGURE 4-9. Back Stretch. **FIGURE 4-10.** Back Stretch.

Stretch 2

- Purpose: To dynamically stretch back muscles.
- Starting position (**Figure 4-11** and **Figure 4-12**): Start on hands and knees. Keep the shoulders aligned with hands and pelvis aligned with knees.
- Movement: Round your spine upward and let your head and tailbone be heavy as shown in **Figure 4-11**. Gently reverse the curve of the spine, looking forward as you pull the chest forward and the pelvis back as shown in **Figure 4-12**. Keep moving back and forth, coordinating with your breath.



FIGURE 4-11. Back Stretch 2.

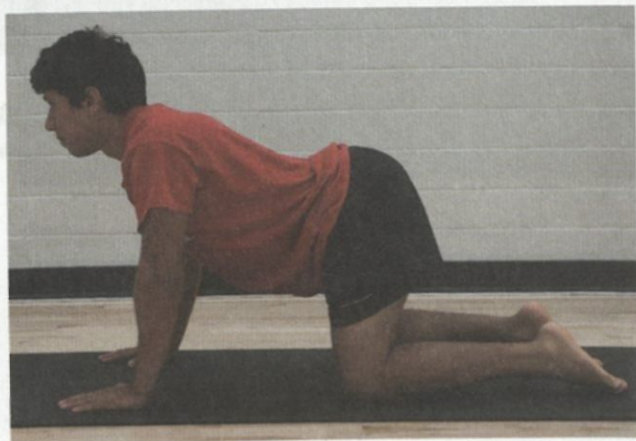


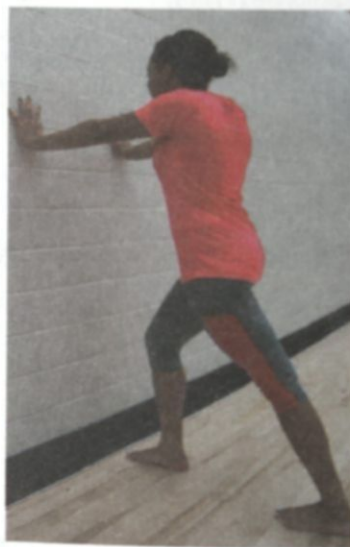
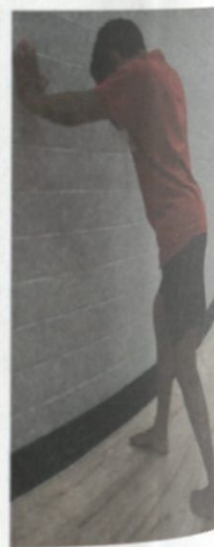
FIGURE 4-12. Back Stretch 2.

Stretch 3

- a. Purpose: To stretch back muscles.
- b. Starting position (**Figure 4-13**): Lie/lay on your back with your pelvis off to the right side and your knees to your chest. Have your arms out to the side with your palms facing up.
- c. Movement: Roll onto the left side of your pelvis and rest the legs on the floor. Hold the stretch for 15-30 seconds. Engage your abs as you roll back onto your back, then bring your feet to the floor. Move the pelvis off to the left and reverse the stretch.

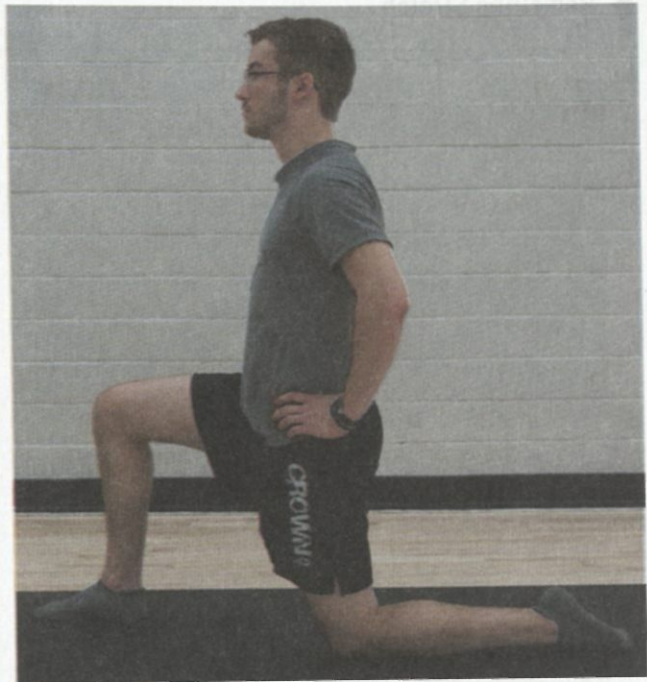
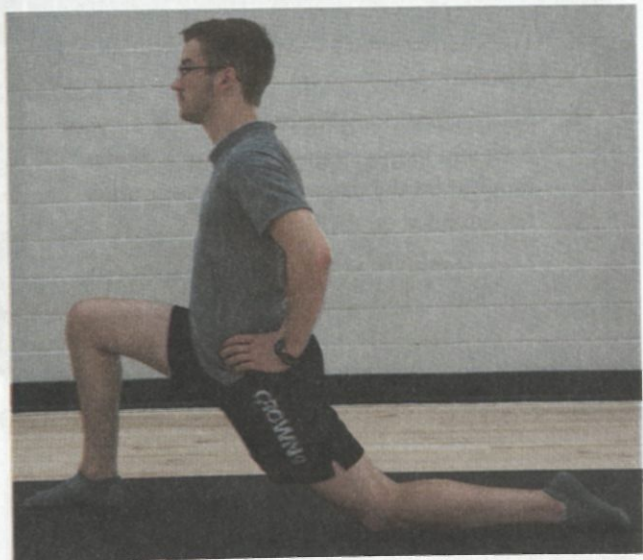
**FIGURE 4-13.** Back Stretch 3.**■ Hip Flexor and Lower Leg***Stretch 1*

- a. Purpose: To stretch your hip flexor and calf.
- b. Starting position (**Figure 4-14** and **Figure 4-15**): Face the wall and place both hands flat against the wall while your feet are staggered. Slightly bend your front leg; the heels of both feet should be placed flat on the floor as shown in **Figure 4-14**.
- c. Movement: While keeping your body straight, sink your hips forward and weight your rear heel to stretch both your hip flexor and calf. Hold the stretch for 15 to 30 seconds. Keeping the back heel on the floor, bend the back knee a little, stretching the front of the lower leg as shown in **Figure 4-15**. Hold the stretch for 15-30 seconds. Switch the position of your legs to stretch your other hip flexor and calf.

**FIGURE 4-14.** Hip Flexor and Lower Leg Stretch 1.**FIGURE 4-15.** Hip Flexor and Lower Leg Stretch 1.

Stretch 2

- a. Purpose: To stretch your hip flexor as shown in **Figure 4-17**.
- b. Starting position (**Figure 4-16** and **Figure 4-17**): Start with your left foot forward and make sure your shin is perpendicular to the floor (or your left knee is over your left foot). Extend your right leg behind you and drop your right knee on the floor with the top of your right foot on the floor as shown in **Figure 4-16**.
- c. Movement: Drop hips forward toward your front foot to stretch your hip flexor as shown in **Figure 4-17**. Hold the stretch for 15 to 30 seconds. Switch legs to stretch your opposite hip flexor.

**FIGURE 4-16.** Hip Flexor and Lower Leg Stretch 2.**FIGURE 4-17.** Hip Flexor and Lower Leg Stretch 2.

■ Hamstring Stretch

Stretch 1

- a. Purpose: To stretch the back of the thigh (hamstrings).
- b. Starting position (**Figure 4-18**): Stand on your left leg with your left knee bent. Put your right heel in front of you with a straight knee as shown in **Figure 4-18**.
- c. Movement: Keep your back straight and fold forward at the hip joint to feel stretch in back of leg. Hold the stretch for 15 to 30 seconds. Switch the position of your legs to stretch your other hamstring.



FIGURE 4-18. Hamstring Stretch 1.

Stretch 2

- a. Purpose: To stretch the back of the thigh (hamstrings).
- b. Starting position (**Figure 4-19**): Lie on your back and loop a strap over the arch of your foot out on the diagonal. Have your other leg extended on the floor.
- c. Movement: Using the strap, bring your leg up until you feel a mild to moderate stretch in the back of the leg as shown in **Figure 4-19**. The floor leg should be gently pressing down into the floor. Hold the stretch for 15 to 30 seconds. Bend the knee to remove the strap. Loop the strap over the other leg and reverse the stretch.



FIGURE 4-19. Hamstring Stretch 2.

■ Hip Extensor Stretch

- Purpose: To stretch the hip extensors (buttocks).
- Starting position (**Figure 4-20**): Lay flat on the floor with chest facing upward, arms to the side and your right leg bent. Place your left foot in front of your right knee so your left shin is parallel to the floor. Your legs in this position should resemble the number four as shown in **Figure 4-20**.
- Movement (**Figure 4-21**): Place both hands on the back of your right leg (hamstring) and gently pull your right leg toward your chest as shown in **Figure 4-21**. You should feel the stretch in your hip extensors (buttocks). Hold the stretch for 15 to 30 seconds. Switch the position of your legs to stretch the opposite side.

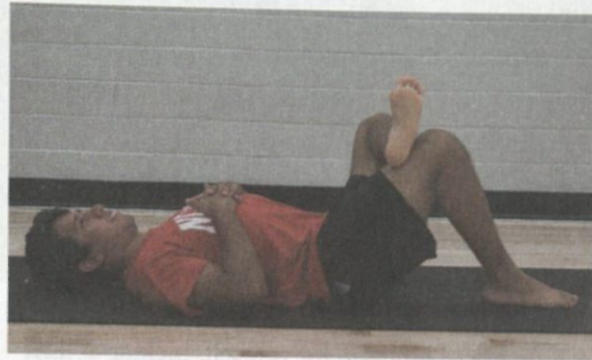


FIGURE 4-20. Hip Extensor Stretch.



FIGURE 4-21. Hip Extensor Stretch.

■ Inner Thigh, Groin, and Buttocks (Gluteus Maximus) Stretch

- Purpose: To stretch inner thigh, groin, and buttocks area.
- Starting position (**Figure 4-22**, person on your left): Sit flat on the floor and place both soles of your feet together so your legs create a diamond shape (butterfly) as shown in **Figure 4-22**. Grasp your shins with your hands.
- Movement (**Figure 4-22**, person on your right): Keep your back flat and gently lean forward to feel the stretch in your inner thighs, groin, and buttocks. Hold the stretch for 15 to 30 seconds.

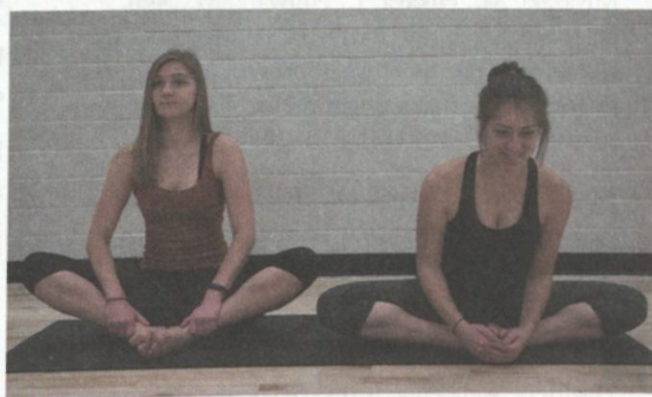


FIGURE 4-22. Inner Thigh, Groin, and Buttocks Stretch.

Summary Questions

1. List the major benefits of stretching.
2. Describe a static stretch and give an example.
3. Describe a dynamic stretch and give an example.
4. Describe a PNF stretch and give an example.
5. What types of stretches are most effective during the warm-up phase of a workout?
6. What types of stretches are most effective during the cooldown/recovery phase of a workout?
7. Create a flexibility plan for yourself. Include at least one stretch for each region of the body.

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Useful Websites

- <https://stretchcoach.com>
- <https://www.harvard.edu/stayhealthy>
- <http://www.acsm.org>
- http://www.ncoa.org/improve-health/center-for-healthy-aging/content-library/ExerciseGuide_FINAL_Aug2010_0.pdf
- <http://orthoinfo.aaos.org>
- <http://www2.gsu.edu/~wwwfit/flexibility.html>
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- <http://exercise.wsu.edu/flexibility/default.aspx>
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chapter 5



Fitness/Sports-Related Injuries, Safety, Prevention

by Darrin DeReu, M.A. and Shawn Cradit, Ph.D.

Participation in sports, exercise, and recreational activities has significant health benefits in one's physical and mental well-being. 23.4% of the population in the United States engage in these types of activities every year, according to new research data from the Center for Disease Control's (CDC) National Center for Health Statistics. Inherently, those same activities come with a risk of injury.

Most injuries in physical activity and sport affect the musculoskeletal system. This system is composed of muscles, tendons, ligaments, and cartilage. Muscles are contractile tissue that can actively shorten and lengthen, creating movement. Tendons are composed of connective tissue and are located at the ends of muscle tissue. Tendons allow for muscle tissue to have a solid connection with bones. Ligaments are composed of connective tissue connecting bone to bone. Ligaments are generally located at joints and provide joint stability. There are a few different types of cartilage. Cartilage is a matrix of tissue that has elastic qualities. In the skeletal system cartilage is located on the ends of bones in joint surfaces and sometimes in between bones inside a joint capsule. Cartilage acts as a cushion absorbing compressive forces and also creates a smooth surface for joints to move smoothly and minimize friction.

5

Chapter Five

Acute vs. Chronic

Generally most musculoskeletal injuries can be classified into two categories: Acute (direct) and Chronic (indirect).



Acute injuries are the result of a single, direct trauma cause or event. The person can tell you exactly how, when, and where the injury occurred. These types of injuries can transpire from sudden, direct impacts with objects or another person or producing an action that forces a joint beyond its normal range of motion. Damage can occur to any tissue of the musculoskeletal system and may include fractured bones, torn muscles, and joint sprains.

Acute injuries can be severe. You should always seek medical attention for severe acute injuries. A few symptoms you should seek medical attention for are severe swelling and pain, unusual noises that occurred at the time of injury, like a pop or crunching sensation, visible bodily deformities that often accompany a fracture or joint dislocation, inability to bear weight, inability to move a body part, difficulty breathing, or light-headedness.

Chronic injuries occur from long-term, indirect trauma and repetitive movements. Chronic injuries are common in endurance sports, such as running, cycling, and swimming. They can also arise in highly specialized sports in which a movement is repetitive. Sports like baseball or tennis have specific, high-velocity movements that are repetitious. A pitcher in baseball may throw 100 pitches in a game or a tennis player may practice a forehand many times in the course of a practice session.

Chronic injuries occur when the tissue breakdown and remodeling cycle are not balanced. When force is applied to tissue there is a mechanical failure resulting in tissue breakdown and damage. The body reacts to this process at

rest by rebuilding the stressed tissue and making it stronger and more resilient to handle the applied stress. This process adapts musculoskeletal tissues and reduces the chance of the body experiencing injuries due to repetitive stress. If too much force is applied to tissue in too short a period of time, not allowing for proper adaptation, the tissue will break down resulting in injury.



In order to avoid and treat chronic injuries, one must be able to recognize and manage the injury mechanism. The source of injury may be as simple as over-training or as complicated as readjusting the biomechanics of a specific movement. For example, a distance runner is having low back discomfort due to poor hip stability. In order to effectively treat the back pain, the hip stability must be identified and corrected before full recovery will happen.

Healing depends on the extent of the injury and location of the stump ends (the now separated ends of the damaged tissue). If the separation of the stump ends is minor or small, the cells can form a bridge binding the stump ends together. This is referred to as primary healing, which is common in surgical incisions and minor wounds. If the wound is more severe, the stump ends will be further apart and the cells are unable to bridge by single cells. The wound will produce cells from the sides and bottom of the wound to fill in the gap. This is known as secondary healing. This type of healing takes longer due to the distance between stump ends. A second degree ankle sprain, due to the ligament tissue being separated by distance, is an example

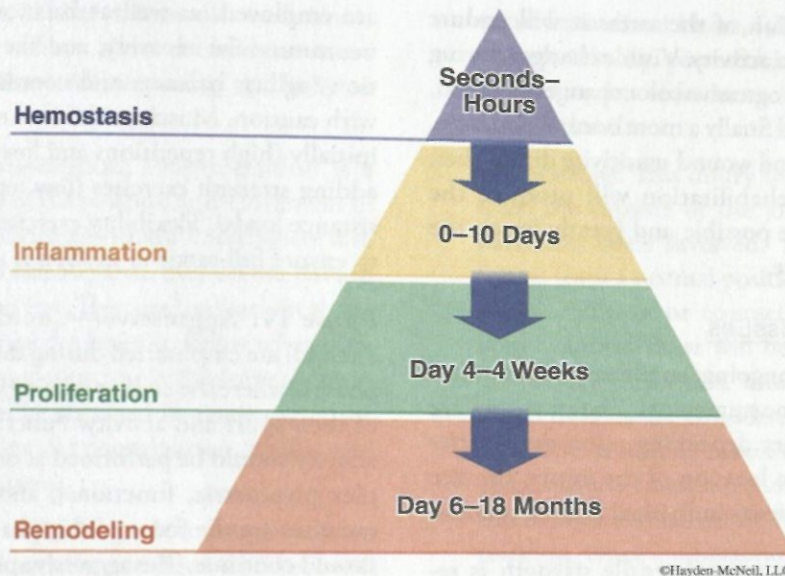


FIGURE 5-1. Phases of Healing.

Four Phases of Healing

A common question of athletes suffering from injuries is "How long until I am better?" This is a complex question, and is beyond the scope of this chapter. Fortunately the general time frames involved for certain types of tissues to heal is known. Healing time is also dependent on the severity of tissue damage. Healing takes place in four phases. Although we categorize healing in distinct phases, they can occur simultaneously and will overlap:

1. **Phase one: Hemostasis.** Damage to vasculature (blood vessels) will occur with any injury; this damage lays the foundation of the body's response to the injury. Blood contains platelets, which form a clot (a very complicated process involving other cells, chemicals, factors, proteins, etc.) to form a fibrin plug. This plug prevents the vessels from removing the excess fluid accumulation or swelling. The lymph vessels are thus compromised, unable to remove the excess fluid (edema) which is their normal function.
2. **Inflammatory Phase:** The body is attempting to protect the injured site while attempting to return to homeostasis (a relative state of balance). Swelling, discoloration, and heat are common indicators. This is often the most painful phase of healing. The body is delivering nutrients and growth factors to stimulate healing, while working to remove damaged tissue.
3. **Proliferation Phase:** This stage overlaps the inflammation phase which begins the formation of new scar tissue and growth of new blood vessels. This phase is regarded as the new growth and regeneration phase. As this new tissue is formed in a haphazard manner, the fiber is thin and weak, not as strong as the original tissue. The strength of the scar tissue is directly correlated to the type, arrangement, and amount of collagen present. The variability of the length of this phase depends on the extent of the injury and type of tissue involved. External signs during this phase include pressure sensitivity, increased capillaries and water volume increase.
4. **Maturation or Remodeling Phase:** This is the final phase and overlaps with the proliferation phase. Collagen fibers align in a parallel, organized manner resulting in cross-links providing increased strength of the tissue. Proper loading of the newly formed tissue is important in this phase to remodel the tissue.

This activity increases the temperature and is why the injured body part often feels warm to the touch. Other signs of inflammation are rubor (redness) that is localized at the injury site, loss of normal function, pain, edema (caused by increased leakage of chemicals, cells, and fluid due to vasodilation), and pain (caused by the pressure of edema on the nerve endings).

fibers in the direction of the stress it will endure following a return to activity. Visible changes during this phase include progressive color changes from red, to pink, to white and finally a more normal skin tone. Swelling decreases and wound sensitivity diminishes. Proper care and rehabilitation will produce the strongest scar tissue possible and greatly lessen the chance of recurrence.

Healing of Specific Tissues

This area of research is ongoing, so please keep in mind these are approximate measurements. The processes are complicated and will vary depending upon the severity of the injured tissue, the location of the injury, the size of the injury and the patient's individual healing process.

- **Ligaments**—Almost normal tensile strength is re-established around 40–52 weeks. These tissues may take up to one or two years for complete healing.
- **Tendons**—The length of time the area was immobilized will impact the time frame. 85%–95% strength should occur around 40–50 weeks.
- **Muscles**—90% near normal ability to contract, around six weeks to six months.
- **Articular cartilage**—Cartilage has a normal appearance and is comprised of Type I and Type II collagen that has calcified, around six months.
- **Bone**—The fracture site is healed around three to four months, however remodeling is still taking place. Almost normal strength is achieved around 12 weeks.

What Steps Are Crucial to Returning to Play?

Phase I: Inactive—This phase includes utilizing modalities for pain relief, edema, and spasm. This phase coincides with the hemostasis and inflammation phases of healing. During the inactive phase, minimal range of motion is permitted depending upon the type of injury.

Phase II: Active—This phase occurs after the inflammation healing phase and during the proliferation phase of healing. The active phase includes joint mobilization, increasing range of motion, soft tissue mobilization, and increasing mobility with flexibility exercises.

Phase III: Resistive—During this phase, resistance exercises to improve deficits are utilized due to tissue injury and repair. Muscle strength and endurance exercises

are employed, as well as balance exercises to improve neuromuscular recovery, and the ABC's of proprioception (agility, balance, and coordination) exercises used with caution. Muscle endurance exercises are performed initially (high repetitions and low resistance), eventually adding strength exercises (low repetitions with high resistance loads). Flexibility exercises should also continue to ensure full range of motion is regained.

Phase IV: Aggressive—Coordination, power, and strength are emphasized during this phase. The aggressive phase is where the patient is being prepared for the stresses of their sport and activity. Functional and performance activity should be performed at or near full effort. Complex plyometric, functional, and performance-specific exercises are the focus of this phase. Flexibility exercises should continue. The aggressive phase coincides with the healing phase remodeling, only during the later stages, depending on the patient and their progress.

With the help of a team of medical professionals, here are some items that need to be completed in order to safely return to activity.

1. **Reduce Pain and Swelling:** This can be as simple as utilizing the RICE method. Resting, applying ice, applying compression, and elevating the injured body part can assist in reducing associated pain and swelling. Protection of the injured body part may be beneficial.
2. **Range of Motion:** Most injuries cause some type of range of motion loss. The loss may be due to pain, tight tissue, or scar tissue formation. A limited range of motion will cause the body to compensate with poor motion in other areas of the body. This compensation will then lead to injuries to other body parts.
3. **Muscular Endurance:** Following injuries, unused or underutilized muscles will lose endurance. Fatigued muscles do not function at optimal capacity. The poor functioning of fatigued muscles do not allow the body protection from outside forces or unexpected movements. For example, when stepping on an uneven surface muscles will contract to keep the ankle from inverting beyond normal range of motion. Fatigued muscles will not react as quickly or strongly, resulting in greater injury.

4. **Muscular Strength:** Similar to muscular endurance, a lack of strength will not allow the body to move properly and protect itself, exposing the body to further injury.
5. **Balance and Proprioception:** Proprioception is a person's perception of the position and movement of the body without having to visually know where it is. Asking someone to run 50 yards, they do not have to look at their legs and feet. They use feedback from the tissues in the body to the brain to know what their legs are doing without consciously thinking about it. Proprioception can be regained by challenging the system and regaining the coordination, agility, and balance of normal tissue.
6. **Gradual Return to Activity:** It is important to gradually return to activity to reduce the likelihood of reinjury. A progressive step-by-step process to physically and emotionally return to normal activity is important. Mental readiness is often overlooked by many coaches. The athlete must go through a process including the stages of grief (sadness, anger, bargaining, denial, and acceptance), which may take longer than the healing of the injury.

Common Types of Acute Injuries

1. **Contusion:** This common injury is also known as a bruise. The tissue surrounding the area has been damaged, and blood flow is increased to the injured tissues creating a hematoma (a pool of clotting blood that forms a fibrin plug). This will result in ecchymosis (bluish discoloration of the skin).
2. **Sprain:** This is an injury to ligaments. When a joint is forced beyond normal range of motion the supporting structures, ligaments, of that joint are damaged. Sprains are categorized as 1st, 2nd, and 3rd degree and are related to the extent of damage to the ligament. Please see **Table 5-1** for further details.
3. **Strain:** This is an injury to muscle and tendon tissues. Generally muscular and tendinous strains occur when a muscle or tendon is over-exerted or possibly stretched beyond its normal range of motion. Similar to ligament sprains, they are categorized into 1st, 2nd, and 3rd degree depending on the extent of injury. Please see **Table 5-1** for further details.
4. **Fractures:** Fractures are when a bone breaks. There are many different mechanisms to fractures. They can occur from direct blows, falling, or some other type of high-velocity, powerful impact. There are several different types of fractures. Please see **Table 5-1** for further details.

5. **Dislocations:** This injury involves a bone displaced from the capsule of the joint associated with the particular bone involved. The end of the bone is forced from a normal position. This can result from a fall, collision or contact sport, or other direct force trauma. There will be an obvious deformity; do not try to fix this, more damage could occur. These injuries are considered a medical emergency and EMS should be enacted. A subluxation can also occur. This is when the end of the bone slips out of the capsule momentarily, but returns to a normal position. Once a subluxation has been reported, the patient is more susceptible to a dislocation.

Common Types of Chronic Injuries

1. **Tendonitis, tendinosis, tenosynovitis:** This is an overuse injury that occurs to tendons that connect muscle tissue to bones. The discomfort is usually a gradual onset with moderate pain and possible swelling and thickening of the tendon. Please see **Table 5-2** for further details.
2. **Bursitis:** A bursa is a fluid-filled sac that works to cushion and lubricate high friction areas in the body. Bursitis can often present similar to tendonitis and often is caused by similar mechanisms to tendonitis. Bursa can also sustain injury from a direct blow, such as getting hit with a baseball or kicked during a soccer match. Please see **Table 5-2** for further details.
3. **Capsulitis, synovitis:** Fluid accumulation and/or irritation of the tissues associated with a joint capsule. The area where two bones coherently work together. The shoulder and hip are common areas associated with these injuries.
4. **Neuritis:** Inflammation of the nerve associated with a specific activity. Carpal tunnel syndrome in administrative personnel and students who use computers frequently are susceptible to this injury.
5. **Overuse Syndrome and Microtrauma:** These injuries are a result of repetitive and abnormal stresses, which can limit or hinder performance. Running, throwing, and jumping are common culprits. These injuries affect soft tissues, joints, and bones.

6. **Stress Fracture:** Just like soft tissue, bones will adapt to stress placed upon it. During movement stress is placed on bone tissue and the bone tissue experiences a breakdown at the cellular level. At rest, the breakdown heals and the bone adapts to better handle the stress placed upon it. When there is too much stress and not enough rest the bone tissue will start to break down in the form of a stress fracture. Stress fractures are very small and often not seen on x-rays. If left untreated they can become full fractures. Please see **Table 5-2** for further details.

Other Medical Conditions in Sports and Fitness

There are other types of conditions and injuries that are precipitated by sports and activities. Be aware of these as they can become life threatening if not recognized and treated properly. Conditions in this section need to be referred to an appropriate medical professional.

Traumatic Brain Injuries (TBI) and Concussions

Concussions are generally caused by a bump, blow, rapid twist, or jolt to the head. These rapid movements cause the brain to essentially bounce around in the skull. It is estimated by the Centers for Disease Control and Prevention that 1.6 to 3.8 million sports-related concussions occur in the U.S. each year.

If a concussion is suspected the patient should seek medical attention immediately. Some common signs observed in concussed individuals are:

1. Amnesia
2. Appears dazed
3. Easily confused by simple questions
4. Clumsy and may have difficulty walking normally
5. Delayed responses to questions
6. May or may not lose consciousness
7. Mood, behavior, or personality changes

Some common reported symptoms of concussion are:

1. Headache
2. Nausea or vomiting
3. Balance or dizziness
4. Vision problems
5. Photophobia or sensitivity to light
6. Feeling of being sluggish, hazy, or foggy
7. Confusion, concentration, or memory problems

The symptoms from a majority of concussions are typically short lived. Most people recover symptomatically within 7–10 days. The American Academy of Pediatrics recommends that adolescents with concussions be evaluated and cleared by a doctor before returning to sports. The American Academy of Neurology recommends that doctors who clear athletes for return to sports should be trained in managing and assessing sports concussions.

Second Impact Syndrome describes a condition in which an individual experiences a 2nd concussion before complete recovery from an initial injury. The mortality rate of Second Impact Syndrome has been reported to be as high as 50%, further highlighting the importance of recognizing and reporting suspected concussions.

Sudden Cardiac Arrest

About 1.5 in 100,000 young athletes experience a sudden cardiac arrest each year. In most cases, arrest occurs with little to no warning in the midst of play or practice. If immediate emergency action is not taken within minutes the athlete can die or be left with serious brain damage.

Sudden cardiac arrest is usually caused by a structural or electrical abnormality of the heart. Many of the abnormalities are inherited and often undiagnosed. A comprehensive medical history, physical exam, and screening electrocardiogram (EKG) may help in the detection of heart abnormalities.



Some common signs are:

1. Fainting during exercise
2. Chest pain with exercise
3. Excessive shortness of breath with exercise
4. Heart palpitations (heart racing)

The most important factor in survival is how quickly an automated external defibrillator is used. Just a few minutes can mean the difference between life and death.

Exercise Induced Asthma

Exercise induced asthma is an airway condition where airflow can become restricted causing shortness of breath, chest tightness, unusual level of fatigue during activity, wheezing, and coughing. This condition is triggered by strenuous exercise. Most athletes with this condition can continue to exercise and remain active by treating symptoms with prescribed medications and taking preventative measures. Other factors, such as, cold, dry air and air pollution can further exacerbate symptoms.

Environmental Conditions to Consider

Hyperthermia—Elevated body temperature above normal range. Temperature along with humidity level have the greatest impact on this condition.

Heat can be gained or lost through metabolic production (heat production and radiation due to normal body process of metabolism); conduction (physical contact with a hot surface—turf on an 80 degree day can reach

above 100 degrees Fahrenheit); convection (a mass of water or air moves around the body—a cool breeze can cool off the body); radiation (heat loss or gain from direct exposure—sunshine heating up the body on a sunny day); and evaporation (sweat production to the skin surface and turning the liquid into vapor—if temperature and radiant heat become higher than body temperature, the body depends on evaporation).

Exertional Heat Illness

Exercise and sports require energy expenditure with a byproduct of creating heat from that metabolic process. During exercise evaporation is the body's primary mechanism for cooling itself. It takes energy for sweat to evaporate in a gas. This energy is taken from the body's skin creating a cooling effect. The evaporation rate of sweat is highly dependent on relative humidity. When humidity is high, very little evaporation occurs and severely hampers the body's ability to cool down.

Some factors increasing the chances of exertional heat illness are: dehydration, poor sleep, obesity, poor acclimation to environmental conditions, activity level, excessive clothing, high humidity, high temperature.

Exertional heat illness can lead to death, so prevention is key. The following progression usually occurs in exertional heat illness: heat rash, heat syncope (heat collapse), heat cramps, heat exhaustion, and finally heat stroke. Understanding the environmental conditions and other exacerbating factors are crucial in prevention.

There are generally three phases of heat illness: heat cramps, heat exhaustion, and heat stroke. These can range in symptoms from cramps, feelings of weakness, profuse sweating, progressing to no sweat and cool clammy skin, loss of consciousness, and death. See **Table 5-3** for more details. If heat illness is suspected, the main goal is to immediately reduce body temperature. If recognized early, replacing fluids and electrolytes and moving to a cooler environment is the solution. If an athlete progresses from heat exhaustion into heat stroke heroic measures need to be taken to reduce the core body temperature. The best way to quickly accomplish this goal is to submerge the body in cool to cold water. If heat stroke is suspected EMS should be activated as heat stroke can quickly lead to serious brain damage and death.

Other Environmental Injuries, Illness, and Conditions

Hypothermia—Abnormally low body temperature due to outdoor temperature or water temperature. This condition can lead to dehydration, disorientation, unconsciousness, and death. Proper clothing, warm-up, and wind chill factor are factors in preventing this condition. Symptoms include shivering that continues to uncontrolled shivering, bluish lips and extremities, goose bumps, and skin feeling cold to the touch.

Frostnip—Affects chin, cheeks, ears, fingers, nose, and toes and occurs with high wind, severe cold or both. Skin will have cold, painless areas and feel firm. These areas may blister or peel within 42–72 hours.

Frostbite—Constant prolonged exposure for many hours, or for a short period of time in extremely frigid temperatures and conditions. Pain, redness, tingling and swelling will be present and the area may feel hard. Do not rub. Skin may appear waxy, pale if the frostbite is superficial. Submerge in water 100 degrees Fahrenheit. If the frostbite is deep, blisters and numbness may present. Skin may appear blotchy, red, purple or black. This is a medical emergency and requires hospitalization.

Lightning Safety—When thunder and lightning are present, if you feel your skin tingle or hair stand on end, assume a crouched position, get as small and low as you can, but do not lie flat. If you can hear thunder or see lightning and the flash-to-bang count reaches 30 (once you see the lightning start counting until you hear the thunder, divide the number by 5, this will give an approximate distance to the lightning strike), stop activity immediately, and seek shelter indoors. An automobile will suffice if there is no indoor facility near. Do not stand under a tree or near a telephone pole. If you have to choose a tree, make sure it is small and assume the crouched position. If you are outdoors and no facility or automobile is available, try to find the lowest area, a valley or ravine, and get into the crouched position. Do not stand in water or on a metal surface, avoid using metal objects (golf clubs, umbrellas, etc.). Wait 30 minutes after the last flash-to-bang 30 count before returning outdoors.

Summary

Unfortunately, injuries are a part of participating in physical activity. Knowing how to recognize and treat these occurrences is important. Understanding the basic concepts of the phases of healing and rehabilitation is the first step to realizing the complexity of an injury. Rest is crucial in treating injuries, as our bodies recover and repair at optimal levels when we are sleeping. Getting enough sleep (seven to nine hours) is critical to the healing process.

Table 5-1. Comparison of Different Types of Acute Injuries

INJURY TYPE	TISSUE INVOLVED	DEGREE	SIGNS	TREATMENT
Sprain	Ligament/Joints	1st Degree - Minimal pain/swelling - No structural damage - No joint instability 2nd Degree - Moderate pain/swelling - Some structural damage - Some joint instability - Difficulty bearing weight 3rd Degree - Severe pain/swelling - Complete ligament rupture - Pop/snap felt - Joint instability - Difficulty bearing weight strain	- Immediate onset of pain - Often rapid onset of swelling - Tender upon palpation - Discoloration - Decreased range of motion at the involved joint - Difficulty bearing weight or performing everyday activity with involved joint - Feelings of instability	- Rest, ice, compression, elevation (RICE) - Protective bracing to protect involved joint - Possible surgery - Range of motion exercises - Strengthening of muscles surrounding involved joint to improve active stabilization
Strain	Muscle/Tendon	1st Degree - Muscle is tender/painful when used - No structural damage 2nd Degree - Moderate pain/swelling - Some structural damage - Difficult to use involved muscle - Discoloration 3rd Degree - Severe pain/swelling - Complete muscle rupture - Use of involved muscle is impossible	- Immediate onset of pain and difficulty using involved muscle - May feel a snap/pop - Muscle spasm - Discoloration - Tender upon palpation - Partial or complete loss of function	- Rest, ice, compression, elevation (RICE) - Anti-inflammatory medications - Analgesics - Range of motion exercises and stretching as pain subsides - Strengthening of involved muscle once full range of motion is restored
Fracture	Bone	Simple and Non-Displaced - Simple crack in the bone - No displacement Simple and Displaced - Simple crack in the bone - Displacement of bones from their normal position Comminuted - Several cracks in the bone - Multiple bone fragments - Usually displaced Compound or Open - Bone fragment pierces the skin - Severe pain/tenderness - Deformity of displaced fractures - Bleeding of compound fractures	- May feel pop/snap - Severe pain/tenderness - Deformity in displaced fracture - Bleeding in compound fracture	- Immediate immobilization - Transportation to a facility capable of taking x-rays of the injured area - Cast or brace for non-displaced fractures - Reduction of displaced fracture - Surgery of all compound fractures to avoid infection and to reduce displaced fragments

Table 5-2. Comparison of Different Types of Chronic Injuries

INJURY TYPE	TISSUE INVOLVED	SIGNS AND SYMPTOMS	TREATMENT	COMMON EXAMPLES
Tendonitis	Tendon	• Pain with use in and around the tendon • Tenderness with palpation of the tendon • Occasional swelling or thickening of the tendon	• Rest: Decrease the intensity/duration of the exercise until pain subsides. Complete rest may not be ideal as it takes away the stimulus of the tendon to adapt and heal. Often finding alternative exercises that still use the injured structure is ideal. • Anti-inflammatory medication • Ice • Stretching • Occasionally, a physician may use corticosteroid injections. Must be used with caution as these tend to weaken tendon and increase the likelihood of complete tendon rupture, especially in weight-bearing tendons (Achilles tendon among others).	• Achilles tendonitis • Rotator cuff tendonitis • Tennis elbow • Patella tendonitis or jumper's knee
Stress Fracture	Bone	• Gradually increasing pain over a bone, eventually leading to severe pain that forces athlete to stop exercising • Palpable tenderness on the bone at the site of the stress fracture • Most common in distance runners	• Rest: Avoidance of the aggravating impact activity. Cross training with a non-weight bearing exercise is good to maintain fitness level. • Total non-weight bearing or immobilization is rarely needed. • Sometimes surgery is needed to stabilize poor healing stress fractures.	• Forefoot stress fracture • Tibia or shin bone stress fracture • Hip stress fractures
Bursitis	Bursa	• Swelling or thickening of bursa • Palpable tenderness around the bursa	• Rest: Avoidance of the aggravating activity. Cross training is good to maintain fitness level. • Stretch the involved tendon causing the friction over the bursa. • Anti-inflammatory medication • Protective padding to shield bursa from further irritation	• Achilles bursitis • Shoulder bursitis

Table 5-3. Forms of Exertional Heat Illness

CONDITION	PREVENTION	SIGNS AND SYMPTOMS	TREATMENT
Heat Illness	• Gradual acclimatization • Wear proper, light clothing • Proper hydration • Maintain proper body weight • Be aware of temperature/humidity and adjust workouts accordingly	Heat Cramps	
		• Sudden painful contraction of muscle tissue • Dehydration • Mineral imbalance	• Stretching of involved muscle tissue • Fluid and electrolyte replenishment • Rest
		Heat Exhaustion	
		• Feeling of weakness • Fatigue • Occasional collapse without loss of consciousness • Profuse sweating	• Fluid and electrolyte replenishment • Cooling the body off • Rest
		Heat Stroke	
		• Serious emergency • Collapse • Confusion • Loss of consciousness possible • Elevated core temperature • Decreased or no sweating • Complete shutdown of body's defensive mechanism against overheating	• Immediate cooling through removal of clothes, shade, ice or fanning • Call 911 for immediate professional emergency care

Summary Questions

1. What is the difference between acute and chronic injuries?
2. What are the phases of healing? Describe the role of each.
3. What are the phases of rehabilitation, and how do they coincide with the phases of healing? What is included in each phase?
4. Sprains and strains are categorized by the amount of tissue damage. Describe 1st, 2nd, and 3rd degree tissue damage.
5. Describe the general treatment approach to chronic injuries.
6. What are the three types of exertional heat illness?
7. Briefly describe the other environmental conditions, injuries, and illnesses that can occur.

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Useful Websites

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<https://rosept.com/blog/when-will-i-feel-better#:~:text=%22Healing%20takes%20place%20in%203,re%20looking%20to%20return%20to>
Rose Physical Therapy Group

https://www.cdc.gov/traumaticbraininjury/get_the_facts.html
Centers for Disease Control and Prevention

<https://orthoinfo.aaos.org/en/diseases--conditions/sports-concussion/>

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The Sport Institute at UW Medicine

chapter 6



Current Health Issues

by Renee Harrington, Ph.D. and Joy Kagendo, M.Ed.

Introduction

Since the early 1980s, there has been a marked decline in mortality and morbidity rates from infectious communicable diseases and non-communicable diseases. This chapter covers current health topics related to cardiovascular, respiratory, kidney/liver, metabolic, bone/connective tissue, digestive, drug addiction, and sexual health issues. Within each topic an overview is presented along with pertinent information.

Cardiovascular Issues

The leading cause of death in the United States is cardiovascular diseases (JAMA, 2021). Cardiovascular diseases (CVDs) are disorders of the heart and blood vessels. In the United States, 659,000 people die each year from heart disease (CDC, 2022). The American Heart Association (AHA) suggests that risk factors for CHD are grouped into two categories: primary, or major risk factors, and secondary, or contributing risk factors. Primary risk factors have been found to have a direct relationship to coronary heart disease. Secondary risk factors contribute to CHD, but their exact contribution has yet to be determined. Additionally, some of these risk factors can be modified, controlled, or treated, while some cannot. Risk factors for CVD are discussed in depth in Chapter 2. About one-half of all Americans (47%) have at least 1 of 3 key risk factors for heart disease: high blood pressure, high cholesterol, and use of tobacco (Fryar et al., 2012). There are many different types of CVD. Four of the main types are described below.

Coronary heart disease—occurs when the flow of oxygen-rich blood to the heart muscle is blocked or reduced. This puts an increased strain on the heart, and can lead to angina (chest pain caused by restricted blood flow to the heart muscle), heart attack (blood flow to the heart muscle is suddenly blocked) or heart failure (the heart is unable to pump blood around the body properly).

6

Chapter Six

Strokes and transient ischemic attacks

A stroke is where the blood supply to part of the brain is cut off, which can cause brain damage and possibly death. A transient ischemic attack (also called a TIA or “mini-stroke”) is similar, but the blood flow to the brain is only temporarily disrupted. The main symptoms of a stroke or TIA can be remembered with the word FAST, which stands for:

- **Face**—the face may have drooped on one side, the person may be unable to smile, or their mouth or eye may have dropped.
- **Arms**—the person may not be able to lift both arms and keep them there because of arm weakness or numbness in one arm.
- **Speech**—their speech may be slurred or garbled, or they may not be able to talk at all.
- **Time**—it’s time to dial 911 immediately if you see any of these signs or symptoms.

Peripheral arterial disease

Peripheral arterial disease occurs when there’s a blockage in the arteries to the limbs, usually the legs, which can cause dull or cramping leg pain that is often made worse when walking and gets better with rest, hair loss on the legs and feet, numbness or weakness in the legs, or persistent ulcers (open sores) on the feet and legs.

Aortic diseases

Aortic diseases are a group of conditions affecting the aorta, which is the largest blood vessel in the body and carries blood from the heart to the rest of the body. One of most common aortic diseases is an aortic aneurysm, where the aorta becomes weakened and bulges outwards. This doesn’t usually have any symptoms, but there’s a chance it could burst and cause life-threatening bleeding.

High blood pressure

In order to survive and function properly, your muscle tissues and organs need the oxygenated blood that your circulatory system carries throughout the body. When the heart beats, it creates pressure that pushes blood through a network of tube-shaped blood vessels, which include arteries, veins, and capillaries. This blood pressure is the result of two forces: the first force (systolic pressure) occurs as blood pumps out of the heart and into the arteries that are part of the circulatory system, whereas the second force (diastolic pressure) is created as the heart rests between heart beats. High blood pressure (also referred to as hypertension) is when your blood pressure, the force of blood flowing through your blood vessels, is consistently too high. Coupled with high cholesterol, this can ultimately lead to other conditions ranging from arrhythmia to heart attack and stroke. **Figure 6-1** provides information on blood pressure categories.

Blood pressure stages:	Systolic	and/or	Diastolic	
Hypertensive crisis	>180		>120	Seek emergency care!
Stage 2 hypertension	≥140	or	≥90	} High blood pressure
Stage 1 hypertension	130–139	or	80–89	
Elevated	120–129	and	<80	
Normal	<120	and	<80	

Source: American Heart Association

FIGURE 6-1. Blood Pressure Categories.

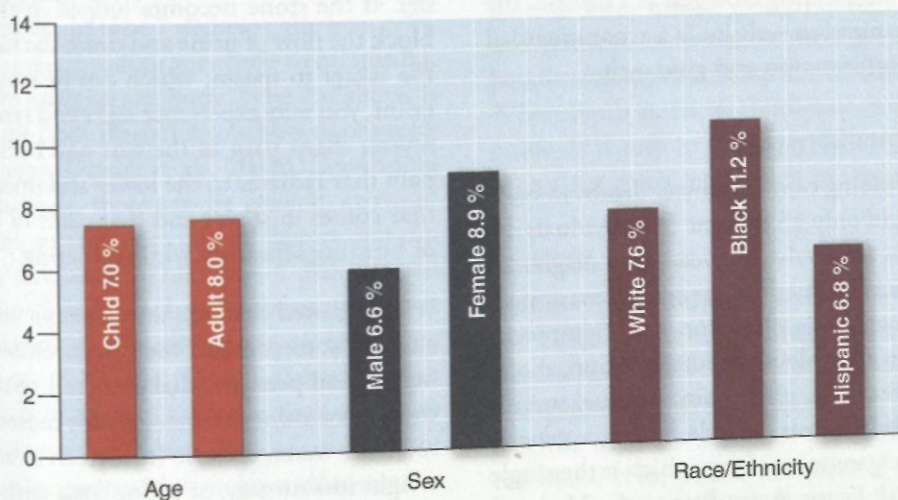
Respiratory Issues

Asthma

Asthma is a disease that affects your lungs. Asthma causes wheezing, breathlessness, chest tightness, and coughing at night or early in the morning. Genetic, environmental, and occupational factors have been linked to developing asthma. "Atopy," the genetic tendency to develop an allergic disease, can play a big part in developing allergic asthma. However, not all asthma is allergic asthma. Being exposed to allergens in the environment, such as mold, dust mites, and secondhand tobacco smoke have been linked to developing asthma. Air pollution and viral lung infection may also lead to asthma. Occupational asthma occurs when someone who never had asthma develops it because he or she is exposed to something at work. This can happen if you develop an allergy to something at work such as mold or if you are exposed to irritants such as wood dust or chemicals at work over and over at lower levels or all at once at higher levels.

An asthma attack can happen when you are exposed to "asthma triggers." Your asthma triggers can be very different from someone else's asthma triggers. Some of the most common triggers are tobacco smoke, dust mites, outdoor air pollution, cockroach allergen, pets, mold, smoke from burning wood, grass, and infections like flu. An asthma attack may include coughing, chest tightness, wheezing, and trouble breathing. The attack happens in your body's airways, which are the paths that carry air to your lungs. As the air moves through your lungs, the airways become smaller, similar to how the branches of a tree are smaller than the tree trunk. During an asthma attack, the sides of the airways in your lungs swell and the airways shrink. Less air gets in and out of your lungs, and mucus that your body makes can clog up the airways. Current asthma prevalence percents by age, sex, and race/ethnicity are provided in **Figure 6-2**.

Current Asthma Prevalence Percents by Age, Sex, and Race/Ethnicity, United States, 2019



Source: National Health Interview Survey, National Center for Health Statistics, Centers for Disease Control and Prevention

FIGURE 6-2. Current Asthma Prevalence Percent.

Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory lung disease that causes obstructed airflow from the lungs. Symptoms include breathing difficulty, cough, mucus (sputum) production, and wheezing. Emphysema and chronic bronchitis are the most common conditions that make up COPD. Damage to the lungs from COPD can't be reversed. Symptoms include shortness of breath, wheezing, or a chronic cough. COPD makes breathing difficult for the 16 million Americans who have this disease. Millions more people suffer from COPD, but have not been diagnosed and are not being treated. Although there is no cure for COPD, it can be treated.

Coronavirus Disease (COVID-19)

Coronavirus (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. The World Health Organization (WHO) first learned of this new virus on 31 December 2019, following a report of a cluster of cases of "viral pneumonia" in Wuhan, People's Republic of China. The most common symptoms of COVID-19 include fever, dry cough, and fatigue. Individuals who are 60 years and over, and those with underlying medical problems like high blood pressure, heart and lung problems, diabetes, obesity, or cancer are at higher risk of developing serious illness. As COVID-19 recently emerged as a disease, the World Health Organization website is a recommended place to find latest information and guidance.

Lung and Bronchus Cancer

Lung cancer is the leading cause of cancer deaths in both men and women, and only 15 percent of individuals diagnosed with the disease survive five years after diagnosis. This is due to the fact that by the time symptoms appear and diagnosis is made, it is often too late. Symptoms include a persistent cough, blood-streaked sputum, shortness of breath or wheezing, chest pain, unusual weight loss, and fatigue. Risk factors include having a genetic predisposition and cigarette smoking, which is the single most preventable risk factor. According to the National Cancer Institute, 87 percent of all reported lung cancer cases are from smokers. Among nonsmokers, radon is the most common agent known to cause lung cancer.

Renal/Hepatic (Kidney/Liver) Issues

Cirrhosis

Cirrhosis is a condition in which the liver is scarred and permanently damaged. Scar tissue replaces healthy liver tissue and prevents the liver from working normally. As cirrhosis gets worse, the liver begins to fail. Cirrhosis has many signs and symptoms, such as fatigue and severe itchy skin. They may not appear until the liver is badly damaged. Causes include alcoholic liver disease, nonalcoholic fatty liver disease, chronic hepatitis C, and chronic hepatitis B. Doctors do not have specific treatments that can cure cirrhosis.

Kidney Stones

Kidney stones are hard deposits made of minerals and salts that form inside your kidneys. Diet, excess body weight, some medical conditions, and certain supplements and medications are among the many causes of kidney stones. Kidney stones can affect any part of your urinary tract—from your kidneys to your bladder. Often, stones form when the urine becomes concentrated, which causes minerals to crystallize and stick together. A kidney stone usually will not cause symptoms until it moves around within your kidney or passes into your ureters—the tubes connecting the kidneys and the bladder. If the stone becomes lodged in the ureters, it may block the flow of urine and cause the kidney to swell and the ureter to spasm, which can be very painful. At that point, you may experience signs and symptoms including severe, sharp pain in the side and back, below the ribs; pain that radiates to the lower abdomen and groin; pain that comes in waves and fluctuates in intensity; or pain or burning sensation while urinating.

It is estimated that one in ten people may have a kidney stone at some time in their lives. Other diseases such as high blood pressure, diabetes, and obesity may increase the risk for kidney stones. Possible causes include drinking too little water, exercise (too much or too little), obesity, weight loss surgery, or eating food with too much salt or sugar. Infections and family history might be contributors in some people. Eating too much fructose correlates with increasing risk of developing a kidney stone. Fructose can be found in table sugar and high fructose corn syrup.

Kidney stones increase the risk of developing chronic kidney disease. If you have had one stone, you are at increased risk of having another stone. Those who have developed one stone are at approximately a 50% greater risk for developing another stone within 5 to 7 years.

Metabolic Issues

A metabolic disorder occurs when the metabolism process fails and causes the body to have either too much or too little of the essential substances needed to stay healthy. Our bodies are very sensitive to errors in metabolism. The body must have amino acids and many types of proteins to perform all of its functions. Metabolic disorders can take many forms including having a missing enzyme or an insufficient vitamin that is necessary for an important chemical reaction. Other metabolic disorders include a disease in the liver, pancreas, endocrine glands, or other organs involved in metabolism or nutritional deficiencies.

Diabetes

Diabetes Mellitus is a condition that results in hyperglycemia which can cause blood and erythrocytes (red blood cells) to change their consistency potentially resulting in physiological abnormalities and interruptions (American Diabetes Association, 2009). While there are many types of diabetes, the common three are type 1, type 2 and gestational. In type 1 diabetes, the beta cells, housed in the pancreas, produce very little to no insulin, a hormone used to energize the body. Type 2 diabetes is diagnosed when the body doesn't know how to properly use or process glucose (Roder et al., 2016). Depending on the type of diabetes, there can be genetic, environmental, behavioral, social and structural factors that can influence insulin resistance. While type 1 diabetes was considered childhood diabetes there has been significant increase in prevalence in the pediatric population being diagnosed with type 2 diabetes. Type 2 diabetes makes up approximately 90% of all individuals diagnosed with diabetes. Data indicate that at least 75% of new cases of type 2 diabetes can be prevented through regular exercise and maintaining normal weight. Diabetes has numerous long-range complications, which primarily involve degenerative disorders of the blood vessels and nerves.

Lupus

Lupus is an autoimmune disease that develops when the immune system attacks healthy cells. One of the major characteristics of an autoimmune disorder is chronic inflammation, which researchers believe may be the link between lupus and a higher predisposition to metabolic syndrome. Systemic lupus erythematosus, referred to as lupus, is a chronic (long-term) disease that causes systemic inflammation which affects multiple organs. In addition to affecting the skin and joints, it can affect other organs in the body such as the kidneys, the tissue lining the lungs (pleura), heart (pericardium), and brain. Many patients experience fatigue, weight loss, and fever. Lupus flares vary from mild to serious. Most patients have times when the disease is active, followed by times when the disease is mostly quiet—referred to as a remission.

The cause of lupus is unknown, as well as what drives its diverse presentation. We know that multiple factors are required, including: genetic makeup, environmental exposures, and organ specific characteristics. People with lupus may also have an impaired process for clearing old and damaged cells from the body, which in turn provides continuous stimuli to the immune system and leads to an abnormal immune response. Most often, lupus starts in young females in their fertility age, although it can sometimes start during childhood. The disease is more common in some ethnic groups, mainly blacks and Asians, and tends to be worse in these groups. About 20% of people with lupus develop the disease as children or teens. When lupus starts in childhood, it is called childhood-onset. It is rare to get lupus before age 5 years. Lupus occurs ten times more often in women than in men.

Anemia

Anemia is a condition in which you lack enough healthy red blood cells to carry adequate oxygen to your body's tissues. Anemia can be due to a condition present at birth (congenital) or to a condition you develop (acquired). Anemia occurs when your blood doesn't have enough red blood cells, which can occur if your body does not make enough red blood cells. Anemia can also occur when bleeding causes you to lose red blood cells more quickly than they can be replaced or your body destroys red blood cells. The various types of anemia are described below.

- *Iron deficiency anemia.* This most common type of anemia is caused by a shortage of iron in your body. Without adequate iron, your body cannot produce enough hemoglobin for red blood cells. Without iron supplementation, this type of anemia occurs in many pregnant women. Anemia also caused by blood loss, such as from heavy menstrual bleeding; an ulcer in the stomach or small bowel; cancer of the large bowel; and regular use of some pain relievers that are available without a prescription, especially aspirin, which can cause inflammation of the stomach lining resulting in blood loss.
- *Vitamin deficiency anemia.* Besides iron, your body needs folate and vitamin B12 to produce enough healthy red blood cells. A diet lacking in these and other key nutrients can cause decreased red blood cell production. Sometimes people who consume enough B12 are not able to absorb the vitamin. This can lead to vitamin deficiency anemia, also known as pernicious anemia.
- *Anemia of inflammation.* Certain diseases—such as cancer, HIV/AIDS, rheumatoid arthritis, kidney disease, Crohn's disease, and other acute or chronic inflammatory diseases—can interfere with the production of red blood cells.
- *Aplastic anemia.* This rare, life-threatening anemia occurs when your body doesn't produce enough red blood cells. Causes of aplastic anemia include infections, certain medicines, autoimmune diseases and exposure to toxic chemicals.
- *Anemias associated with bone marrow disease.* A variety of diseases, such as leukemia and myelofibrosis, can cause anemia by affecting blood production in your bone marrow. The effects of these types of cancer and cancer-like disorders vary from mild to life-threatening.
- *Hemolytic anemias.* This group of anemias develops when red blood cells are destroyed faster than bone marrow can replace them. Certain blood diseases increase red blood cell destruction. You can inherit a hemolytic anemia, or you can develop it later in life.

- *Sickle-cell anemia.* This inherited and sometimes serious condition is a hemolytic anemia. It is caused by a defective form of hemoglobin that forces red blood cells to assume an abnormal crescent (sickle) shape. These irregular blood cells die prematurely, resulting in a chronic shortage of red blood cells.

Thyroid Disease

Your thyroid creates and produces hormones that play a role in many different systems throughout your body. When your thyroid makes either too much or too little of these important hormones, it's called a thyroid disease. The thyroid controls your metabolism with the T4 and T3 hormones. When your thyroid works properly, it will maintain the right amount of hormones to keep your metabolism working at the right rate. As the hormones are used, the thyroid creates replacements. Located in the center of the skull, below your brain, the pituitary gland monitors and controls the amount of thyroid hormones in your bloodstream. When the pituitary gland senses a lack of thyroid hormones or a high level of hormones in your body, it will adjust the amounts with its own hormone. This hormone is called thyroid stimulating hormone (TSH). The TSH will be sent to the thyroid and it will tell the thyroid what needs to be done to get the body back to normal. Hypothyroidism, often referred to as underactive thyroid gland, leads to inadequate thyroid hormone secretion. Symptoms include abnormal weight gain, tiredness, hair loss, cold intolerance, irregular menstrual cycle, infertility and constipation. Hyperthyroidism, often referred to as overactive thyroid gland, leads to excess thyroid hormone secretion. Symptoms include unexplained weight loss, nervousness, irritability, increased perspiration, heart racing, hand tremors, and anxiety.

A woman is about five to eight times more likely to be diagnosed with a thyroid condition than a man. Risk factors for developing thyroid disease include family history of thyroid disease, certain medical conditions (such as pernicious anemia, type 1 diabetes, lupus, rheumatoid arthritis), taking a medication that's high in iodine, being older than 60 (especially in women), or having had treatment for a past thyroid condition or cancer.

Bones and Connective Tissue Issues

Arthritis

Arthritis is the swelling and tenderness of one or more joints. The main symptoms of arthritis are joint pain and stiffness, which typically worsen with age. The most common types of arthritis are osteoarthritis and rheumatoid arthritis (**Figure 6-3**). Osteoarthritis causes cartilage to break down, whereas rheumatoid arthritis is a disease in which the immune system attacks the joints, beginning with the lining of joints. While arthritis usually affects older adults, it can develop in men, women, and children of any age. Arthritis is most common in the hands, feet, hips, knees and lower back. Arthritis is the most common cause of disability in the U.S. About 50 million adults and 300,000 children manage some form of arthritis.

Osteoporosis

Osteoporosis is a bone disease that develops when bone mineral density and bone mass decrease, or when the quality or structure of bone changes. This can lead to a decrease in bone strength that can increase the risk of fractures (broken bones). Osteoporosis affects women and men of all races and ethnic groups. Osteoporosis can occur at any age, although the risk for developing the disease increases as you get older. For many women, the disease begins to develop a year or two before menopause. Other factors to consider include:

- Osteoporosis is most common in non-Hispanic white women and Asian women.
- African American and Hispanic women have a lower risk of developing osteoporosis, but they are still at significant risk.
- Among men, osteoporosis is more common in non-Hispanic whites.
- Certain medications, such as some cancer medications and glucocorticoid steroids, may increase the risk of developing osteoporosis.

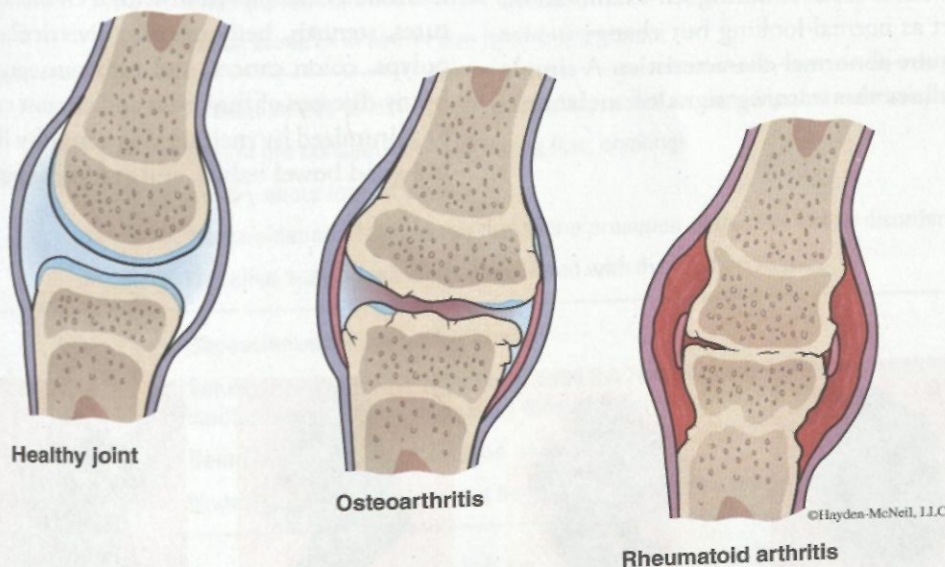


FIGURE 6-3. The Most Common Types of Arthritis Are Osteoarthritis and Rheumatoid Arthritis.

Skin Cancer

Many forms of skin cancer will permanently change a person's appearance. Skin cancer is the most common type of all cancers. The sun is responsible for over one million cases of non-melanoma skin cancer found in the United States each year.

Risk factors include:

- Severe sunburn during childhood
- Fair complexion
- Family history
- Occupational exposure to coal, tar, pitch, creosote, arsenic compounds, or radium

Prevention includes:

- Use of sunscreen with a sun protection factor (SPF) of 15 or greater
- Avoiding sun exposure between 11:00 A.M. and 2:00 P.M.
- Use of clothing and other garments to protect the skin from sun exposure

Skin cancer can be detected early, and both doctor and patient play a role in finding the cancer. It is important for people to know what to look for during self-examination. Moles often start as normal-looking but change in size or color and acquire abnormal characteristics. A simple ABCD rule outlines the warning signs of melanoma (Figure 6-4):

- Asymmetry—one half of the mole does not match the other half
- Border irregularity—edges are uneven, notched or scalloped
- Color—pigmentation is not uniform. Melanoma may vary in color from tan to deeper brown, reddish-black, black, or deep bluish-black
- Diameter—the diameter is greater than 6 millimeters (about the size of a pea)

Digestive Issues

Gastrointestinal Diseases

Gastrointestinal diseases affect the gastrointestinal (GI) tract from the mouth to the anus. There are two types: functional and structural. Functional diseases are those in which the GI tract looks normal when examined, but does not move properly. They are the most common problems affecting the GI tract (including the colon and rectum). Constipation, irritable bowel syndrome (IBS), nausea, food poisoning, gas, bloating, GERD, and diarrhea are common examples. Structural gastrointestinal diseases are those where your bowel looks abnormal upon examination and also does not work properly. Sometimes, the structural abnormality needs to be removed surgically. Common examples of structural GI diseases include strictures, stenosis, hemorrhoids, diverticular disease, colon polyps, colon cancer, and inflammatory bowel disease. Many diseases of the colon and rectum can be prevented or minimized by maintaining a healthy lifestyle, practicing good bowel habits, and getting screened for cancer.



Asymmetry



Border irregularity



Color



Diameter: ¼ inch or 6 mm

FIGURE 6-4. Simple ABCD Rule Outlines the Warning Signs of Melanoma. Source: National Cancer Institute.

Eating Disorders

Contrary to stereotypes, disordered eating impacts people of all sizes, races/ethnicities, and genders. Disordered eating can cause significant problems with relationships, work, and academic performance. Signs of various types of eating disorders are listed in **Table 6-1**.

Table 6-1. Signs of Various Types of Eating Disorders

DISORDER	SYMPTOMS
Anorexia	• Unusual eating habits, refusal to eat, or avoidance of events that center around food • Excessive weight loss (weight less than 85% of expected) • Extreme physical activity • Hair, nail, or skin problems • Depression and low self-esteem • Denial of the problem
Bulimia	• Purchasing large quantities of food • Feeling a lack of control while eating • Abuse of laxatives or diuretics • Secretive behavior regarding eating habits • Depression • Denial of the problem
Binge Eating	• Eating large amounts of food in one sitting • Eating until uncomfortably full • Feeling a lack of control while eating • Eating alone or in secret due to embarrassment
Avoidant/Restrictive Food Intake Disorder	• Avoidance due to issues with the texture, smell, or sensory characteristics of food • Fear of the consequences of eating (i.e., choking) • Apathy about food or eating • The avoidance of food is not due to the presence of another eating disorder • Negative body image is not associated with the food avoidance
Orthorexia	• Obsession with food being "healthy" • Refusal to eat entire categories of food (i.e., carbs, gluten, dairy) with no diagnosable medical reason for avoidance of those foods • Being overly critical of the food choices of others • Negative body image may not be associated with the food avoidance

If you feel you may have an eating disorder, you may wish to complete a free online screening for eating disorders (<https://www.helpyourselfhelpothers.org/>). If you are ready to seek professional assistance, please contact the NC State Counseling Center at 919.515.2423 or visit the Counseling Center in person to set up an appointment. The Counseling Center has clinicians with specific expertise in addressing eating concerns and an Eating Disorder Treatment Team to make sure best practices are being observed during treatment and when making referrals.

Drug Addiction Issues

A drug is any substance that alters one's ability to function emotionally, physically, intellectually, financially, or socially. Drug use refers to taking a drug correctly for a legitimate medical reason. Drug misuse is the unintentional or inappropriate use of prescribed or over-the-counter drugs, while drug abuse is intentional and inappropriate use of a drug resulting in physical, emotional, financial, intellectual, or social consequences for the user. Drug misuse may result from not understanding a drug's effects or its purpose, such as discontinuing too soon (e.g., antibiotics), consuming more than prescribed, not following directions for use, mixing drugs or more than one prescription without your doctor knowing, or saving and using old medication. A sign of drug dependency is experiencing physical or psychological withdrawal symptoms in the absence of the drug. Addiction occurs when brain functions are restructured leading to compulsive drug abuse despite negative consequences and at which

point it is an ingrained habit that undermines a person's health, work, relationships, and is difficult to change. A discussion of drugs that are commonly misused or become a dependency are discussed below.

Alcohol

With regards to alcohol there are several categories: social drinkers, which are considered low risk; problem drinkers or binge drinkers; and alcoholics who cannot control drinking and experience withdrawal. Moderate drinking is considered 2 drinks per day for men and 1 drink per day for women. Light drinking is less than that. Binge is considered 5 or more drinks in one sitting for men and 4 or more drinks in one sitting for women.

Factors contributing to alcohol use include cost, urban versus rural neighborhood, gender, sexual orientation, ethnicity, age, and income. Issues that can arise from excessive alcohol consumption are listed in Table 6-2.

Table 6-2. Issues that Can Arise from Excessive Alcohol Consumption

SYSTEM IMPACTED	IMPACTS
Liver	Fatty liver, alcohol hepatitis, cirrhosis (liver cells destroyed)
Gastrointestinal	Impacts absorption of nutrients/malnutrition, irritated stomach, can cause stomach bleeding, irritation of esophagus, acute pancreatitis
Cardiovascular	High blood pressure

Tobacco and E-Cigarettes

Tobacco use has greater prevalence in females, ages 25–44 years (18–25 for smokeless tobacco), and greater in non-college vs. college students. Tobacco use tends to have triggers including following a meal, talking on the phone, drinking coffee, and being around other smokers. Tobacco is highly addictive and has been compared to heroin and cocaine addiction. It is highly reinforcing as it reaches the brain in a few seconds and nicotine releases the neurotransmitter norepinephrine (stimulation, appetite suppression). An electronic cigarette (e-cigarette) is an electronic device that simulates tobacco smoking. It consists of an atomizer, a power source such as a battery, and a container such as a cartridge or tank. Instead of smoke, the user inhales vapor. As such, using an e-cigarette is often called “vaping.” Although it has gained popularity, e-cigarettes contain nicotine and are not considered safe.

Pain Killers and Over-the-Counter Drugs

Over-the-counter (OTC) drugs are perceived as being relatively harmless because they are readily accessible, are often marketed as medication instead of drug (thus helpful versus harmful), and some have been switched from prescription to OTC (e.g., emergency contraception). Issues arise with OTC drugs as many people do not follow directions carefully. Abuse is most commonly by teens (e.g., decongestants, cough suppressants, anti-histamines) whereas issues often occur in elderly due to incompatible combining (e.g., aspirin and alcohol).

Substance Use Disorders

According to the National Survey on Drug Use and Health (NSDUH), 19.7 million American adults (12 and over) battled a substance use disorder. Approximately

74% of adults with substance use disorder struggled with an alcohol use, approximately 38% of adults battled an illicit drug use disorder, 1 out of 8 adults struggled with both alcohol and drug use simultaneously, and 8.5 million adults suffered both mental health and substance use disorder.

As stress increases, people may have fewer ways to manage it, which contributes to the uptick in substance misuse. In recent years, resilience-promoting activities, like physical activity and social interactions, haven't been as safe to engage in or easy to access, which can lead some people to start using drugs or use them more often or in greater amount.

Sexual Health Issues

Sexually Transmitted Infections (STIs)

The continual rise of sexually transmitted infections (STIs) is the result of several factors. One of these factors is a rise in sexual activity with many individuals having multiple partners. Another factor is that the use of spermicides and condoms has decreased as the use of birth control pills has increased. Many STIs do not produce obvious symptoms, so people are often unaware that they have an STI. Feelings of guilt, embarrassment, and denial may prevent people from seeking adequate treatment. Six of the most well-known STIs are explained in **Table 6-3**.

Table 6-3. Symptoms, Diagnosis, and Treatment for the Most Well Known STIs

STI	SYMPTOMS	DIAGNOSIS	TREATMENT
Chlamydia	Females: • Mild irritation • Itching of genital tissues • Burning during urination • Slight discharge PID symptoms • Disrupted menstrual periods • Pain in the lower abdomen • Elevated temperature • Nausea • Vomiting • Ectopic pregnancy may also occur Males: • Burning sensation during urination and discharge of pus • Sensation of heaviness in the affected testicle • Inflammation of scrotal skin • Formation of small area of hard painful swelling of the testicle	• Obtain urethral or cervical discharge, grow a culture and examine the culture. • A urine test that detects bacterial DNA in the urine.	• Treated and cured with a week of antibiotic drugs such as erythromycin and doxycycline. • Penicillin is not effective.
Gonorrhea (Clap)	• Foul-smelling yellowish-green, cloudy discharge from the penis • Burning sensations during urination	• A smear is made of the discharge and examined microscopically. • A culture is grown and then examined. • An application of an enzyme-sensitive immunoassay can detect gonorrhea.	• Penicillin used to be the cure-all; however, there are now penicillin-resistant strains, so patients may use ceftriaxone, azithromycin, and doxycycline.

(Continues on the next page.)

STI	SYMPTOMS	DIAGNOSIS	TREATMENT
Herpes	Small painful, red bumps which usually appear between 2 and 12 days after sexual contact.	- Direct observation. - Cultures of virus grown in lab.	- Antiviral drugs, such as acyclovir, to reduce discomfort and speed healing during the initial outbreak. - Use of valacyclovir has been shown to both suppress and reduce duration of outbreaks.
Syphilis	Primary - Painless sore ("chancre")—10 to 90 days after exposure, at site where spirochete enters the body. 95% of chancres are on the genitals; others occur in the mouth, lips, tongue, rectum or anus. Secondary - Skin rash on hands and feet. - Raised bumps with rubbery, hard consistency (typically, does not hurt or itch). - Fever, swollen lymph glands, fatigue, weight loss and sores. Latent - May be no observable symptoms. Tertiary - Severe, may result in death.	- Blood tests. - Microscopic examination of fluid from chancre.	Primary and secondary syphilis treated with a single intramuscular injection of penicillin. If the patient is allergic, then tetracycline erythromycin can be prescribed. Latent and tertiary syphilis requires larger doses of antibiotics over a period of several weeks.
HPV (Human Papilloma virus) or Genital Warts	Females: - Warts appear at the bottom part of vaginal opening, perineum, labia, inner walls of vagina and cervix. Males: - Warts commonly occur on glans, foreskin and shaft of penis.	- Observation. - Tissue biopsy.	- Remove by laser. - Treat with acid. - Topical applications (podophyllin). - Freeze with liquid nitrogen. - Surgical removal. - The virus remains in the body and warts can often reappear.

Abstinence is the most effective way to avoid sexually transmitted infections. Abstinence is defined differently according to different groups. Some would state that abstinence can be defined as not engaging in vaginal intercourse. Thus, those only engaging in oral-genital sex would be defined as abstinent according to the previous definition. Here, abstinence will be defined as not engaging in any type of sexual contact such as penile-vaginal, penile-anal, oral-genital, mutual masturbation, or cross-contact of penile/vaginal fluids. People choose abstinence for a variety of reasons. Some of these include fear of pregnancy and STIs, health issues, moral/religious purposes, and because they have no current relationship. For those who do not choose abstinence, be clear about your boundaries. Make sure your partner knows what

sexual activities that you will participate in and the ones that you will not. Research various methods of contraception, in order to avoid pregnancy, to choose the one that will work best for your lifestyle and medical history. In conclusion, the only method of contraception that works 100% of the time in the prevention of STIs is abstinence.

HIV/AIDS

In the U.S., there are up to 1 million people with HIV and 40,000 new cases of HIV each year. Worldwide, there are 33 million people infected with HIV, with over 3 million new infections each year. HIV causes AIDS. It took 8 years to record the first 100,000 AIDS cases, and just 2 years for the next 100,000 cases.

The most common fluids involved in the transmission of HIV are blood, semen, and vaginal secretions. The virus can be transmitted in the womb and through breast milk. HIV is found in saliva, tears, urine, and feces, but the possibility of transmission from these fluids has been shown to be unlikely.

HIV is a retrovirus which consists of a protein shell surrounding the genetic material RNA. HIV attaches to T-lymphocytes known as CD4s, a type of white blood cell, and injects its RNA into the CD4 cell. RNA is then converted into DNA by an enzyme called reverse transcriptase. The HIV DNA hijacks the CD4's DNA, causing the cell to become a viral factory. Numerous viral particles are produced, and then they break through the CD4 membrane, causing cellular death, and go on to invade other CD4 cells. Over time, this action suppresses the immune system, leaving the individual vulnerable to other infectious agents.

There are four stages of HIV infection. The duration of these stages varies according to the person's health.

1. Primary HIV disease occurs soon after being infected with HIV. Some people experience a fever, swollen glands, and fatigue. They may think they have the flu. As the immune system charges into action, these symptoms usually subside within a couple of weeks.
2. Chronic asymptomatic disease is a decline in the immune cells with no specific disease symptoms.
3. Chronic symptomatic disease is a major depletion of immune cells, leaving the body vulnerable to opportunistic infections. One common infection is a yeast infection of the mouth called thrush. Other symptoms during this stage are fevers, diarrhea, night sweats, and weight loss.
4. AIDS: Diagnosis is made after one or more of 26 diseases has appeared. An example is pneumocystis carinii which is pneumonia caused by a proliferation of a fungus due to a suppressed immune system.

When someone becomes infected with HIV, the body begins to produce antibodies in an attempt to destroy the virus. Antibodies to the virus are what HIV tests are trying to detect. Generally, antibodies show up anywhere from 6 weeks to 6 months after infection. Thus, a person may be advised to get another test 6 months later after their last suspected infection incident. The local health department can administer an HIV test.

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chapter 7



Nutrition and Energy Balance

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Introduction

Weight that is higher than what is considered healthy for a given height is described as overweight or obesity. Body Mass Index (BMI) is a screening tool for overweight and obesity. Rates of individuals who are overweight or obese is a growing concern in the United States and around the world. According to the Centers for Disease Control and Prevention (CDC), 73.6% percent of adults aged 20 and over in the U.S. were categorized as overweight or obese and approximately 36.9% were obese (based on 2015–2016 data). In the United States, 37.9% of men and 41.1% of women are considered to be obese, which is twice as many as three decades ago. As of 2022, the United States ranked 12th in the world for obesity. It is estimated that by 2030, 20% of the world's population will be obese (TFAH 2020).

Obesity is the result of several factors including overeating, lack of physical activity, poor diet choices, genetics, metabolism, and culture. Americans are more likely to consume simple carbohydrates, convenient fast food, and processed pre-packaged foods. These foods tend to be higher in calories, less filling, and less nutrient-dense, causing people to consume more calories than they need. This caloric surplus combined with a lack of physical activity and exercise causes weight gain over time. For healthy weight management, and to combat the negative effects of obesity-related issues, physical activity and caloric intake must be balanced.

Energy balance involves being aware of the balance of proper physical activity and nutritional habits. Therefore, the first step towards eating nutritionally is to develop a better understanding of nutrients, where they come from, what they do in the body, and how much of each you need. The next step is to translate this nutritional knowledge into a diet consisting of appropriate amounts of foods that are both affordable and enjoyable then balancing diet with your physical activity. This chapter will explain the basic principles of nutrition and body composition based on guidance contained in the latest editions of the Dietary Guidelines for Americans (2020–2025) and Physical Activity Guidelines for Americans (2018).

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Chapter Seven

Dietary Components

Nutrients are divided into six classes, which we refer to as essential nutrients, which are broken down into two categories: **macronutrients** and **micronutrients**. Macronutrients are needed in relatively large amounts (gram or kilogram), whereas micronutrients are needed in small quantities (milligram or microgram). Carbohydrates, protein, fat, and water are macronutrients; vitamins and minerals are micronutrients. It is essential that your diet consist of nutrients from all six essential nutrients in order for the body to function properly. Many individuals consume too much of one nutrient and not enough of another. If your dietary intake is unbalanced, you run the risk of reducing your energy levels, impairing body processes, and increasing the risk of developing several chronic diseases or conditions.

Carbohydrates

Carbohydrates are used for energy during moderate- and high-intensity exercise. When ingested, carbohydrates are broken down into glucose, which circulates in the blood and is a readily available energy source for the cells. Any glucose that is not used is stored as glycogen in the liver and skeletal muscles. When energy is needed again, the glycogen can be converted back to glucose for use. There are limits as to how much glucose can be stored as glycogen, so any excess can be converted and stored as fat.

Carbohydrates are classified into two groups: simple and complex. **Simple carbohydrates** are defined structurally as monosaccharides (e.g., glucose, fructose, galactose) and disaccharides (e.g., sucrose, maltose, lactose). Simple carbohydrates occur naturally in fruits, honey, sweet potatoes, milk products, and some cereal products. Simple carbohydrates are also added to foods during processing and preparation to add calories and taste, but they offer limited other essential nutrients.

Complex carbohydrates, which include starches and fiber, are made up of long-chain monosaccharides linked together into polysaccharides. Starches are found in a variety of plants, especially grains (wheat, rice, oats, barley), legumes (beans, peas, and lentils), and tubers (potatoes and yams). Most vegetables contain a mixture of simple and complex carbohydrates. Fiber is a non-digestible carbohydrate found in fruits, vegetables, and grains. Rather than being digested like starches, fiber moves through the intestinal tract and provides bulk in the large intestine to

aid in the elimination of waste. The daily recommended amount of fiber for women is 21–25 grams and for men is 30–38 grams, which can be found in fresh fruits, vegetables, and foods made from whole grains.

When carbohydrates are broken down after a snack or meal, there is a spike not only in blood glucose levels, but an increase in insulin levels as well. Some carbohydrates cause an immediate rise in blood insulin, while others result in a slower insulin release. The effect carbohydrates have on the speed of insulin released into the bloodstream is known as the **glycemic index**. High glycemic index foods, which increase the speed of insulin release, include foods such as simple sugars, white rice, and potatoes. Low glycemic index foods, which decrease the speed of insulin release, include foods such as whole grains and vegetables.

Protein

Proteins are important for tissue growth and repair, production of enzymes and hormones, and regulation of the acid–base quality of body fluids.

Amino acids are the basic units or building blocks for protein. Roughly 500 amino acids have been identified in nature, but just 20 amino acids make up the proteins found in the human body. Nine of these 20 amino acids are considered essential as they cannot be made by the body and must be obtained from food. The remaining 11 are considered non-essential because they can be produced endogenously and are manufactured by the body.

Proteins sources are classified as complete or incomplete. **Complete** protein sources provide all the essential amino acids whereas **incomplete** proteins lack one or more of the essential amino acids. Eggs are a perfect protein, to which all other food sources are compared. Animal foods (e.g., meat, fish, and dairy products) are complete proteins. Vegetarian sources include quinoa, soy products (e.g., tofu, tempeh, and edamame), and pseudocereals including quinoa, amaranth, buckwheat, and hemp seeds and chia seeds. Incomplete proteins include whole grains, legumes, and nuts.

Fats

Fats are also an important energy source for our bodies, especially during low-intensity exercise and during rest. Fat is a dense fuel source, providing 9 calories per gram. In addition to being an energy source, fats have other

important functions in the body. Fats provide cushion and support for the body's vital organs, they help our bodies retain heat by acting as insulation, and they are needed for the absorption of fat-soluble vitamins. Most importantly, fats provide foods with texture and flavor and help us to feel satiated after a meal.

Of the three types of fats common in foods (triglycerides, phospholipids, and sterols), triglycerides make up about 95% of the fat we eat. Triglycerides are also the form of fat commonly found in the body. Triglycerides have different fatty acid structures that can result in a different type of fat based on their length, level of saturation, and shape. Different types of fatty acids have different characteristics and different effects in your body. Regardless of the type of fat, the small intestine is where the major part of fat digestion occurs.

The designation of saturation is based on the number of double bonds in the fatty acid chain. Saturated fats have no double bonds; therefore, they can be packed more tightly, which is why most saturated fats are solid at room temperature. The unsaturated fats, (e.g., monounsaturated and polyunsaturated), contain one or more double bonds in the chain and are typically in the *cis* shape. These fats tend to be liquid at room temperature because they cannot be packed tightly together.

Another form of fat that occurs naturally, but is prominent in our food due to a man-made process, is *trans* fat. **Trans fats** are made by heating unsaturated fats to remove some or all of the double bonds, resulting in a chain similar to that of saturated fat. *Trans* fats are used especially in processed crackers and snacks in order to prolong shelf-life. If you read *hydrogenated* or *partially hydrogenated* oil in the list of ingredients, the product contains *trans* fat. Because *trans* fats are as great a concern as saturated fats, food manufacturers are now required to list the amount of *trans* fat in their products. As a result, there has been a movement to reduce or eliminate *trans* fats from many products.

Table 7-1. Sources of Triglycerides

TYPE OF FAT	FOOD SOURCES
Saturated	Animal sources: cheese, whole milk, half and half, lard, bacon, hot dogs Tropical oils: palm oil, coconut oil
Monounsaturated	Olive, peanut, canola, and avocado oils
Polyunsaturated (omega-3 sources)	Corn, safflower, sunflower, soybean, sesame, and vegetable oils
<i>Trans</i> fat	Processed foods: snack crackers, cookies, cereals

The majority of our fat intake should be from monounsaturated and polyunsaturated fats. One polyunsaturated fat, omega-3 fatty acids, helps to reduce heart-related diseases. *Omega-3* fatty acids are considered essential because the body cannot make them. *Omega-3* fatty acids are found in fish and certain nuts and seeds (e.g., hempseeds, flaxseeds, chia seeds, and walnuts).

Cholesterol is a sterol fat found in foods of animal origin or synthesized within the body. Cholesterol is not found in vegetable food sources and is negligible in egg whites and skim milk. The highest content of cholesterol is found in egg yolks. Other foods that contain large amounts are red meat, organ meats (e.g., liver, kidney, and brain), and dairy products such as ice cream, butter, cheese, and whole milk.

In the body, we are typically concerned about High Density Lipoproteins (HDL) and Low Density Lipoproteins (LDL). HDL is produced in the liver and small intestine and is known as the "good" cholesterol because it protects against heart disease by removing cholesterol from the artery wall and carrying it to the liver, where it is converted into bile and excreted through the intestine. LDL is known as the "bad" cholesterol because it deposits cholesterol on the artery walls that can build up, resulting in "plaque" formation, which causes limited or stopped blood flow. *Trans* fats, like saturated fats, increase LDL levels and decrease HDL, contributing to the onset of heart disease.

In the United States, our dietary fat intake on average is about 40–50% of our total caloric intake. The American Heart Association suggests a diet of less than 30% of total calories from fat, with saturated, monounsaturated, and polyunsaturated fats making up 10% each. Cholesterol is continually manufactured by the body and therefore should be limited to less than 300 milligrams per day.

Vitamins

Vitamins are water-soluble or fat-soluble organic substances required in small amounts to regulate important processes in the body and to perform very specific functions for the metabolism of carbohydrates, fats, and proteins for energy.

The fat-soluble vitamins, A, D, E, and K, are stored in the liver and in the cells of adipose tissue and therefore are retained for a relatively long time in the tissue. They are absorbed with dietary fat in the intestines.

Table 7-2. Fat-Soluble Vitamins

VITAMIN	FUNCTION	SOURCES
Vitamin A	Important in vision and resistance to infection	Leafy green vegetables, yellow and orange vegetables, milk, butter, cheese
Vitamin D	Growth of bones and calcium absorption	Eggs, dairy products, fortified milk, fish liver oil
Vitamin E	Antioxidant* to prevent cell damage by free radicals	Seeds, leafy green vegetables, margarine
Vitamin K	Blood clotting	Green leafy vegetables, cereals

Water-soluble vitamins, which are the B vitamins and vitamin C, dissolve in water and are associated with the water parts of food and body tissue. Water-soluble vitamins are absorbed through the intestinal wall directly into the bloodstream. Water-soluble vitamins cannot be stored in the body and, if not used, will be flushed out in the urine. Your diet must contain these on a regular basis.

Table 7-3. Water-Soluble Vitamins

VITAMIN	FUNCTION	SOURCES
Thiamine (B1)	Releases energy from carbohydrates during metabolism; growth and muscle tone	Fortified cereals and oatmeal, rice, pasta, meats, whole grains, and liver
Riboflavin (B2)	Releases energy from protein, fat, and carbohydrates during metabolism	Whole grains, green leafy vegetables, organ meats, milk and cheese
Niacin (B3)	Carbohydrate, fat, and protein metabolism; fatty acid synthesis	Meat, poultry, fish, potatoes, dairy products, eggs, enriched cereals
Pantothenic Acid (B5)	Energy metabolism, production of red blood cells, hormone production	Meat, vegetables, unprocessed grains
Pyridoxine (B6)	Builds body tissue and aids in metabolism of protein	Fish, poultry, lean meats, bananas, dried beans, whole grains, avocado
Biotin (B7)	Energy metabolism, hair and nail health	Eggs, nuts, fish, nut butter, beans, whole grains
Folate (B9)	Protein and amino acid metabolism, DNA synthesis, red blood cell production	Green leafy vegetables, organ meats, dried peas, beans, and lentils
Cobalamin (B12)	Development and functioning of the nervous system; protein and fat metabolism, formation of red blood cells, brain and nervous system function	Meats, milk products, and seafood
Vitamin C (ascorbic acid)	Bone, cartilage, muscle, and blood vessel structure; maintains capillaries and gums; aids in absorption of iron	Citrus fruit, berries, vegetables—especially peppers

Minerals

Minerals differ from the other five essential nutrients in that they are not broken down during digestion or absorption. Instead they maintain their structure in all environments. Minerals have many functions in the body. First, they help maintain proper fluid balance and normal cell and muscle activity. Second, they provide structure in the formation of bones and teeth. Third, they help maintain normal heart rhythm, muscle contractions, and nerve impulse conduction. Fourth, they regulate metabolism.

Minerals cannot be produced in the body, and therefore must be obtained from the diet on a regular basis. There are 18 minerals known to be useful to the body, and seven are considered essential and have FDA requirements. Minerals are divided into two groups, major and trace, based on how much is found in our bodies and how much we need to consume through our diet.

Trace minerals are required in amounts less than 100 mg per day. Common trace minerals include selenium, iron, copper, zinc, fluorine, iodine, chromium, molybdenum, and manganese. Of these trace minerals, iron deficiency is common, especially in females. Iron is important for transporting oxygen to the body, which is especially important for exercise. Iron can be found in eggs, lean meat, legumes, whole grains, and dark green leafy vegetables.

Table 7-4. Major Minerals: Needed in Greater than 100 mg per Day

MINERAL	FUNCTION	SOURCES
Calcium	Bone and teeth formation; blood clotting; nerve transmission; weight maintenance	Milk, cheese, dark green vegetables, dried legumes
Sodium	Acid-base balance; body water balance; nerve function	Salt
Potassium	Acid-base balance; fluid balance; nerve transmission	Leafy vegetables, cantaloupe, lima beans, potatoes, bananas, milk, meats
Chloride	Acid-base balance; fluid balance; nerve transmission	Salt
Magnesium	Strengthen bones; release of energy	Nuts, eggs, whole grain cereals, leafy green vegetables, seeds, beans, bananas
Phosphorus	Works with calcium to strengthen bones	Dairy products, meat, poultry, eggs, whole grain cereals, legumes
Sulfur	Component of B vitamins thiamine and biotin; helps to stabilize the shape of proteins	Synthesized from protein-containing foods

Water

Water is essential for our survival. We can go weeks without food, but we can only survive a few days without water. Water has many functions. Water is important for muscle contraction, nerve conduction, waste elimination, joint lubrication, nutrient transport, metabolism, and proper fluid balance.

About 50–70% of a healthy individual's body weight is water. As we age, our body water decreases. In addition, males usually have a higher percentage of their total body mass coming from water than females. This difference is due to the amount of lean muscle tissue (lean muscle is 70% water) as compared to fat tissue.

The recommended intake for females and males is 2.7 and 3.7 quarts of water each day, respectively. We get this water from liquid, food, and metabolic processes. It is recommended that we drink a minimum of 8 glasses of water a day. We usually consume around 1,350 milliliters of water in liquid, 1,000 milliliters from foods, especially fruits and vegetables that have a high water content, and the rest from metabolized water when food nutrients are broken down for energy. Additional water intake will be required during exercise and in hot or humid weather.

Thirst is not always a reliable early indicator of the body's need for water as many people do not feel thirsty until they are already dehydrated. When you lose body fluid equivalent to just 2% of your body weight, you will feel thirsty and your body's ability to perform starts to fall. When you lose 3%, you become thirstier and may experience symptoms such as feeling faint and suffering a loss of appetite. When you lose 4% to 5% of your body weight, you experience dehydration symptoms such as fatigue, headaches and dizziness (Yoshida et al., 2002). Hydration is also important for exercise as research has found that athletic performance is reduced by 10–20% at 2% dehydration, and losses in excess of 5% of body weight can decrease the capacity for work by about 30%. In addition, at 4–5% dehydration, cognitive function is also reduced by 20–30% (Jeukendrup and Gleeson, 2010).

Recommended Dietary Intakes

Dietary Reference Intake for Macronutrients

The Food and Nutrition Board's Dietary Reference Intake committee (DRI) created a group to evaluate current information pertaining to macronutrients (e.g., carbohydrates, proteins, and fats) found in scientific literature to expand upon the DRIs. Their goals were four-fold:

1. Evaluate what foods provide the best quality macronutrients;

2. Develop intake levels that would influence good nutrition for life and decrease the risk of disease;
3. Evaluate the safety of consuming large quantities of certain macronutrients; and
4. Specifically address macronutrient requirements for certain populations.

The DRI includes four types of nutrient standards: Adequate Intake (AI), Estimated Average Requirement (EAR), Tolerable Upper Intake Level (UL), and Recommended Dietary Allowance (RDA). DRIs are frequently reviewed and updated as new nutrition-related information becomes available. In 2002, the Institute of Medicine (IOM) published the Dietary Reference Intake for Macronutrients, designed to replace and expand upon the former RDAs (Recommended Daily Allowances) established by the Food and Nutrition Board (Institute of Medicine, 2002). This report established ranges for fat, carbohydrates, and protein, and stressed the importance of a balanced diet with exercise. Highlights of the report include:

- Adults should get 45% to 65% of their calories from carbohydrates, 20% to 35% from fat, and 10% to 35% from protein (Figure 7-1).

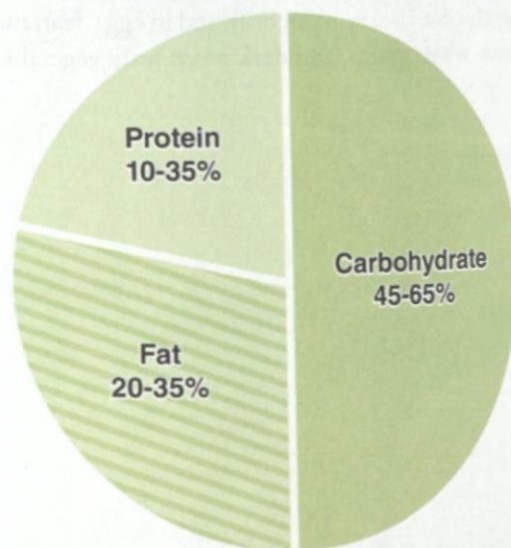


FIGURE 7-1. Recommended Macronutrient Distribution Range.

- Added sugars should comprise no more than 25% of total calories consumed. Added sugars are those incorporated into foods and beverages during

production, which usually provide insignificant amounts of vitamins, minerals, or other essential nutrients. Major sources include soft drinks, fruit drinks, pastries, candy, and other sweets.

- The recommended intake for total fiber for adults 50 years and younger is set at 38 grams for men and 25 grams for women, due to decreased food consumption.
- Using new data, the report reaffirms previously established recommended levels of protein intake, which is 0.8 grams per kilogram of body weight for adults; however, recommended levels for pregnancy are increased.
- The report did not set maximum levels for saturated fat, cholesterol, or *trans* fatty acids, because increased risk exists at levels above zero; however, the recommendation is to eat as little as possible while consuming a diet adequate in other important essential nutrients.
- Recommendations are made for linoleic acid (an omega-6 fatty acid) and for alpha-linolenic acid (an omega-3 fatty acid).

Using the Nutrition Facts Label

The U.S. Food and Drug Administration (FDA) requires a Nutrition Facts label on most packaged foods and beverages. If you are buying food, it is important to know how to read package labels. By knowing how to read the food facts on the food label, you will be able to make wise choices and meet the daily dietary recommendations.

At the top of the Nutrition Facts label (**Figure 7-2**), you will find the total number of servings in the container and the serving size. The serving size on the label is based on the amount of food that people typically eat at one time and is not a recommendation of how much to eat. The rest of the nutrition information on the label is usually based on one serving of the food or beverage but it can also be for the whole container (see Food Label A). However, if the container has more than one serving but could be consumed in one sitting—such as a pint of ice cream—the label will have two columns (see Food Label B). The first column lists the calories and nutrients in one serving. The second column lists the calories and nutrients in the entire container. If you eat a whole package of food that contains two servings, you will get twice as many calories, nutrients, sugar, and fat as are found in one serving.

A

Nutrition Facts	
Serving Size 1 cup (228g)	
Servings Per Container 2	
Amount Per Serving	
Calories	250
Calories from Fat	110
% Daily Value*	
Total Fat 12g	18 %
Saturated Fat 3g	15 %
Trans Fat 3g	
Cholesterol 30mg	10 %
Sodium 470mg	20 %
Total Carbohydrate 31g	10 %
Dietary Fiber 0g	0 %
Sugars 5g	
Protein 5g	
Vitamin A	4 %
Vitamin C	2 %
Calcium	20 %
Iron	4 %

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

B

Nutrition Facts

Serving Size 16 pieces (40g)

Servings Per Container 2.5

Amount Per Serving	1 Serving	2.5 Servings 1 Container
Calories	150	370
	% DV*	% DV*
Total Fat	0g 0%	0g 4%
Sodium	25mg 0%	60mg 3%
Total Carbohydrate	37g 12%	92g 31%
Sugars	26g	64g
Protein	0g	0g
Iron	2%	2%

Not a significant source of calories from fat, saturated fat, trans fat, cholesterol, dietary fiber, vitamin A, vitamin C, calcium, and iron.

**Percent Daily Values (%DV) are based on a 2,000 calorie diet.

FIGURE 7-2. Food Nutrition Label.

Percent Daily Value (DV) is a reference amount of a nutrient to consume each day. The percent Daily Value (%DV) tells you how much a nutrient in a serving of the food contributes to a total daily diet. Daily Values are based on a 2,000-calorie diet, so if you are eating fewer calories and then eat a serving of this food, your %DV will be higher than what you see on the label. Some nutrients on the Nutrition Facts label do not have a %DV, so use the number of grams to compare and choose products.

The nutrition label also provides information on areas of special nutritional concern due to over- or under-consumption of nutrients. Most Americans exceed the recommended limits for saturated fats, sodium, and added sugars. Many Americans also do not get the recommended amounts of dietary fiber, vitamin D, calcium, iron and potassium. Eating a variety of foods that contain these nutrients can reduce the risk of developing some diseases and conditions, such as cardiovascular disease, osteoporosis, and high blood pressure.

When reading labels, it is also important to read through the ingredients list. Ingredients are listed in descending order of weight. By looking through the ingredients, you can determine if sugars, fats (especially *trans* fats), and other additives and chemicals have been added to the product. You can compare similar products to find a food that has the most natural and best quality ingredients.

Determining a Serving Size

Table 7-5 offers some tips to help you correctly estimate the size of your food portions. You may need to use measuring spoons and cups at first to have an accurate measure.

Table 7-5. Food Serving Size Equivalents

FOOD SERVING	SERVING SIZE EQUIVALENT
1 teaspoon of margarine/butter	tip of your thumb
1 ounce of cheese	your thumb or four dice stacked together
3 ounces of meat	a deck of cards or the palm of your hand
½ cup of rice or cooked vegetables	an ice cream scoop
2 tablespoons of peanut butter	a ping-pong ball
1 cup of pasta	a woman's fist or a tennis ball
1 medium potato	a computer mouse
1 apple/peach/orange/pear	a baseball

Nutritional Guidelines and Recommendations

In 1980, the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) joined efforts to provide science-based advice for reducing the risk of diseases and promoting health through a proper diet and physical activity. These recommendations are called the Dietary Guidelines for Americans and are updated every five years. Below you will find the current *2020–2025 Dietary Guidelines for Americans* recommendations, updated in 2020.

Key Recommendations

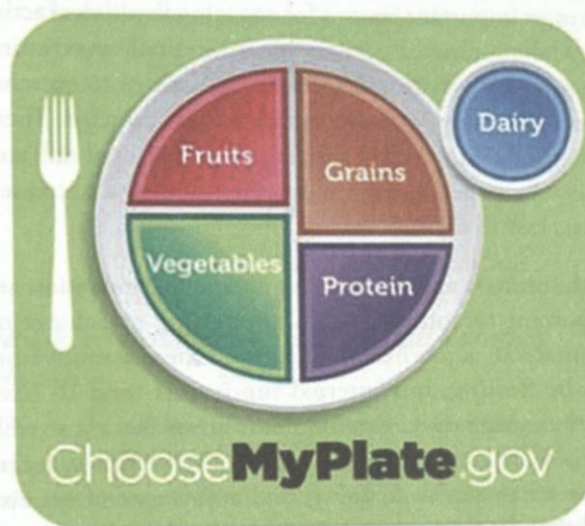
1. Follow a healthy dietary pattern at every life stage.
2. Customize and enjoy nutrient-dense food and beverage choices to reflect personal preferences, cultural traditions, and budgetary considerations.
3. Focus on meeting food group needs with nutrient-dense food and beverages, and stay within calorie 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 grain

- 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. Guidelines are listed below:
- 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. Drinking less alcohol is better for health than drinking more. There are some adults who should not drink alcohol, such as women who are pregnant.

My Plate

In 2011, the United States Department of Agriculture replaced the food pyramid model with the MyPlate model, which is the current nutrition guide for portion size and balanced nutrition. MyPlate is designed to simplify healthy eating by eliminating recommendations for serving numbers and sizes. By showing that servings of fruits and vegetables should be larger than grains, it is easier to portion out a healthy meal. Keep in mind that the amounts of fruits, vegetables, whole grains, proteins

and dairy will vary depending on your age, sex, and level of physical activity. You can find this information on the many charts available for you on the ChooseMyPlate.gov website.



Developing a Healthy Relationship with Food and Physical Activity

There is an undeniable relationship between food and physical activity. Food provides energy; physical activity utilizes energy. Having a healthy relationship with food means not looking at food as a reward for physical activity or at physical activity as a punishment for food. It involves making conscious, mindful efforts to put healthy and nutritious food into your body and finding intrinsic motivation for regular physical activity.

Intrinsic and Extrinsic Motivation

Self-regulation is an important concept for understanding why individuals are motivated to eat healthy and be physically active. Factors that influence self-regulation can be organized into two categories: intrinsic motivators and extrinsic motivators. Intrinsic motivation represents our internal drive towards behaviors, while extrinsic motivation includes factors such as rewards or punishment.

Many people begin a physical activity plan because they are motivated by extrinsic factors, such as a desire to lose weight or to get in better shape. Unfortunately, body-related motives are not usually sufficient to sustain a regular exercise program, and, therefore, should not be the most important reasons for engaging in physical activity. Making physical activity more internally motivating is a practical way to enhance the persistence to exercise. There are many intrinsic motivators to exercise. These can include improved health, enhanced personal skill and ability, increased energy, improved mood, and decreased stress, just to name a few.

Both intrinsic and extrinsic regulators of motivation are important to consider when attempting to achieve or maintain an active healthy lifestyle. External motivators can be fleeting, but internal motivators tend to have more staying power. Research has shown that those who focused on internal motivators like self-efficacy, interest in what they were doing, and enjoyment of exercise had the most success at long-term weight management (Teixeira et al., 2006).

Mindful Eating

Mindful eating focuses on your eating experiences, body-related sensations, and thoughts and feelings about food, with heightened awareness and without judgment. Attention is paid to the foods being chosen, internal and external physical cues, and your responses to those cues. The goal is to promote a more enjoyable meal experience and understanding of the eating environment. Mindful eating is guided by four aspects: *what to eat*, *why we eat*, *what we eat*, *how much to eat*, and *how to eat* (Fung et al., 2016). The opposite of mindful eating, sometimes referred to as mindless or distracted eating, is associated with anxiety, overeating, and weight gain (Stanszus et al., 2019). Examples of mindless eating include eating while driving, working, or viewing a television or other screen (phone, tablet) (Ogden et al., 2013). Although socializing with friends and family during a meal can enhance an eating experience, talking on the phone or taking a work call while eating can detract from it. In these scenarios, one is not fully focused on and enjoying the meal experience.

Intervention studies have shown that mindfulness approaches can be an effective tool in the treatment of unfavorable behaviors, such as emotional eating and binge eating, that can lead to weight gain and obesity. Research has also shown that mindful eating can lead to greater psychological well-being and body satisfaction (Katterman et al., 2014). Mindful eating is associated with a higher diet quality, such as choosing fruit instead of sweets as a snack or opting for smaller serving sizes of calorie-dense foods (Fung et al., 2016). Lastly, mindfulness training develops the skills needed to be aware of and accept thoughts and emotions without judgment and helps a person be able to distinguish between emotional hunger cues and physical hunger cues (Ruffault et al., 2017). Mindful eating is an approach to eating that can complement any eating pattern.

A note about eating disorders: It is important to note that mindful eating is not intended to replace traditional treatments for severe clinical conditions such as eating disorders. If you or someone you know is struggling with an eating disorder, you can call the National Eating Disorders Association Helpline at 1-800-931-2237. Resources are also available at the NC State Counseling Center (919.515.2423).

A note about food insecurity: Many individuals may be facing food shortages for any number of reasons. If you (or someone you know) are struggling to access enough food to keep yourself healthy, there are several options to help. NC State is dedicated to providing support for those who are food and/or housing insecure. From the Feed the Pack Food Pantry to temporary and emergency housing, there are resources for students across campus. More information can be found at: <https://dasa.ncsu.edu/support-and-advocacy/pack-essentials/food-and-housing-resources/>

Intuitive Eating and Internal Signals for Eating

The concept of intuitive eating involves rediscovering the ability to eat according to internal cues, specifically eating in response to physical hunger and stopping when physically full or satiated (Tribble & Resch, 2012). The ability to use hunger and fullness cues has been shown to be related to fewer disordered eating symptoms, greater body positivity, higher self-esteem, and maintaining a healthier weight (Tylka & Kroon Van Diest, 2013).

Steps for learning how to listen to hunger and fullness cues include:

1. *Pay attention to eating.* To be able to detect hunger and fullness signals, we have to pay attention to the process of eating, the experience, and our bodies' sensations (Tribole, 2010).
2. *Identify physical hunger signals.* There are many factors that impair our ability to detect hunger, including following external diets that tell us what to eat and when, and being constantly busy where we may miss detecting hunger signals. To identify sensations of physical hunger before eating, you can ask yourself: "How hungry am I?" or "How do I know I am hungry?" Hunger may manifest in any of the following ways: stomach rumbling or growling, feeling light-headed or faint, having trouble focusing on a task, and head or stomach hurting (Tribole & Resch, 2012).
3. *Identify other types of hunger.* As you start trying to identify physical hunger, there may be times when none of the physical symptoms are present, but you still have the urge to eat. These urges may come from other types of "hunger" that are not physical. Environmental or mental hunger is in response to the sight or smell of food. For example, people often eat cake at a celebration even if they are not physically hungry. The sight of restaurants or advertisements, social situations, or other triggers may also cause a person to want to eat. Emotional hunger is hunger we feel as a result of experiencing negative emotions such as loneliness, anger, sadness, stress, anxiety, or boredom (May 2017).
4. *Identify sensations of fullness.* The following strategies may help identify feelings of fullness: eat slowly to allow time to experience the sensation of becoming full, put your fork or spoon down between bites to slow the eating process, portion your food out by splitting it in half or into thirds and check in with your fullness level before you move to the next section, check in regularly to see how your stomach feels, and assess your energy level—food should make you more energetic rather than tired (May & Fletcher, 2012).
5. *Use a numerical scale to monitor hunger and fullness.* It is recommended to use a scale to rate hunger prior to eating, and fullness after eating, to determine what

level of hunger and fullness feels comfortable and satisfying for you (Tribole & Resch, 2012). Eating is not a standardized process. Instead, it is a personal experience, so the scale will work differently for different people. In general, the numbers represent the following:

0–1 = extreme, ravenous hunger

3 = moderately hungry

5 = a neutral space; neither hungry nor full

6–7 = comfortably full or satisfied

9–10 = overly, uncomfortably full

Nutrition Counseling at NC State Campus Health

The team of dietitians at Campus Health practices a Health at Every Size® approach to nutrition care. This concept means that diversity in body shapes/sizes is appreciated, and that health is not measured by the number on the scale. Clients are encouraged to nourish the body with foods that support physical and mental health and reduce the emphasis on specific weight or aesthetic goals.

Registered dietitians are available to provide nutrition counseling for current NC State students at the Campus Health Center by appointment Monday through Friday. Each student is allowed two free nutrition counseling visits per academic year. For each additional visit after the first two, there is a charge that can be billed to insurance or paid out of pocket.

Energy Balance

Energy provided through food is expressed as **kilocalories**, more typically referred to as a **calories**. One kilocalorie represents the amount of energy it takes to raise the temperature of one liter of water 1 degree Celsius. The term calories is also used to determine the amount of energy burned through physical activity.

There is literature that supports a correlation between healthy weight and achieving physical quality of life. The dietary guideline for healthy weight is to balance energy intake with energy output. If the calories expended equals the calories consumed, you will maintain current weight. However, if there is an imbalance in calories expended or consumed you will have weight loss or weight gain.

For weight loss it is important to note that there are 3500 calories in one pound of fat. A safe way to lose weight would be to create a deficit of 500 calories a day which could be through activity, reduced caloric intake, or through a combination of both. Doing so would put you at a 1-pound deficit at the end of a seven-day period.

Total Daily Energy Expenditure

Your total daily energy expenditure (TDEE) is determined by compiling three different components: your basal metabolic rate (BMR, also referred to as RMR or resting metabolic rate), the thermic effect of food, and your physical activity (**Figure 7-3**).

- BMR, or basal metabolic rate, is the amount of energy your body uses to keep you breathing and your blood flowing. BMR is considered a function of lean mass and accounts for about 60% of the TDEE.
- The thermic effect of food (TEF) is the amount of energy used to digest, absorb, and store nutrients from what you eat and drink. This only accounts for about 10–15% of the TDEE.

- Physical activity level (PAL)—Physical activity level makes up about 15–30% of the TDEE, and accounts for two factors:

- EAT—Exercise-related Activity Thermogenesis, which refers to the energy burned through organized exercise, and
- NEAT—Non-Exercise-related Activity Thermogenesis, which accounts for every other physical movement. NEAT includes activities of daily living, fidgeting, maintaining posture, standing, sitting, and many other unplanned movements.

The TDEE of these components is broken into estimated daily percentages with BMR accounting for 60–70%, food digestion for 10–15%, and physical activity for 15–30% of your total daily energy expenditure.

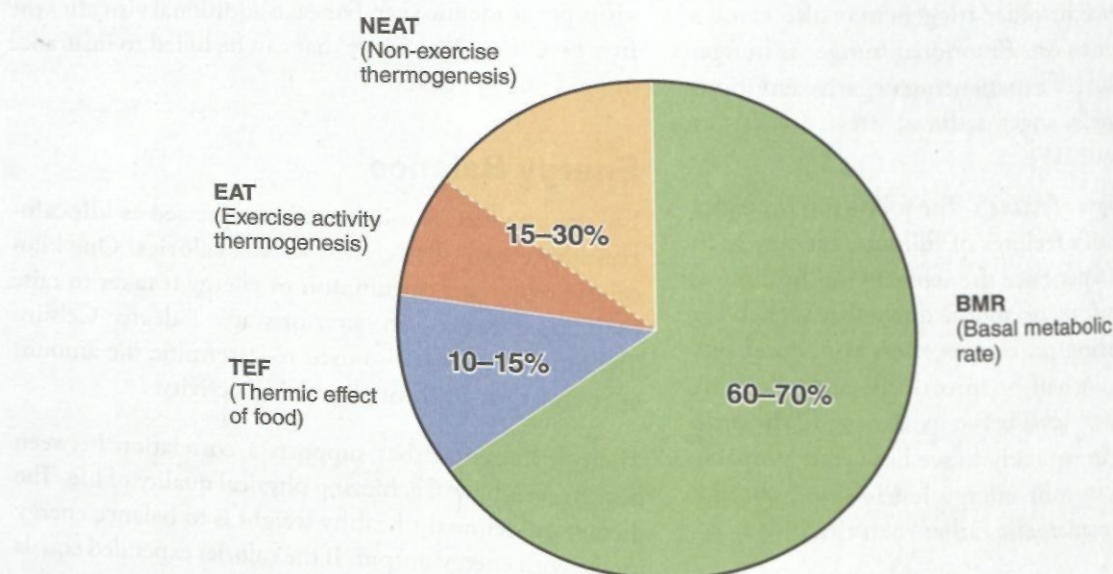


FIGURE 7-3. Total Daily Energy Expenditure.

Basal Metabolic Rate

BMR is the amount of energy required to maintain the function of vital organs at rest. BMR is most affected by muscle mass, thus individuals with a higher percentage of muscle mass will have a higher BMR. In addition, as we age, BMR decreases due to decreases in muscle mass. The Harris-Benedict equation, created in 1918, historically has been used to calculate BMR. In the 1990s, an updated method for calculating metabolic rate was developed by Mifflin St Jeor. This equation is considered a more valid estimate of BMR because it reflects the number of calories that a body burns while it is at rest, which includes breathing, circulation, organ functions, and basic neurological functions.

The Mifflin St Jeor equation provides an estimate of BMR calories.

- Men: $\text{BMR} = (10 \times \text{weight in kg}) + (6.25 \times \text{height in cm}) - (5 \times \text{age in years}) + 5$
- Women: $\text{BMR} = (10 \times \text{weight in kg}) + (6.25 \times \text{height in cm}) - (5 \times \text{age in years}) - 161$

Thermic Effect of Food

Food digestion is the thermic effect of food, which includes the energy cost of chewing, swallowing, digesting, absorbing, and storing food.

Energy Expenditure

Physical activity is arguably the component that we have the most control over. Physical activity energy expenditure (EE) is compiled by the metabolic equivalent of task (MET). A MET is generally used as the standard index for describing the intensity or energy cost of physical activity. The process of identifying specificity when calculating physical activity EE is completed by using the MET formula.

The MET formula to calculate EE:

- $\text{Weight (kg)} \times \text{MET value} \times \text{activity time (1 hour = 1.0; } \frac{1}{2} \text{ hour = .5)} = \text{calories expended}$
- Example: 150lb, 10 min/mi pace running; $\frac{1}{2}$ hour = $68 \text{ kg} \times 9.8 \times 0.5 = 333 \text{ calories expended}$

Wearable Tracking Devices

The development of wearable devices for tracking energy expenditure has become a popular and efficient method to record exercise-related data. Wearable devices also heighten awareness of our behaviors and can assist with goal setting and self-regulation. Calorie counting and energy expenditure tracking are effective methods to maintain or influence your body weight; however, these associations may lead to eating disorders as well. Individuals who are confused about all the information obtained through the media should speak with a licensed dietician and develop a nutrition and exercise plan that is appropriate for them.

Wearable devices can be used to provide a general guideline for your daily energy expenditure. Most device manufacturers do not disclose their algorithms for estimating accuracy and reliability of their energy expenditures, thus caution should be used when monitoring wearable devices. Studies have identified both under- and over-estimation of energy expenditure due to heart rate and step miscalculations when compared to an accelerometer, which is a movement monitor that captures the intensity of physical activity.

Body Composition

A two-component model of body composition consists of the ratio of fat mass to fat-free mass (e.g., lean body mass) in the human body. Fat-free mass is the non-fat components of the body such as your internal organs, bones, and muscles. On the other hand, fat mass contains fat from adipose tissue in your body. Fat mass consists of essential body fat and non-essential body fat in the body. Essential body fat is needed for normal physiological functioning such as hormone regulation, including the hormones that control fertility, vitamin absorption, and temperature regulation. Women are believed to need slightly more essential body fat than men because of childbearing and hormonal functions. Non-essential fat is excess fat not needed for physiological functioning and could pose challenges to an individual's health. The more body fat an individual possesses creates an increased risk for a multitude of conditions and diseases such as heart disease, morbidity, and mortality.

Health Implication Assessment

Body Mass Index

Body Mass Index (BMI) is a non-invasive technique that scientists and physicians use to determine risk of health. BMI assesses your weight relative to height and provides categories such as underweight, healthy weight, overweight, and obese. The higher your BMI, the greater the risk of negative health conditions and diseases. An increased risk of obesity-related diseases, health conditions, and mortality are associated with a BMI ≥ 30.0 kg/m² or greater.

BMI, which is used to determine health implications, cannot be used as a body composition assessment because of its inability to distinguish between fat-mass and free fat-mass. For example, a 5'10" 250 pound football running back with more fat-free mass than a 5'10" 250 pound inactive individual with more fat mass will have the same BMI. However, their body composition will be completely different. **Figure 7-4** shows that these differences in the body appearance are due to muscle being more dense than fat. Muscle does not occupy as much space in the human body as fat. For example, one pound of muscle and one pound of fat both weigh the same, however the one pound of muscle will be smaller than the one pound of fat. BMI is calculated by dividing the weight in kilograms by the square of the height in meters.

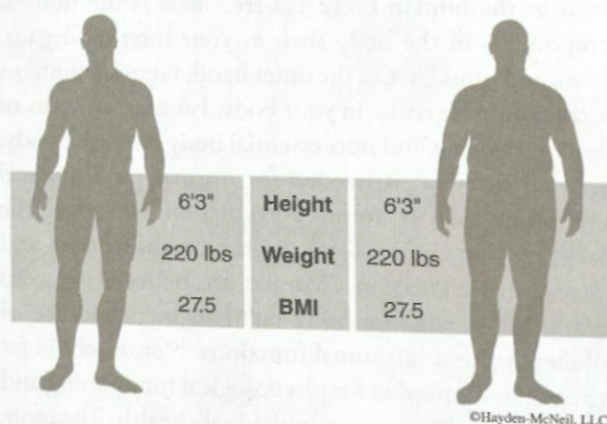


FIGURE 7-4. Differences in Body Composition.

Table 7-6 shows the standard weight status categories for males and females.

Table 7-6. BMI and Weight Status

BMI	WEIGHT STATUS
Below 18.5	Underweight
18.5–24.9	Healthy Weight
25.0–29.9	Overweight
30.0 and Above	Obesity

Body Circumferences

Body Circumferences are measurements taken around areas of the body such as the waist and hip with a tape measure. Certain areas of the body can be important indicators of health. For example, increased levels of abdominal body fat (android obesity) increases an individual's risk of obesity-related diseases compared to increased levels of hip/thigh body fat (gynoid obesity). The waist-to-hip ratio (WHR) is the circumference of the waist (around the belly-button area) in centimeters divided by the circumference of the hips (around the largest portion of the buttocks) in centimeters.

For males, body fat is typically deposited in the upper body area. For females, body fat is typically deposited in the lower body area. Your health risk increases as your WHR increases. Risks vary with age and sex. A waist circumference alone may be used as an indicator of obesity-related health risk. Similar to BMI and WHR, greater levels of abdominal fat mass establish greater risks for obesity-related diseases such as high blood pressure, diabetes, heart disease, and early mortality.

Table 7-7 and **Table 7-8** show the very high health risk category for waist circumference and waist-to-hip ratio, respectively, for males and females.

Table 7-7. Waist to Hip Ratio for Men and Women

WAIST CIRCUMFERENCE (VERY HIGH HEALTH RISK)	
Males	Females
>100cm	>90cm

Table 7-8. Waist to Hip Ratio for Men and Women

WAIST-TO-HIP RATIO (VERY HIGH HEALTH RISK)	
Males	Females
≥ 0.95	≥ 0.86

Body Composition Assessment

There are no national standards for body fat percentages, but recommended body fat percentages are based on your biological sex (male or female) and age. According to the American College of Sports Medicine, a lower body fat percentage is better for your health; however, no less than 3% body fat percentage for males and no less than 10–13% body fat percentage for females. In a practical sense, body fat percentages are often used to assess your body composition. There are body composition assessments available which are more valid and reliable in estimating body composition than other assessments. Validity refers to the accuracy of the assessment. Reliability refers to the consistency of the assessment results taken several times. Each assessment below is explained and they will vary in cost, validity, reliability, and measurement procedures.

Body Composition Laboratory Assessments

Hydrostatic Weighing, also known as Hydro-Densitometry or Underwater Weighing, is one of the highly valid and reliable body composition assessments. Often considered a gold standard body composition assessment in the fitness industry, hydrostatic weighing initially calculates body volume and features an individual in a specialized chair suspended above a pool of water. Individuals exhale fully prior to being submerged completely into the water while holding their breath. This procedure calculates body volume through the Archimedes' principle, which states that body volume is equal to the difference between body weight on land and the weight in water, corrected for the density of water. The body volume, along with body mass, is used to calculate body density and percentage of body fat. Hydrostatic weighing is typically conducted in laboratories, so it can have a limited accessibility to expensive calibrated equipment.

Air displacement plethysmography is another highly valid and reliable assessment for body composition and is also considered a gold standard assessment in the fitness industry. Air displacement plethysmography is often performed utilizing a BOD POD. This procedure requires an individual to sit in an enclosed chamber with

displaced air to determine body volume. Body volume is calculated by subtracting the volume of air remaining in the chamber with the subject inside from the volume of air in the chamber when it is empty to determine body fat and lean body mass. Air displacement plethysmography is also typically conducted in laboratories with a BOD POD, which can also have a limited accessibility to expensive calibrated equipment.

Dual-Energy X-Ray Absorptiometry (DXA) is a newer body composition assessment commonly used to assess bone density. DXA is highly valid and reliable in estimating body composition because it differentiates fat-free mass and fat-mass by applying dual-energy scanning. DXA is typically conducted in laboratories. Body composition is also estimated through other laboratory technologies such as Ultrasound (UT), Magnetic Resonance Imaging (MRI), and Computed Tomography (CT).

Body Composition Field Assessments

Skinfold caliper devices measure the amount of subcutaneous fat stores at specific body sites. The principle behind the skinfold technique is that the amount of subcutaneous body fat is proportional to the total amount of body fat. Skinfold assessments are inexpensive and consist of procedures for either three body sites or seven body sites. A trained tester is required to pinch a fold of skin and the associated subcutaneous fat at specified angles and sites. For the three-site procedures (**Figure 7-5**), males and females would have specific body sites to measure. The male body sites for the measurement are the Abdominal (vertical fold), Chest (diagonal fold), and Thigh (vertical fold) skinfolds. The female body sites for the measurement are the Tricep (vertical fold), Iliac Crest (diagonal fold), and Thigh (vertical fold) skinfolds. There is also a seven-site procedure available which is universal for males and females. The more sites that are measured on the body the greater the accuracy of body composition. Once the skinfold values are identified, equations such as the Jackson-Pollock skinfold formula must be used to estimate body composition.

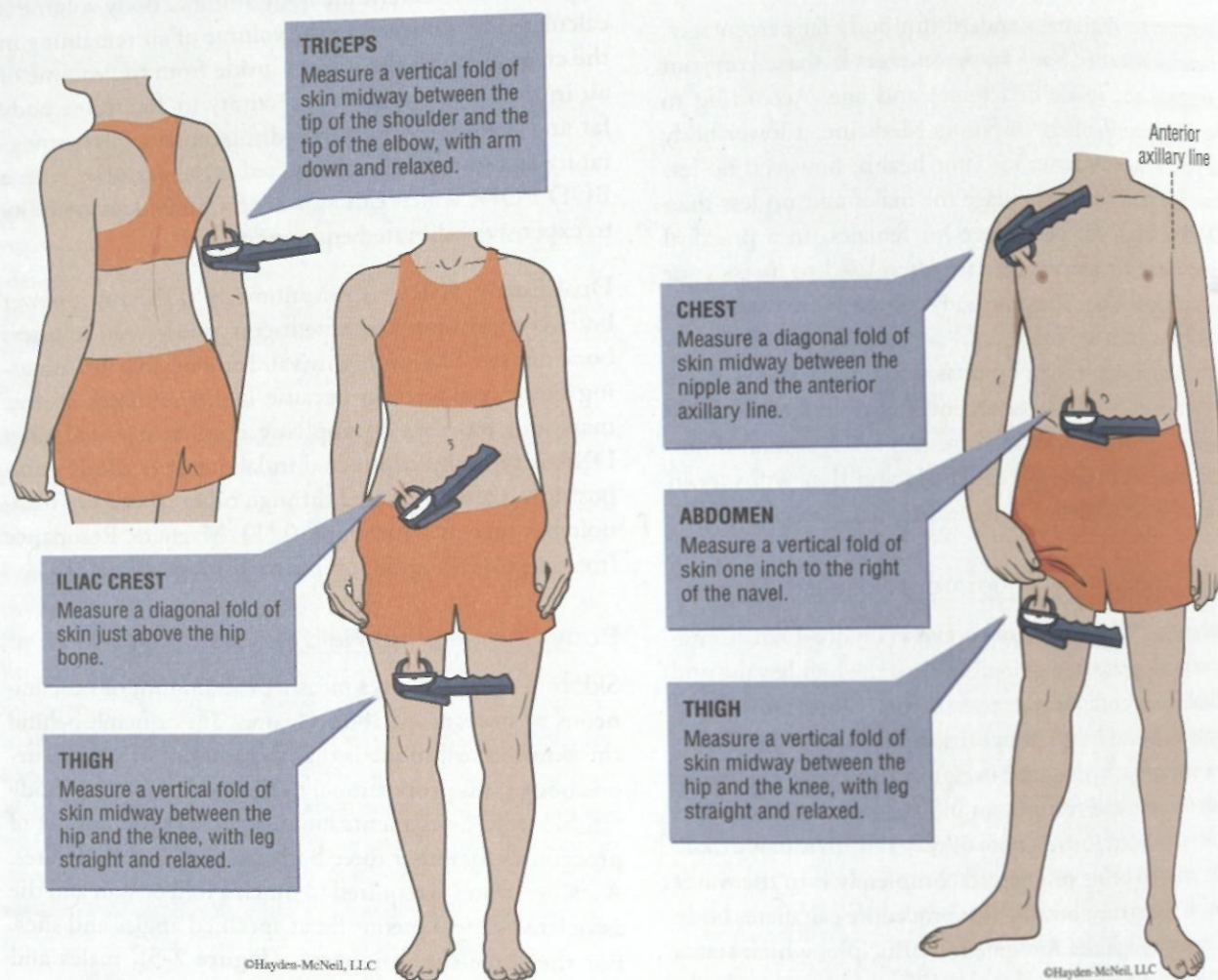


FIGURE 7-5. Three-Site Skinfold Locations for Women and Men.

Bioelectrical impedance analysis (BIA) equipment has been increasingly used in the fitness industry due to its ease of use when determining body composition. BIA estimates body fat percent, body mass, and/or total body water (TBW). This procedure assesses the rate at which a small electrical current flows through the body between electrodes which are contacted to the body, and measures the resistance and reactance (impedance) to the flow of this current. In fat-free mass, the electrical current moves through it with ease due to the mixture of electrolytes (certain vitamins and minerals) and water. On the other hand, an individual with higher amounts of fat tissue will have increased resistance to the electrical current which

leads to a higher body fat percentage. This assessment, depending on the specific equipment and other factors, has an ability to be less or more valid and reliable. For example, an individual's hydration level could affect the results of the assessment. Therefore, it's best to perform this assessment with a normal hydration level rather than after exercise or soon after waking up from multiple hours of sleep. In addition, single-frequency BIA (Handheld or Foot Scale assessment) and multi-frequency BIA (Full-Body assessment) present differences in accuracy of body composition. Multi-frequency BIA, which could be costly, estimates body composition more accurately than the cost-effective single-frequency BIA.

Summary Questions

1. What percent of total daily caloric needs is recommended to be consumed from carbohydrate, protein, and fat?
2. What three components comprise total daily energy expenditure?
3. What is the difference between HDL and LDL, and which of the two should be limited?
4. Describe the three ways to maintain energy balance.
5. Skinfold caliper devices measure the amount of subcutaneous fat stores as specific body sites. Where are the specific body sites used to measure in males? In females?
6. What is one benefit and one drawback of using body mass index measurement?
7. Describe one body composition laboratory assessment and one body composition field assessment.

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Table 7-9. Percent Body Fat Estimations for Women—Jackson and Pollock Formula

SUM OF SKINFOLDS (mm)	AGE GROUPS								
	Under 22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	over 57
23-25	9.7	9.9	10.2	10.4	10.7	10.9	11.2	11.4	11.7
26-28	11.0	11.2	11.5	11.7	12.0	12.3	12.5	12.7	13.0
29-31	12.3	12.5	12.8	13.0	13.3	13.5	13.8	14.0	14.3
32-34	13.6	13.8	14.0	14.3	14.5	14.8	15.0	15.3	15.5
35-37	14.8	15.0	15.3	15.5	15.8	16.0	16.3	16.5	16.8
38-40	16.0	16.3	16.5	16.7	17.0	17.2	17.5	17.7	18.0
41-43	17.2	17.4	17.7	17.9	18.2	18.4	18.7	18.9	19.2
44-46	18.3	18.6	18.8	19.1	19.3	19.6	19.8	20.1	20.3
47-49	19.5	19.7	20.0	20.2	20.5	20.7	21.0	21.2	21.5
50-52	20.6	20.8	21.1	21.3	21.6	21.8	22.1	22.3	22.6
53-55	21.7	21.9	22.1	22.4	22.6	22.9	23.1	23.4	23.6
56-58	22.7	23.0	23.2	23.4	23.7	23.9	24.2	24.4	24.7
59-61	23.7	24.0	24.2	24.5	24.7	25.0	25.2	25.5	25.7
62-64	24.7	25.0	25.2	25.5	25.7	26.0	26.7	26.4	26.7
65-67	25.7	25.9	26.2	26.4	26.7	26.9	27.2	27.4	27.7
68-70	26.6	26.9	27.1	27.4	27.6	27.9	28.1	28.4	28.6
71-73	27.5	27.8	28.0	28.3	28.5	28.8	29.0	29.3	29.5
74-76	28.4	28.7	28.9	29.2	29.4	29.7	29.9	30.2	30.4
77-79	29.3	29.5	29.8	30.0	30.3	30.5	30.8	31.0	31.3
80-82	30.1	30.4	30.6	30.9	31.1	31.4	31.6	31.9	32.1
83-85	30.9	31.2	31.4	31.7	31.9	32.2	32.4	32.7	32.9
86-88	31.7	32.0	32.2	32.5	32.7	32.9	33.2	33.4	33.7
89-91	32.5	32.7	33.0	33.2	33.5	33.7	33.9	34.2	34.4
92-94	33.2	33.4	33.7	33.9	34.2	34.4	34.7	34.9	35.2
95-97	33.9	34.1	34.4	34.6	34.9	35.1	35.4	35.6	35.9
98-100	34.6	34.8	35.1	35.3	35.5	35.8	36.0	36.3	36.5
101-103	35.3	35.4	35.7	35.9	36.2	36.4	36.7	36.9	37.2
104-106	35.8	36.1	36.3	36.6	36.8	37.1	37.3	37.5	37.8
107-109	36.4	36.7	36.9	37.1	37.4	37.6	37.9	38.1	38.4
110-112	37.0	37.2	37.5	37.7	38.0	38.2	38.5	38.7	38.9
113-115	37.5	37.8	38.0	38.2	38.5	38.7	39.0	39.2	39.5
116-118	38.0	38.3	38.5	38.8	39.0	39.3	39.5	39.7	40.0
119-121	38.5	38.7	39.0	39.2	39.5	39.7	40.0	40.2	40.5
122-124	39.0	39.2	39.4	39.7	39.9	40.2	40.4	40.7	40.9
125-127	39.4	39.6	39.9	40.1	40.4	40.6	40.9	41.1	41.4
128-130	39.8	40.0	40.3	40.5	40.8	41.0	41.3	41.5	41.8

Source: Jackson, A.S. & Pollock, M.L.: Practical Assessment of Body Composition. *The Physician and Sportsmedicine*, 13:76-90, 1985.

Table 7-10. Percent Body Fat Estimations for Men—Jackson and Pollock Formula

SUM OF SKINFOLDS (mm)	AGE GROUPS								
	Under 22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	over 57
8-10	1.3	1.8	2.3	2.9	3.4	3.9	4.5	5.0	5.5
11-13	2.2	2.8	3.3	3.9	4.4	4.9	5.5	6.0	6.5
14-16	3.2	3.8	4.3	4.8	5.4	5.9	6.4	7.0	7.5
17-19	4.2	4.7	5.3	5.8	6.3	6.9	7.4	8.0	8.5
20-22	5.1	5.7	6.2	6.8	7.3	7.9	8.4	8.9	9.5
23-25	6.1	6.6	7.2	7.7	8.3	8.8	9.4	9.9	10.5
26-28	7.0	7.6	8.1	8.7	9.2	9.8	10.3	10.9	11.4
29-31	8.0	8.5	9.1	9.6	10.2	10.7	11.3	11.8	12.4
32-34	8.9	9.4	10.0	10.5	11.1	11.6	12.2	12.8	13.3
35-37	9.8	10.4	10.9	11.5	12.0	12.6	13.1	13.7	14.3
38-40	10.7	11.3	11.8	12.4	12.9	13.5	14.1	14.6	15.2
41-43	11.6	12.2	12.7	13.3	13.8	14.4	15.0	15.5	16.1
44-46	12.5	13.1	13.6	14.2	14.7	15.3	15.9	16.4	17.0
47-49	13.4	13.9	14.5	15.1	15.6	16.2	16.8	17.3	17.9
50-52	14.3	14.8	15.4	15.9	16.5	17.1	17.6	18.2	18.8
53-55	15.1	15.7	16.2	16.8	17.4	17.9	18.5	19.1	19.7
56-58	16.0	16.5	17.1	17.7	18.2	18.8	19.4	20.0	20.5
59-61	16.9	17.4	17.9	18.5	19.1	19.7	20.2	20.8	21.4
62-64	17.6	18.2	18.8	19.4	19.9	20.5	21.1	21.7	22.2
65-67	18.5	19.0	19.6	20.2	20.8	21.3	21.9	22.5	23.1
68-70	19.3	19.9	20.4	21.0	21.6	22.2	22.7	23.3	23.9
71-73	20.1	20.7	21.2	21.8	22.4	23.0	23.6	24.1	24.7
74-76	20.9	21.5	22.0	22.6	23.2	23.8	24.4	25.0	25.5
77-79	21.7	22.2	22.8	23.4	24.0	24.6	25.2	25.8	26.3
80-82	22.4	23.0	23.6	24.2	24.8	25.4	25.9	26.5	27.1
83-85	23.2	23.8	24.4	25.0	25.5	26.1	26.7	27.3	27.9
86-88	24.0	24.5	25.1	25.7	26.3	26.9	27.5	28.1	28.7
89-91	24.7	25.3	25.9	26.5	27.1	27.6	28.2	28.8	29.4
92-94	25.4	26.0	26.6	27.2	27.8	28.4	29.0	29.6	30.2
95-97	26.1	26.7	27.3	27.9	28.5	29.1	29.7	30.3	30.9
98-100	26.9	27.4	28.0	28.6	29.2	29.8	30.4	31.0	31.6
101-103	27.5	28.1	28.7	29.3	29.9	30.5	31.1	31.7	32.3
104-106	28.2	28.8	29.4	30.0	30.6	31.2	31.8	32.4	33.0
107-109	28.9	29.5	30.1	30.7	31.3	31.9	32.5	33.1	33.7
110-112	29.6	30.2	30.8	31.4	32.0	32.6	33.2	33.8	34.4
113-115	30.2	30.8	31.4	32.0	32.6	33.2	33.8	34.5	35.1
116-118	30.9	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.7
119-121	31.5	32.1	32.7	33.3	33.9	34.5	35.1	35.7	36.4
122-124	32.1	32.7	33.3	33.9	34.5	35.1	35.8	36.4	37.0
125-127	32.7	33.3	33.9	34.5	35.1	35.8	36.4	37.0	37.6

Source: Jackson, A.S. & Pollock, M.L.: Practical Assessment of Body Composition. *The Physician and Sportsmedicine*, 13:76-90, 1985.

chapter 8



Stress Management

by Peter Koutroumpis, M.Ed., Renee Harrington, Ph.D., and Macy Kalb, M.S.

What Is Stress?

The term stress is complicated to define. For **stress** to occur, there must be a stimulus, followed by a physiological reaction to that stimulus, and finally a resulting strain. For example, the stimulus, or **stressor**, could be an upcoming exam. This stressor may trigger a reaction such as muscle tension and increased blood pressure. Ultimately, this physiological reaction may result in a headache or feelings of anxiety.

Stress is inevitable. Stress is needed to perform daily tasks of life, and more importantly, to stimulate growth and development. Stress can be beneficial. However, too much stress, especially when it exists for a prolonged period of time and is unrelieved, can result in physical and mental illness.

Dr. Hans Selye, biologist and endocrinologist, defined stress as the “nonspecific response of the body to any demand made upon it.” He further pointed out that stress is caused or triggered by stressors that may be physical, social, or psychological and that may be negative or positive in nature.

Selye called human reactions to positive stressors **eustress**, that is, stress that is beneficial, and he used the term **distress** to describe detrimental responses to negative stressors. Often there is a fine line between whether something produces eustress or distress. For example, moderate physical exercise is a stressor that can make you feel better and more fit. However, if you do too much too soon, it can produce distress in the form of soreness or injury.

Sometimes the difference between eustress and distress is a matter of perception; do you perceive the stressor as a threat or a challenge? Although we may habitually respond in ways that seem automatic and beyond our control, we can choose to examine the way we think and then work on changing counterproductive thinking or beliefs.

8

Chapter Eight

Stress should not be considered solely as a physiological phenomenon. Stress can also be viewed from a psychological or cognitive perspective. Current research suggests that the stress response is not a simple biological response to nonspecific stressors but is instead an interrelated process that includes the presence of a stressor, the circumstances in which the stressor occurs, the interpretation of the situation by the person, his or her typical reaction, and the resources available to deal with the stressor. For example, one person may find downhill skiing fun and exciting, and look forward to taking winter vacations to ski the slopes. Another person may have tried to ski, but because of dislike of cold weather and fear of injury, finds skiing a distressing activity. Therefore the stress response in a given situation is dependent upon the individual's perceptions.

Psychological or Cognitive Response to Stress

Once the stress process is stimulated by the presence of a stressor, psychological or cognitive processes take over, determining the manner in which the stressor is perceived. An individual's perception of a particular situation can elicit a response that may vary from arousal to anxiety. Arousal is the body's heightened awareness that a stressor is present and is a signal to higher centers in the brain to respond (physiological). **Anxiety**, on the other hand, is described by Spielberger as feelings of tension, apprehension, nervousness, and worry. He maintains that these are cognitive rather than biological responses.

The degree to which a particular situation elicits an emotional response depends to a great extent on how the individual appraises the situation and how well prepared he or she feels to handle it. Those individuals who are prone to stress tend to make extreme, absolute, global judgments and engage in cognitive distortions in which they overemphasize the most negative aspects of a given

situation. Our thought processes seem automatic, but we need to emphasize the necessity of examining our beliefs and working on changing them when they are erroneous or counterproductive.

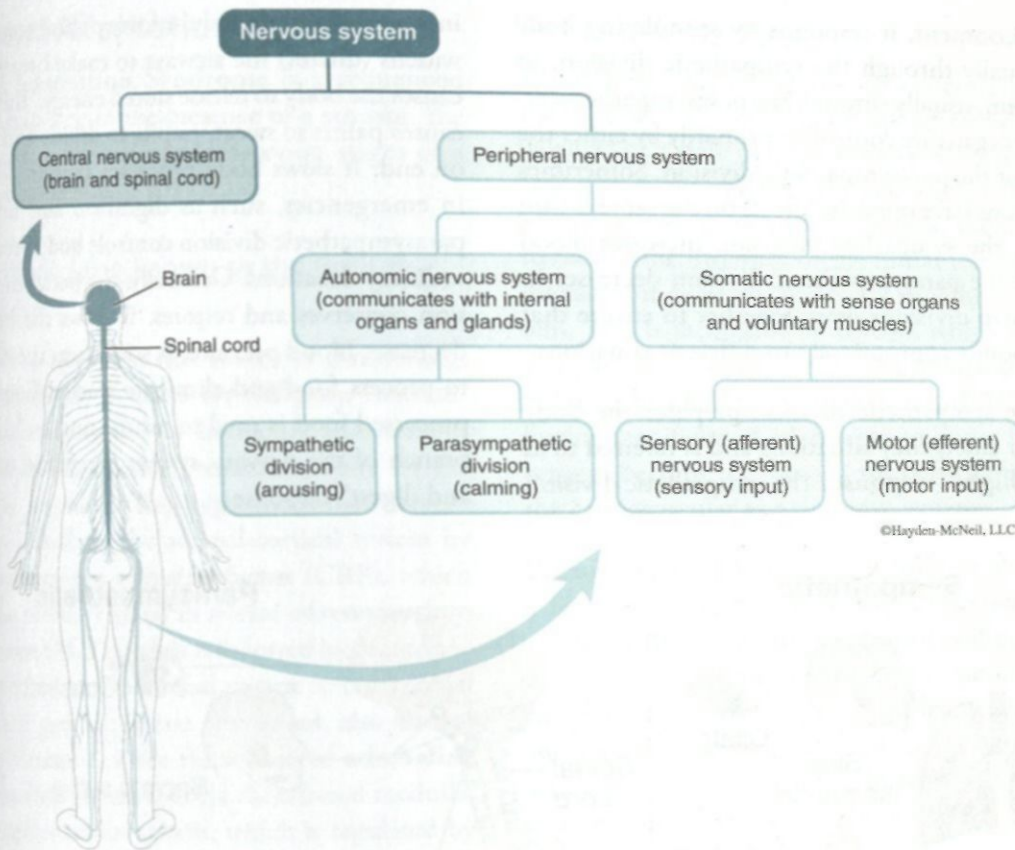
Certainly, there are both biological and cognitive responses to stressors. Even though we talk about them as two separate processes, they are interrelated and often occur simultaneously.

Physiological Response to Stress

Central Nervous System

The **central nervous system** consists of the brain and spinal cord. The brain is a structure composed of billions of interconnected neurons or nerve cells contained in the skull and functions as the coordinating center for almost all of our body's functions. The spinal cord is a bundled network of nerve fibers, connecting most parts of our body to our brain.

The **peripheral nervous system** consists of all of the nerves outside of our brain and spinal cord. It can be categorized into two distinct systems: somatic and autonomic. The **somatic (voluntary) nervous system** allows our muscles and brains to communicate with each other. The somatic system helps our brain and spinal cord to send signals to our muscles to help them move, as well as sends information from the body back to the brain and spinal cord. The **autonomic (involuntary) nervous system** controls the glands and internal organs, such as the heart, lungs, and digestive system. These are, essentially, the things that run our body without us having to intentionally think about them. For example, we can breathe without having to think about taking a breath each time. The autonomic nervous system is important when discussing stress and stress response.



Autonomic Nervous System

As mentioned, the autonomic nervous system regulates certain body processes, such as blood pressure and the rate of breathing. This system works automatically (autonomously), without a person's conscious effort. The autonomic nervous system controls internal body processes such as the following:

- Blood pressure
- Heart rate
- Breathing rate
- Body temperature
- Digestion and metabolism
- The balance of water and electrolytes in the body
- The production of body fluids (saliva, sweat, and tears)
- Urination and defecation
- Sexual response

An autonomic nerve pathway involves two nerve cells. One cell is located in the brain stem or spinal cord. It is connected by nerve fibers to the other cell, which is located in a cluster of nerve cells (called an autonomic ganglion). Nerve fibers from these ganglia connect with internal organs. Most of the ganglia for the sympathetic division are located just outside the spinal cord on both sides of it. The ganglia for the parasympathetic division are located near or in the organs they connect with. The autonomic nervous system is regulated by the hypothalamus, which receives information from the limbic area of the brain. The hypothalamus is important in linking the nervous system and the endocrine system via the pituitary (master gland). It is well accepted that mental and emotional states affect the autonomic nervous system and thus its functioning.

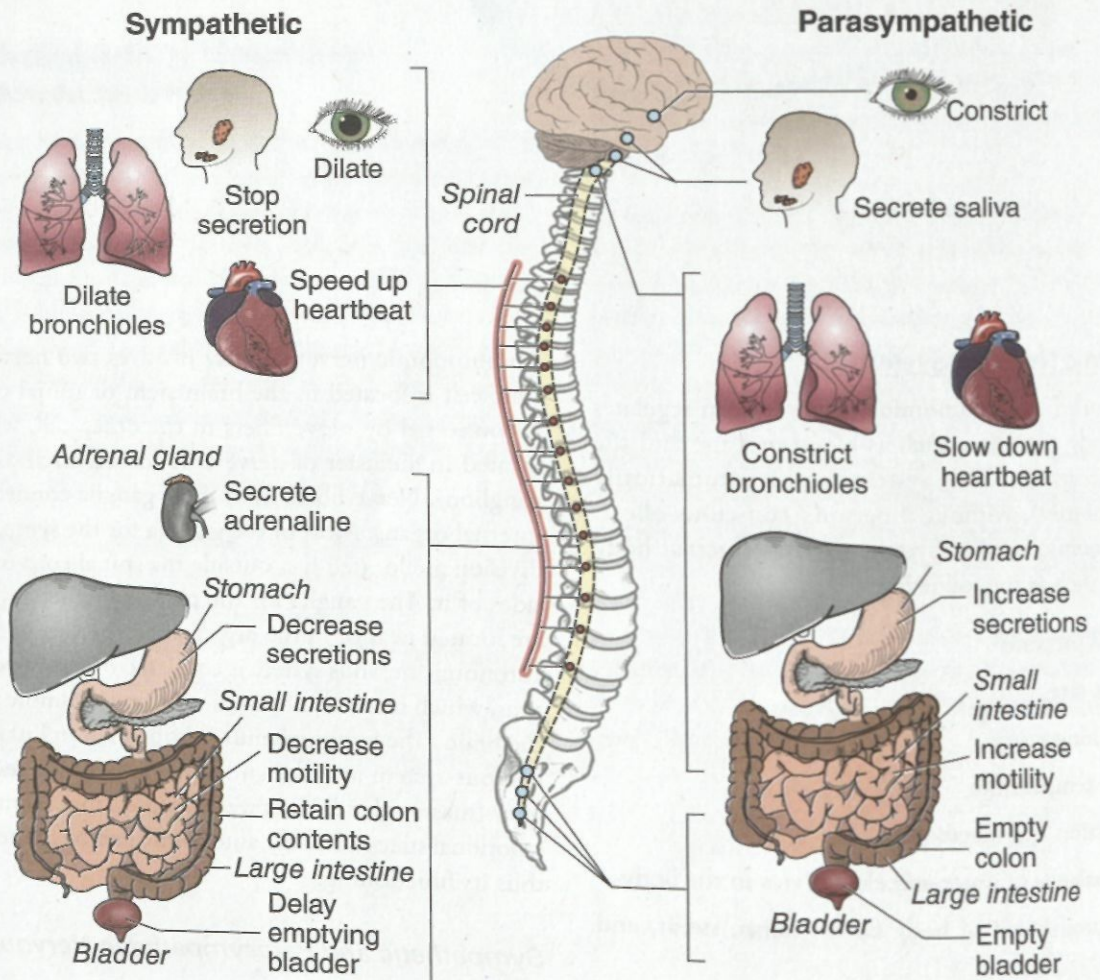
Sympathetic and Parasympathetic Nervous Systems

The autonomic nervous system has two main divisions: **sympathetic** and **parasympathetic**. After the autonomic nervous system receives information about the body and

external environment, it responds by stimulating body processes, usually through the sympathetic division, or inhibiting them, usually through the parasympathetic division. Many organs are controlled primarily by either the sympathetic or the parasympathetic division. Sometimes the two divisions have opposite effects on the same organ. For example, the sympathetic division increases blood pressure, and the parasympathetic division decreases it. Overall, the two divisions work together to ensure that the body responds appropriately to different situations.

Generally, the sympathetic division prepares the body for stressful or emergency situations and is referred to as the **"fight or flight" response**. The sympathetic division

increases heart rate and the force of heart contractions and widens (dilates) the airways to make breathing easier. It causes the body to release stored energy. This division also causes palms to sweat, pupils to dilate, and hair to stand on end. It slows body processes that are less important in emergencies, such as digestion and urination. The parasympathetic division controls body processes during ordinary situations. Generally, the parasympathetic division conserves and restores. It slows the heart rate and decreases blood pressure. It stimulates the digestive tract to process food and eliminate wastes. Energy from the processed food is used to restore and build tissues. This branch of the nervous system is referred to as the **"rest and digest" response**.



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FIGURE 8-1. How Sympathetic and Parasympathetic Nervous Systems Regulate Functioning Organs.

The General Adaptation Syndrome

The **General Adaptation Syndrome** is a sequenced physiological response to the presence of a stressor: the alarm, resistance, recovery, and exhaustion stages of a stress response (Greenberg, 2017).

The Alarm Stage (also known as the fight-or-flight response)

Once exposed to any event that is seen as threatening, the body immediately prepares for difficulty. Involuntary changes are controlled by hormonal and nervous system functions that quickly prepare the body for the fight-or-flight response. The **hypothalamus**, located in the brain, stimulates the adrenal-cortical system by releasing **corticotropin-releasing factor (CRF)**, which stimulates the pituitary gland to release **adrenocorticotrophic hormone (ACTH)**. This is followed by the release of glucocorticoids by the **adrenal cortex** of the adrenal glands which trigger the release of **cortisol**, also known as the stress hormone, while the release of **adrenaline** and **noradrenaline** is delivered via the adrenal medulla. The sympathetic nervous system, which is regulated by the hypothalamus, as a result causes the body to do the following:

- Increase heart rate, blood pressure, and breathing
- Increase force with which heart contracts
- Dilate coronary arteries
- Constrict abdominal arteries
- Dilate pupils
- Dilate bronchial tubes
- Increase tension of skeletal muscles
- Release glucose from liver
- Increase mental activity
- Significantly increase basal metabolic rate

The Resistance Stage

The second stage of response to a stressor, the resistance stage, reflects the body's attempt to reestablish internal balance, or a state of **homeostasis**. The high level of energy seen in the initial alarm stage cannot be maintained very long. Once cortisol levels peak, the body attempts to reduce the intensity of the initial response to a more manageable level via the parasympathetic nervous system. This is facilitated by cortisol which also functions as a part of the inhibitory feedback loop that eventually helps to block further production of ACTH, thus allowing specificity of adaptation to occur. Specific organ systems become the focus of the body's response, such as the cardiovascular and digestive systems.

Because of the ability to move from an alarm stage into a less damaging resistance stage, effective coping or a change in the status of the stressor will probably occur. In fact, as control over the stressful situation is gained, homeostasis is even more completely established and movement toward recovery is seen. The body has returned to its pre-stressed state and hopefully there is minimal evidence of the stressor's existence.

The Exhaustion Stage

Body adjustments made as a result of long-term exposure to a stressor often result in an overload. Specific organs and body systems that were called on during the resistance stage may not be able to resist a stressor indefinitely. This results in exhaustion, and the stress-producing hormone levels rise again. In extreme or chronic cases that lead to serious illness or disease, exhaustion can become so pronounced that complications such as death can occur.

The following table will help identify some of the physiological changes that take place in the body during stress. Indicate how often each of the physical symptoms happen to you and then total the points to determine your level of physiological reactivity to stress.

Table 8-1. Physiological Reactions to Stress

Circle the number that best represents the frequency of occurrence of the following physical symptoms and add up the total number of points.

SYMPTOM	NEVER	INFREQUENTLY (more than once in six months)	OCCASIONALLY (more than once per month)	VERY OFTEN (more than once per week)	CONSTANTLY
1. Tension headaches	1	2	3	4	5
2. Migraine (vascular) headaches	1	2	3	4	5
3. Stomach aches	1	2	3	4	5
4. Increase in blood pressure	1	2	3	4	5
5. Cold hands	1	2	3	4	5
6. Acidic stomach	1	2	3	4	5
7. Shallow, rapid breathing	1	2	3	4	5
8. Diarrhea	1	2	3	4	5
9. Palpitations	1	2	3	4	5
10. Shaky hands	1	2	3	4	5
11. Burping	1	2	3	4	5
12. Gassiness	1	2	3	4	5
13. Increased urge to urinate	1	2	3	4	5
14. Sweaty feet/hands	1	2	3	4	5
15. Oily skin	1	2	3	4	5
16. Fatigue/exhausted feeling	1	2	3	4	5
17. Panting	1	2	3	4	5
18. Dry mouth	1	2	3	4	5
19. Hand tremor	1	2	3	4	5
20. Backache	1	2	3	4	5
21. Neck stiffness	1	2	3	4	5
22. Gum chewing	1	2	3	4	5
23. Grinding teeth	1	2	3	4	5
24. Constipation	1	2	3	4	5
25. Tightness in chest or heart	1	2	3	4	5
26. Dizziness	1	2	3	4	5
27. Nausea/vomiting	1	2	3	4	5
28. Menstrual distress	1	2	3	4	5
29. Skin blemishes	1	2	3	4	5
30. Heart pounding	1	2	3	4	5
31. Colitis	1	2	3	4	5
32. Asthma	1	2	3	4	5
33. Indigestion	1	2	3	4	5
34. High blood pressure	1	2	3	4	5
35. Hyperventilation	1	2	3	4	5
36. Arthritis	1	2	3	4	5
37. Skin rash	1	2	3	4	5
38. Bruxism/jaw pain	1	2	3	4	5
39. Allergy	1	2	3	4	5

Interpretation 40–75 Low physiological symptoms of stress response
76–100 Moderate physiological symptoms of stress response

101–150 High physiological symptoms of stress response
Over 150 Excessive physiological symptoms of stress response

Polyvagal Theory

The **polyvagal theory**, proposed in 1994 by Stephen Porges, described that the evolution of the mammalian autonomic nervous system provides the neurophysiological substrates for adaptive behavioral strategies. It further proposed that physiological state limits the range of behavior and psychological experience. According to the theory, there are two main principles:

- Hierarchy: The autonomic nervous system follows a reaction pattern, which is activated in a specific order and includes:
 - a. social engagement system: parasympathetic, feeling safe and open to social engagement
 - b. fight/flight: sympathetic nervous system, mobilized in response to a perceived threat to fight or flee
 - c. freeze: immobilized in response to an extreme threat, shutdown and unable to move
- Neuroception: Neuroception is cognition without awareness. We are constantly subconsciously scanning the environment for danger which allows the sympathetic nervous system to be triggered when necessary.

The theory also describes two important physiological structures in the body: the psoas muscle and the vagus nerve.

Psoas

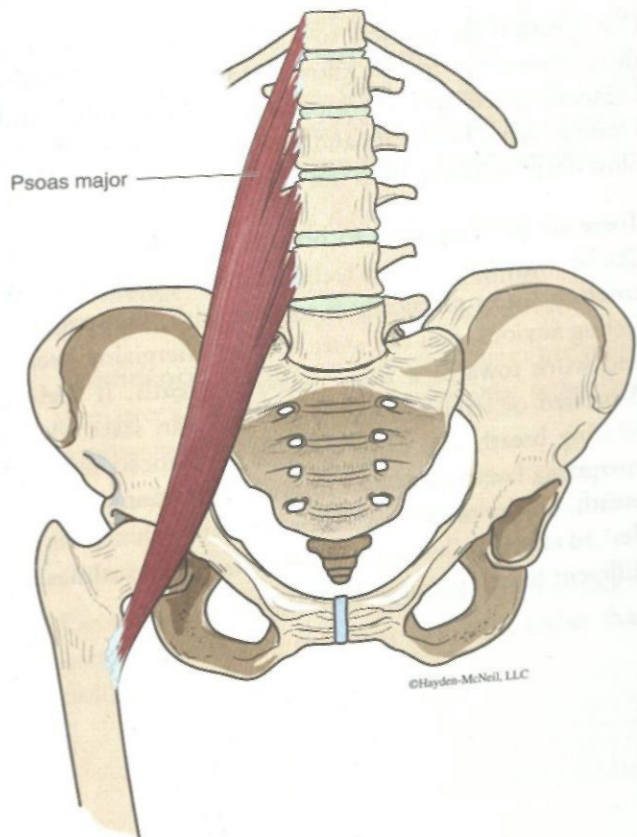
The **psoas** is the only muscle to cross both the lumbar spine and the hip joint, acting as a muscular bridge between the trunk and lower extremities. It attaches at or below the last thoracic vertebrae (T12) and spans to the fifth lumbar vertebrae (L5). There, it crosses through the wing-like bone of the pelvis (ilium), then joins with the iliacus (which is why it is often called the iliopsoas muscle) before attaching to the lesser trochanter, the bony prominence on the femur near the pelvis.

This muscle has three main functions: maintains posture, initiates hip flexion, and has the greatest number of sympathetic nervous system fibers (it is known as the “fight or flight” muscle). Because of its location along the lumbar and sacral nerve plexuses, the psoas is highly innervated.

That means it tends to be very responsive and explains why it is one of the first large skeletal muscles to respond when your nervous system perceives danger.

The psoas plays a vital role in your stress response. When you experience a threat—perceived or real—your body has three main choices: fight, flight, or freeze. In the fight response, the psoas initiates dynamic defensive movements like kicking or punching; in flight, it reflexively activates to help you run. Freezing may cause it to immediately contract so your body can assume a protective fetal position.

Evolutionarily, your psoas helped you bolt from predators, and it remains intricately linked to our fear response. When we are under any kind of mental or emotional stress, our psoas muscle responds by tightening. Even after the stress is gone, the tension may still linger in the body and hip area, contributing to issues such as headaches and lower back pain. The psoas can also become short and tight from excessive time spent sitting. There are several stretches that can be performed in order to lengthen the psoas and reset the stress response in the body. Some stretches include bridge pose, low lunge, quadriceps stretch, and upward facing dog.



Vagus Nerve

The **vagus nerve** (also known as 12th cranial nerve) connects your brain to many important organs throughout the body, including the gut (intestines, stomach), heart, and lungs and is a key part of your parasympathetic “rest and digest” nervous system. It influences your breathing, digestive function and heart rate, all of which can have a huge impact on your mental health. In 2010, researchers discovered a positive feedback loop between high vagal tone, positive emotions, and good physical health. In other words, the more you increase your vagal tone, the more your physical and mental health will improve, and vice versa (Kok et al, 2013). Another study found that meditation reduces sympathetic “fight or flight” activity and increases vagal modulation (Telles et al., 2013). In addition, reflecting on positive social connections improves vagal tone and increases positive emotions as well (Kok et al., 2016).

One of the main ways that you can stimulate the healthy function of the vagus nerve is through deep, slow breathing. The moment we anticipate stress in any form, most of us tend to stop breathing and hold our breath. Breath holding activates the fight/flight/freeze response and tends to increase the sensation of pain, stiffness, anxiety, or fear.

Our breath is the gateway to activating our parasympathetic nervous system. We know that shallow chest breathing tends to activate our sympathetic nervous system and create a higher heart rate and more tension in the body. Slow deep breathing does the opposite.

There are as many ways to breathe as there are people. The basic guidelines when feeling out of balance mentally, emotionally, or physically is to start with the breath. If feeling anxious, you can start with an energizing breath and work towards a more relaxing breath. If feeling depressed or lethargic physically, you can start with a relaxing breath and work towards a balanced or more energizing breath. It is by bringing our awareness to the breath, not by manipulation or force, which creates the desired effect. Following is a basic chart that outlines the different breath patterns and effects.

INHALATION	HOLD	EXHALATION	HOLD	EFFECT
4	1	8	4	Relaxing
4	1	12	1	Relaxing
6	1	10	1	Relaxing
6	1	8	4	Relaxing
8	1	8	1	Balanced
6	2	6	2	Balanced
6	4	6	1	Energizing
6	6	6	1	Energizing

Personality and Stress

In identifying people who are at risk for developing cardiovascular disease, researchers believe that there is a connection between behavior pattern and risk of heart disease. People were classified as being either “Type A” or “Type B” personalities. The **Type A** person is always “on the go,” never satisfied with his or her level of achievement, and appears tense, suffers from a sense of time urgency, and is competitive and impatient. In contrast, the **Type B** person is more easy-going and relaxed, more patient and satisfied with his or her level of achievement. A newer category, the **Type C** person, thrives and stays well during stress. The Type A person was believed to have a higher risk of developing cardiovascular disease. Recent research suggests that only those Type A individuals who have hostile or angry behavior patterns are at risk. Therefore, identifying the sources of anger and hostility in these people and helping them with behavior modification may allow them to cope more effectively with stress.

Type A Behavior

According to the research of Friedman and Rosenman, Type A individuals are more prone to coronary heart disease. The Type A personality possesses the following characteristics: competitive, verbally aggressive, hard-driving, unable to relax, very time conscious, easily angered, and hostile.

Read each of the statements on the following scale and check which behavior best applies to you. This scale, based on the one developed by Friedman and Rosenman, will give you an estimate of your Type A tendencies.

Table 8-2. Assess Yourself

Directions: Answer the following questions by indicating the response that most often applies to you.

YES	NO	STATEMENT
☐	☐	1. I always feel rushed.
☐	☐	2. I find it hard to relax.
☐	☐	3. I attempt to do more and more in less and less time.
☐	☐	4. I often find myself doing more than one thing at a time.
☐	☐	5. When someone takes too long to make their point, I finish their sentence for them.
☐	☐	6. Waiting in line for anything drives me crazy.
☐	☐	7. I am always on time or early.
☐	☐	8. In a conversation, I often clench my fist and pound home important points.
☐	☐	9. I often use explosive outbursts to accentuate key points.
☐	☐	10. I am competitive at everything.
☐	☐	11. I tend to evaluate my success by translating things into numbers.
☐	☐	12. Friends tell me I have more energy than most people.
☐	☐	13. I always move, walk, and eat quickly.
☐	☐	14. I bring work home often.
☐	☐	15. I tend to get bored on vacation.
☐	☐	16. I feel guilty when I am not being "productive."
☐	☐	17. I tend to refocus other people's conversations around things that interest me.
☐	☐	18. I hurry others along in their conversations.
☐	☐	19. It is agonizing to be stuck behind someone driving too slowly.
☐	☐	20. I find it intolerable to let others do something I can do faster.

Scoring: Add up the number of items for which you checked yes. The greater the number of yes items, the more likely it is that you possess a Type A personality.

Type B Behavior

Type B behavior is the absence of Type A. While the person who exhibits Type B behavior may be ambitious and successful, he or she is generally calmer, more patient

and less hurried. Of course, there are gradations within each behavior type. Most of us go back and forth between Type A and Type B as our activities and pressures vary from one day or week to the next. Type A personalities experience a higher continuous stress level than do Type Bs because they are more likely to be stress-seekers and thereby expose themselves to more challenges than do Type Bs. The response to these challenges turns on the sympathetic nervous system and increases secretions of hormones such as norepinephrine, which combine to produce elevated heart rates.

Type C Behavior and Hardiness

Research has also turned attention to those people who tend to thrive and stay well during challenge and difficulty. They are able to interpret challenge and difficulty as positive challenges or opportunities rather than as threats. They tend to be committed rather than detached or alienated. They feel in control of events and their reactions to those events withstand everyday stressors. Salvador Maddi and Suzanne Kobasa of the University of Chicago have identified "a distress resistance pattern." They call it **hardiness**, consisting of three Cs, relating to attitude or perception: challenge, commitment, and control. Type C people tend to engage in regular exercise and are involved in a number of social support groups. Robert Krieger and Marilyn Krieger have also identified a Type C behavior, or what they call a C zone, similar to hardiness, which consists of two of Kobasa and Maddi's three Cs, challenge and control, but replaces commitment with confidence.

The Type C person has the following pattern:

- **Challenge.** The person interprets a difficult task or change as a challenge rather than as a threat.
- **Confidence.** The person believes in his or her ability to master a difficult problem or challenge, rather than approaching it with self-doubt.
- **Commitment.** The person positively engages with his or her job, family, and friends, rather than feeling alienated.
- **Control.** The person believes in his or her ability to control events and reactions to events, rather than feeling helpless.

Stress Management

In this section, we discuss twelve useful ways to limit the negative effects of stress and also a variety of relaxation techniques that are helpful in stress management. The recommendations that follow are not a universal remedy for stress but may give you some insight into dealing with stress and knowing your limits. You must know when your various frustrations, conflicts, and stresses are getting to you and take appropriate action to limit or modify them.

Adjusting to Stress

Here are twelve things you can do to adjust to stress:

1. Try to change how you perceive specific stress-inducing events. For example, the next time you're driving and a person in another car does something foolish, try not to perceive him or her as an enemy who is out to run you off the road but as a friend who has simply made a driving mistake.
2. Try to understand and deal with your anger. Acknowledge your anger to yourself. Learn to differentiate between levels of anger. Try to diagnose the threat that is causing you to be angry—it may be the result of a difference in values or in style and be no real threat to you at all. Finally, try letting go of anger through forgiveness and by canceling the charges against the other person.
3. Take time to relax or meditate. Utilize the relaxation techniques presented in this chapter or find a relaxing activity that you enjoy and allows you to unwind.
4. Utilize your social support system and expand your network by establishing relationships with new people or groups that may be able to give you emotional support. Share worries with someone you can trust.
5. Exercise regularly. Considerable evidence indicates that people who exercise regularly have lower arousal to stress than do people who are less fit. Exercise aids in balancing and stabilizing the physiological consequences of emotional stress, both immediately and in the long term. When you exercise, neurotransmitters in the brain, called **endorphins**, are released and produce feelings of relaxation. Exercise also maintains your body systems in a fit state so that they are able to effectively handle any additional stress.

6. Eat well. Eat regular, well-balanced meals and avoid alcohol and cigarettes. Caffeine and nicotine actually produce a stress-like response by mimicking sympathetic nervous system stimulation.
7. Slow down. Learn to slow your pace of talking, walking, and eating. Take time to "smell the roses."
8. Focus on the positive and be grateful for what you do have.
9. Practice good time management by not taking on too many responsibilities or setting unrealistic deadlines. Give yourself enough time to finish tasks and learn to live with unfinished tasks.
10. Look outside of yourself by volunteering to help those less fortunate than you.
11. Laugh regularly. Laughter produces a physiological response that allows one to enter a state of relaxation and also provides a mental break from daily stressors.
12. When stress becomes too great for you to handle on your own, seek out campus resources and get help. There are counseling services available to you, support groups that you can join, and workshops to help you learn better time management skills.

Relaxation Techniques

There probably are times during the day when you just want to unwind, relax, take time out, and turn off anxiety-producing stimuli. Tension manifests itself in muscle contractions, shallow breathing, a clenched jaw, and a variety of other involuntary responses. With a little practice and patience, you can begin to free yourself of tension with a variety of relaxation techniques such as **diaphragmatic breathing, meditation, progressive relaxation, autogenic training, massage, Hatha Yoga and Tai Chi**. It is important to relieve the tensions in both your body and your brain so that they relax as one. Try the following relaxation techniques to see what works for you.

Diaphragmatic Breathing

Diaphragmatic breathing is a technique that combines relaxation and quieting. Opposed to a shallow breath in the upper chest, diaphragmatic breathing is a deep, three-part breath that gets the diaphragm muscle to move. This technique is often utilized in Lamaze classes, yoga, and Tai Chi, but can be done anywhere and anytime to produce an instant calming effect. Once mastered, diaphragmatic breathing can temporarily lower breathing from a typical

rate of 14 to 18 breaths per minute to nearly 4 breaths per minute. Try this exercise to experience it for yourself:

Assume a comfortable seated or reclining position. Place your hands on your belly and take a deep, cleansing breath through your nose. Feel your hands move as your belly expands with the breath. Exhale. Next, move your hands to your rib cage. Breathe into your belly and feel it expand completely, keep your belly expanded, and fill your ribcage. Exhale. Move your hands to rest on your upper chest. Inhale, drawing your breath deep into the belly, then feel the rib cage expand, then expand the upper chest. Exhale. Let your arms rest by your sides and continue this three-part breath. On each inhale, imagine that your entire torso is expanding with the breath. Fill the belly, then the rib cage, then the upper chest. Hold your breath in for just a moment before exhaling completely and squeezing the breath out fully at the end of the cycle. Continue until you feel more relaxed and refreshed.

Progressive Relaxation and Autogenic Training

Progressive relaxation is a technique that encourages one to learn how to recognize when he or she is bracing, or tensing, muscles. An individual will purposely contract a muscle group to learn how to recognize muscle tension and then relax it to feel the difference, progressing through the body one muscle group at a time. Autogenic training is a relaxation technique that encourages one to imagine the limbs and torso becoming heavy, warm, and tingling. Once muscles are able to relax, one can achieve a more relaxed state of mind. Imagery is a key element incorporated into both of these techniques and can help to establish a body-mind connection in the relaxation process. As a result, people often experience positive physiological and psychological effects, reducing the toll that stress can take on the body and the mind. The following exercise combines these relaxation techniques:

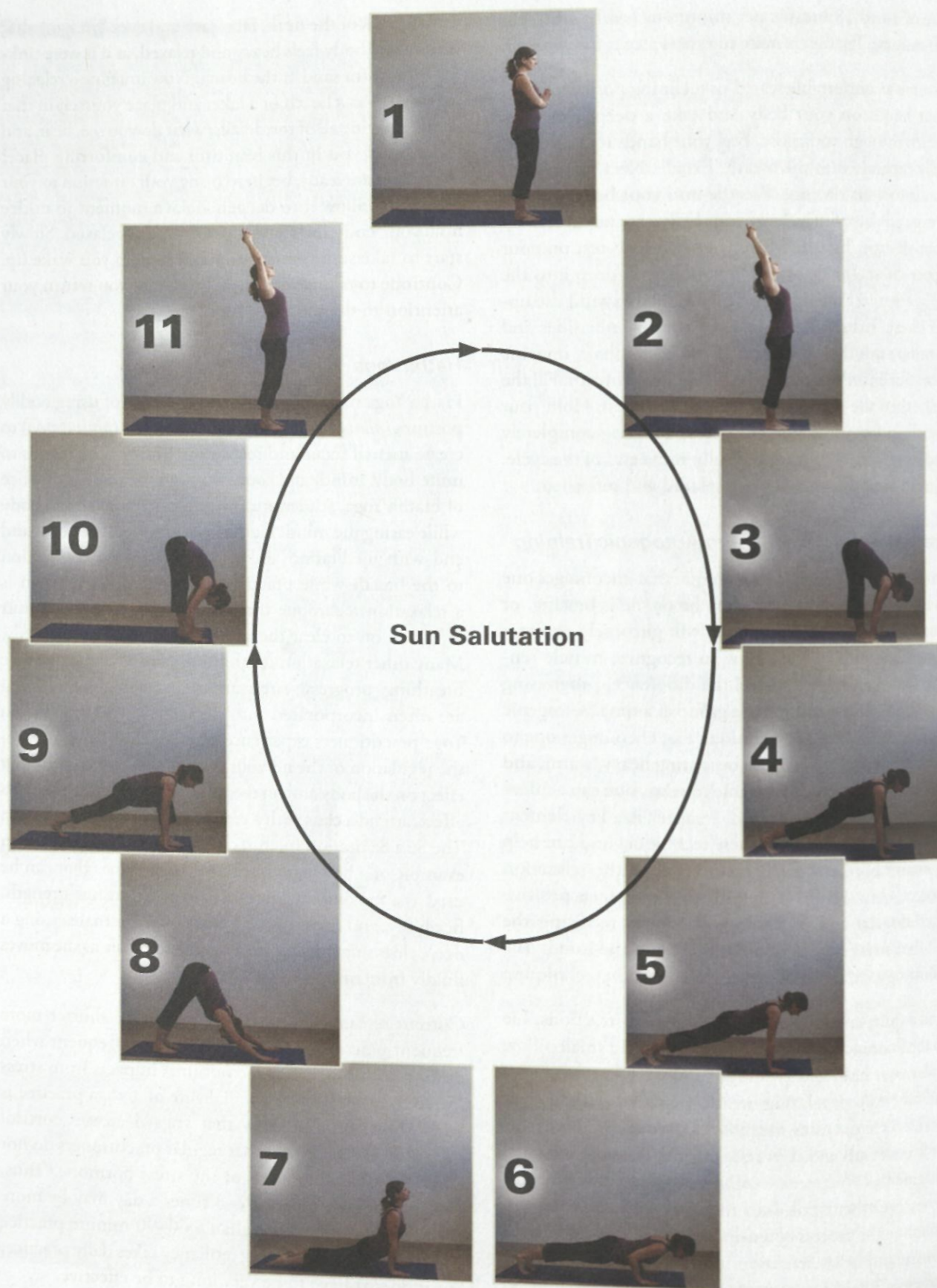
Find a quiet environment that is free of distractions. Lie on the floor in a comfortable position with a small pillow under your head and knees for support. Close your eyes and take a deep, relaxing breath. Begin by curling your toes under and tensing the muscles in your feet. Hold this for five seconds and then release for at least ten seconds. Imagine that your feet are completely relaxed, warm, and heavy. Feel them sink into the floor and relax deeper. Continue the process of tensing, relaxing, and imagining a warm and heavy sensation in each part of your body: lower legs, knees, thighs, buttocks, hips, belly, lower back, middle back, upper back, chest, shoulders, arms, hands,

throat, back of the neck, face, jaw, and eyes. Imagine that your whole body feels heavy and relaxed, as if it were sinking into warm sand at the beach. Now imagine a relaxing scene, such as a beach or a lake, and place yourself in that scene. Imagine all of the details: what do you see, hear, and feel around you in this beautiful and comforting place? When you are ready, begin to bring your attention to your breath and allow it to deepen. Take a moment to notice how your body feels and if your mind is relaxed. Slowly start to take some gentle stretches to help you wake up. Continue to take several deep breaths as you return your attention to the room.

Hatha Yoga

Hatha Yoga refers to the physical practice of using bodily postures (*asanas*) and breathing techniques (*pranayama*) to create mental focus and relaxation. The goal of Yoga is to unite body, mind, and soul. Through the regular practice of Hatha Yoga, students can learn to strengthen the body while easing the mind. Hatha Yoga classes often begin and end with meditation and encourage a deep connection to the breath while practicing the *asanas*. Meditation is a relaxation technique that uses an object to focus your attention on to clear the mind, and thus relax the body. Many other relaxation techniques, such as diaphragmatic breathing, progressive relaxation, and autogenic training are often incorporated into a Hatha Yoga class. Hatha Yoga practitioners experience physiological benefits from the regulation of the nervous system, which has a calming effect on the body and on the mind. To fully experience this effect, attend a class with a certified Hatha Yoga instructor. The Sun Salutation (pictured on the following page) is an example of a flowing sequence of yoga *asanas* that can be used as a moving meditation. This series creates strength, flexibility, and focus as the practitioner alternates using a deep, cleansing inhale with a complete exhale as she moves fluidly from one pose to the next.

Current research findings are pointing to shorter more frequent practices rather than longer less frequent when dealing with physical and emotional impacts from stress (Streeter et. al, 2010). The half-life of a yoga practice is fairly short. Studies show that yoga decreases cortisol right after a practice but that regular practitioners do not have lower baseline levels of the stress hormone. Thus, a twenty minute practice 2–3 times a day may be more effective for some people than a 60–90 minute practice 2–3 times a week. Building resiliency takes daily practice, but it doesn't have to be very long to be effective.



College Students and Stress

A majority of college students deal with stress on a daily basis. Pressure to perform well in school can come from parents, teachers, friends, and even oneself. Many students take on jobs to either support their lifestyle or pay for tuition. Trying to juggle school and work and find time to create meaningful and lasting relationships can place considerable stress on a college student. In addition, during the college years a young college student is faced with numerous and significant tasks such as:

1. Achieving emotional independence from family
2. Choosing and preparing for a career
3. Preparing for emotional commitment and family life
4. Developing an ethical system

Inability to juggle all these tasks can leave a college student feeling overwhelmed and almost in a state of despair. Too much stress depresses the immune system. The common health problems often seen in college health facilities, such as the flu and mono, are most likely stress related. Second to accidents, suicide is the second leading cause of death of college students.

Student Stress Scale

The **Student Stress Scale** represents an adaptation of Holmes and Rahe's Life Event Scale. It has been modified to apply to college-age adults and should be considered a rough indication of stress levels and health consequences.

In the Student Stress Scale, each event, such as beginning or ending school, is given a score that represents the amount of readjustment a person has to make in life as a result of the change. In some studies, people with serious illness have been found to have high scores on similar scales.

To determine your stress score, add the number of points corresponding to the events you have experienced in the past twelve months. Your score indicates your life-change units (LCU). Those with 150–199 LCU have a 37% chance of developing stress-related illnesses within a year. Individuals scoring 200–299 LCU have a 79% chance of developing illness or disease.

EXPERIENCED EVENT	POINTS
1. Death of a close family member	100
2. Death of a close friend	73
3. Divorce between parents	65
4. Jail term	63
5. Major personal injury or illness	63
6. Marriage	58
7. Firing from a job	50
8. Failure of an important course	47
9. Change in health of a family member	45
10. Pregnancy	45
11. Sex problems	44
12. Serious argument with close friend	40
13. Change in financial status	39
14. Change of major	39
15. Trouble with parents	39
16. New girlfriend or boyfriend	37
17. Increase in workload at school	37
18. Outstanding personal achievement	36
19. First quarter/semester in college	36
20. Change in living conditions	31
21. Serious argument with an instructor	30
22. Lower grades than expected	29
23. Change in sleeping habits	29
24. Change in social activities	29
25. Change in eating habits	28
26. Chronic car trouble	26
27. Change in the number of family get-togethers	26
28. Too many missed classes	25
29. Change of college	24
30. Dropping of more than one class	23
31. Minor traffic violations	20
TOTAL	

Warning Signs of Stress

Selye lists stress symptoms that may represent danger signs. If you regularly experience one or more of these symptoms, you may benefit from reducing the stress in your life.

- Anxiety
- Breathlessness
- Crying
- Diarrhea and indigestion
- Dryness of throat and mouth
- Easily startled by small sounds
- Emotional tension
- Fatigue
- Feelings of weakness and dizziness
- Frequent urination
- Heart palpitations
- Impulsive behavior
- Inability to concentrate
- Increased smoking
- Insomnia
- Irritability and depression
- Loss of appetite
- Migraine headaches
- Nervous laughter
- Nervous tics
- Nightmares
- Pain in back
- Premenstrual tension or missed menstrual cycles
- Stuttering or other speech problems
- Sweating
- Trembling hands
- Vomiting

Try keeping a log of the stressors and resulting physical and psychological results you experience. Once you begin to recognize the things in your life that trigger a stress response, you can take measures toward easing that stress. For example, you can practice diaphragmatic breathing or take a yoga class at the first signs of distress. The earlier you intervene, the less likely you are to suffer from negative effects of stress. Find a stress management technique that works for you and know when to ask for help.

Summary Questions

1. What are three physiological responses to stress?
2. What are stages of the stress response according to Selye's General Adaptation Syndrome?
3. How does perception play a role in stress?
4. Which personality type fares better when encountering a stressor?
5. Think of one stressor you have encountered in the past week. Would you classify this stressor as creating eustress or distress and why?

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Useful Websites

<http://www.stress.org>
American Institute of Stress

<http://www.apa.org>
American Psychological Association

<http://www.therapistaid.com/therapy-worksheet/stress-exploration/stress/none>
Therapist Aid

<http://www.yogaalliance.org>
Yoga Alliance

<http://www.yogajournal.com>
Yoga Journal

Worksheets—Stress Exploration (Courtesy: Therapy Aid LLC)

Stress Exploration

Factors that Contribute to Stress

Describe your biggest stressors in each of the following categories and rate them on a scale of 1-10, where 1 is "a little stressful" and 10 is "extremely stressful."

Daily Hassles

Common annoyances or strains of daily life.

Examples: traffic, chores, work problems, lack of sleep, homework, limited free time, argument with partner

	rating
1	
2	
3	
4	

Major Life Changes

Important events, both positive and negative, that require significant adjustment.

Examples: birth of a child, separation or divorce, new job, death of a loved one, moving, major illness / injury

	rating
1	
2	
3	
4	

Life Circumstances

Permanent or long-term circumstances that make life more difficult.

Examples: poverty or financial problems, disability, chronic illness, conflictual relationships, values that conflict with culture, discrimination, job dissatisfaction, living somewhere unsafe

	rating
1	
2	
3	
4	

Stress Exploration

Factors that Protect Against Stress

Describe the things in your life that counteract stress.

Daily Uplifts

Positive experiences that make you happy.

Examples: eating a good meal, spending time with friends, leisure activities, spending time in nature

1

2

3

4

Healthy Coping Strategies

Positive actions that help to reduce or manage stress and other uncomfortable emotions.

Examples: exercise, talking about problems, self-care, journaling, relaxation techniques

1

2

3

4

Protective Factors

Individual characteristics or life circumstances that protect you from stress.

Examples: financial stability, good physical health, supportive family, motivation to succeed, education

1

2

3

4

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